THE IMPACT OF THE EU'S COMMON AGRICULTURAL POLICY ON THE STRUCTURE OF DEMAND FOR SHIPPING TRANSPORT OF GRAIN

SEYED MOHAMMAD REZA MIRMIRAN

A thesis submitted in partial fulfilment of the requirements of London Metropolitan University for the degree of Doctor of Philosophy in International Trade and Transport

Centre for International Transport Management
Department of Business Studies

September 2003

ABSTRACT

Regional economic integration has become a major issue in international trade. Existing literature has failed to evaluate or quantify the implication of policy measures adopted by regional economic blocs on shipping transport services. This thesis quantifies the distorting effects of the European Union's Agricultural Policy (CAP) on the grain trade via the impact on shipping transport.

Three different sets of econometric models were developed and estimated for each bulk carriers market sub-sector (Capesize, Panamax, Handysize), which incorporate protection subsidy component of the CAP. The results revealed that the CAP has a significant depressing effects on international grain prices and its pattern of trade, hence has consequences for the structural changes of demand for shipping transport of grain.

This work also undertakes counterfactual analysis to investigate the impact of possible liberalisation of CAP on the structure of demand for shipping transport of grain. The econometric version of the theoretical model is used to simulate a number of alternative policy scenarios in the Uruguay Round (WTO) of negotiation (EU and USA proposals). The simulation model suggests that the USA proposal will increase the North Atlantic grain trade and consequently the demand for "Capesize" will increase. However the EU proposal would not create a significant change to the existing situation.

This original study contributes to the literature in a number of ways, In terms of economic modelling, a non-related shipping element (agricultural subsidy) is incorporated to the model as an endogenous variable. In the theoretical aspect the relationship between supply and demand in shipping market is highlighted. In econometric techniques, different methods are used for the first time to differentiate the specific nature of each sub-market in the grain trade for different bulk carrier sub-sectors. This research has highlighted the importance of non-shipping related policy measures for the grain shipping sector, especially when it is implemented by an important economic blocs.

Table of Contents — Page

List of Tables

List of Figures

ACKNOWLEDGEMENTS

The author can not take sole credit for completion of this work. Therefore there is a need to acknowledge the assistance which has been provided to me by several people at various stages of this study. However it is not possible to name everybody.

This study is indebted to my supervisors Professors James McConville and Dr. David Glen, not only for their academic input but also for their moral support through what has been a very challenging and demanding experience. My special thanks also go to Dr. Robert Greenhill, Head of Department of Business Studies for his kind guidance and help. This work received invaluable collaboration and comments from Dr. Sallyanne Decker who I am obliged to appreciate. Furthermore the author would like to thank the members of staff of the Department of Business Studies for their help, and the Iranian People who sponsored my study through the Ministry of Culture and Higher Education.

I owe the completion of this thesis to following and would like to express my deepest gratitude and appreciation to all of them, my parents, my brother, my sister and my in-laws without who's love and support this dissertation would not have been possible.

I am eternally grateful to my wife who has had to live with me, cope with my moods and complaints and yet continue to be understanding, loving and caring.

Finally and most importantly, I am thankful to God for our lives.

LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller Unit Root Test
AIC	Akaike Information Criterion
ARCH	Autoregressive Conditional Heteroscedasticity
ARIMA	Autoregressive Integrated Moving Average
BP	Bunker Price
CAP	Common Agricultural Policy
CGF	Capesize Grain Freight Rate
CST	Coal Seaborne Trade
CV	Cointegrating Vector
EBF	Existing Bulk Fleet
ECT	Error Correction Term
ECM	Error Correction Model
EGC	EU Grain Production
EGP	EU Grain Consumption
ESC	EU Soybean Consumption
ESP	EU Soybean Production
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
GFI	Grain Freight Index
GIR	Generalised Impulse Response
GTC	Grain Transported Capesize (Volume)
GTH	Grain Transported by Handysize
GTP	Grain Transported by Panamax
HFC	Handy Fleet Capacity
HGF	Handysize Grain Freight Rate
I(b)	Integrated Variable
K	Fleet Size or Stock of Fleet
LL	Log Likelihood
LR	Likelihood Ratio Test
MCAs	Monitory Compensatory Amounts
NGT	North Atlantic Grain Trade
NST	North Atlantic Soybean Trade
OC	Operation Cost
OIR	Orthognalised Impulse Response
OLS	Ordinary Least Squares
PFC	Panamax Fleet Capacity
PGF	Panamax Grain Freight Rate
PSE	Producers Subsidy Equivalent

PP	Philips and Perron Unit Root Test
Qs	Supply of Shipping Services
Qd	Demand of Shipping Services
RGS	Rest of the World Grain and Soybean Trade
SACF	Sample Autocorrelation Function
SPACF	Sample Partial Autocorrelation Function
SBIC	Schwarz Bayesian Information Criterion
SP	Speed
SURE	Seemingly Unrelated Regressions Estimation
TCE	Time-Charter Equivalent of Spot Rates
TGT	Total World Grain Trade
VAR	Vector Autoregressive Model
VECM	Vector Error Correction Model
WHITE	White Test for Heteroscedasticity
WGP	World Grain Prices

LIST OF SYMBOLS

σ^2	Variance
$\sigma_t^{\ 2}$	Time-varying Variance
In	(n x n) Identity matrix
IN(0, σ^2)	Independently and normally distributed with zero mean and constant variance
$\chi^2(n)$	Chi-square distribution with n degree of freedom
$t(o,\sigma_t^{\ 2},v)$	Student –t distribution with zero mean, time-varying variance and v degrees of freedom
Σ	Variance-covariance matrix
Σ_t	Time-varying variance-covariance matrix
Δ	First difference operator
Δ^n	n period difference operator
$\sum_{i=0}^{n} x_i$	Summation operator over variable x from 0 to n
$\prod_{i=1}^{n} x_i$	Multiplication operator over variable x from 1 to n
L	Log

DECLARATION

I grant powers of discretion to the London Guildhall University Librarian to allow this thesis to be copied in whole or in part without further reference to me. This permission covers only single copies made for study purposes, subject to normal conditions of acknowledgement.

CHAPTER ONE: INTRODUCTION, SCOPE AND JUSTIFICATION FOR THE STUDY

1.1 Issues

The classical model of maritime economics suggests that the demand for shipping services is a derived demand. McConville (1999:35) defines derived demand as "arising as a direct result of the demand for commodities which are required to be hauled by sea. Shipping is, therefore demanded not for itself, but because it is part of the production process of other goods".

Considering the above statement it is important to investigate the impact of policy measures in other sectors of economy on the shipping industry. Such studies have not been carried out in the shipping literature so far. The focus of this study is on the impact of the Common Agricultural Policy (CAP) on the structure of demand for shipping transport of grain.

Grain is an important agricultural product. This is because there is a close relationship between grain prices and the prices of other agricultural products. Grain competes with other agricultural products for land. Thus grain prices determine the allocation of land to these products, and, therefore, their prices. Grain is important for producing pork, poultry, eggs, beef and milk. The revenue from these products and from grain accounts for about 66% of the EU's total agricultural revenue. Hence, the market organisation for grains was one of the first to be set-up within the EU and many other regimes are formed or dependent on the grain regime (Gawei & Addy Suhut, 1997:15).

Furthermore, since grain is an important contributor to seaborne trade. Changes in its demand significantly affect the structure of demand for shipping transport services. Grain mostly uses sea transport to serve its foreign trade. About 90% of grain traded is moved by sea and this volume makes this commodity very important for shipping business (Drewry, 1996:61).

Among the five major dry bulk commodity trades, grain trade is ranked third, with almost 200 million tons per year (Fearnley, 1996:14), shipping transport of grain forms about 5% of the total world seaborne trade volume (including petroleum). It corresponds to 25% of the five major dry bulk commodities (UNCTAD, 1996:21).

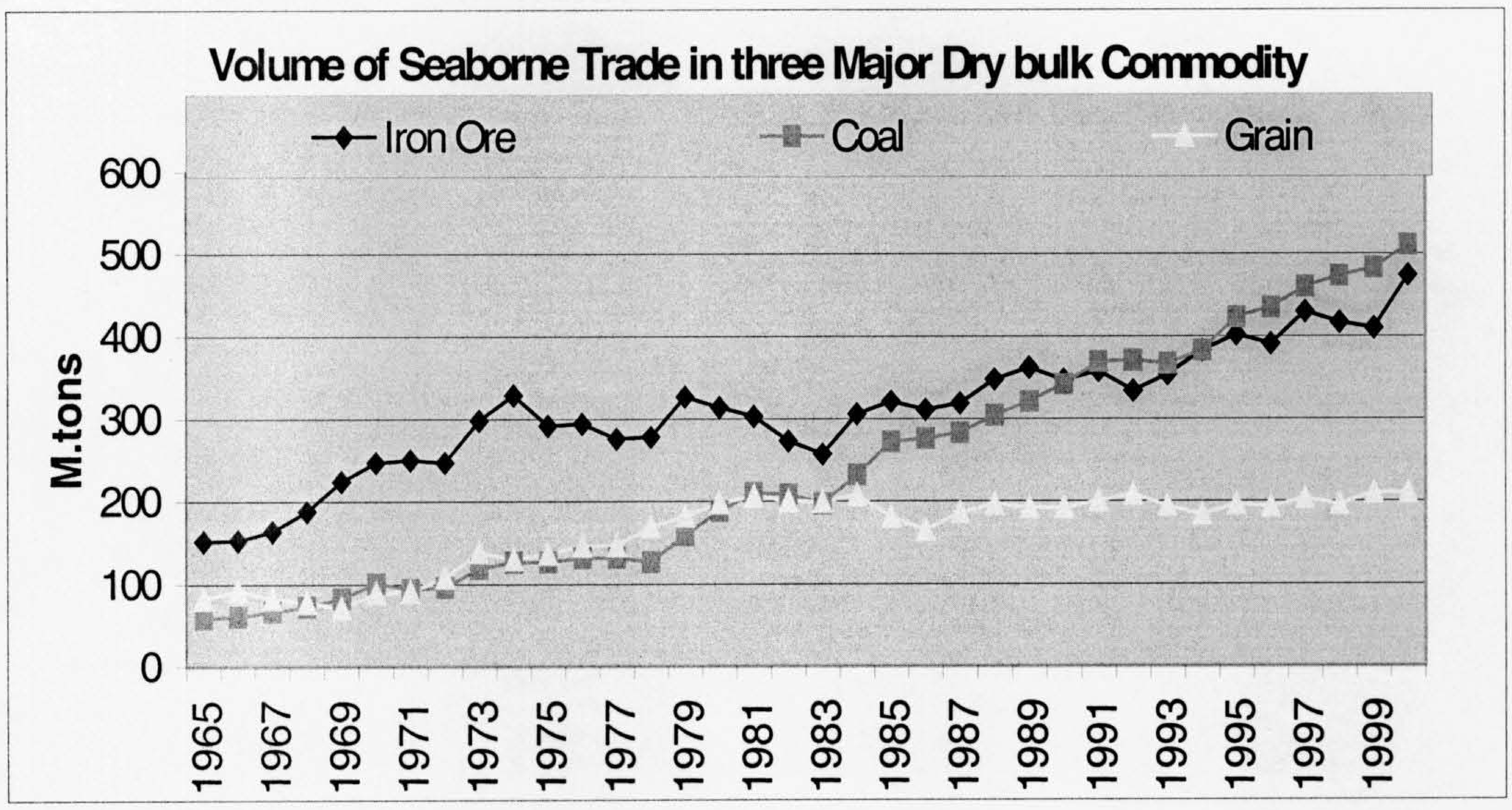
Thus ocean transport of grain can be clearly seen as a factor affecting shipping market conditions.

Figures 1.1 illustrates trends in the volume of seaborne trade in the three major dry bulk commodities- iron ore, coal and grain between 1965 and 2000. While one could observe an increasing trend in dry bulk commodity trades such as iron ore and coal, on the contrary, the volume of seaborne grain trade remains almost unchanged since 1980. According to statistics compiled by Fearnleys, the volume of grain carried by merchant vessels during 1965 was 70 million tons. This increased at an annual rate of about 6.8% until 1981, when it reached 206 million tons. There was a decrease to 200 million tons in 1982, and it remained at almost a constant level after that.

Figure 1.2 shows that the pattern of ton-mile demand generated by these commodities is similar to that of volume of trade in these products. While there is an observed increase in the ton-mile demand for coal and iron ore, that of grain remain relatively constant. Figure 1.3 shows that over the period 1965-2000, the proportion of grain in the sea borne trade for these three commodities has decreased from 23% to 18%. Similarly, Figure 1.4 shows that the proportion of ton-mile demand for grain has decreased significantly from 39% in 1965 to 20% in 2000.

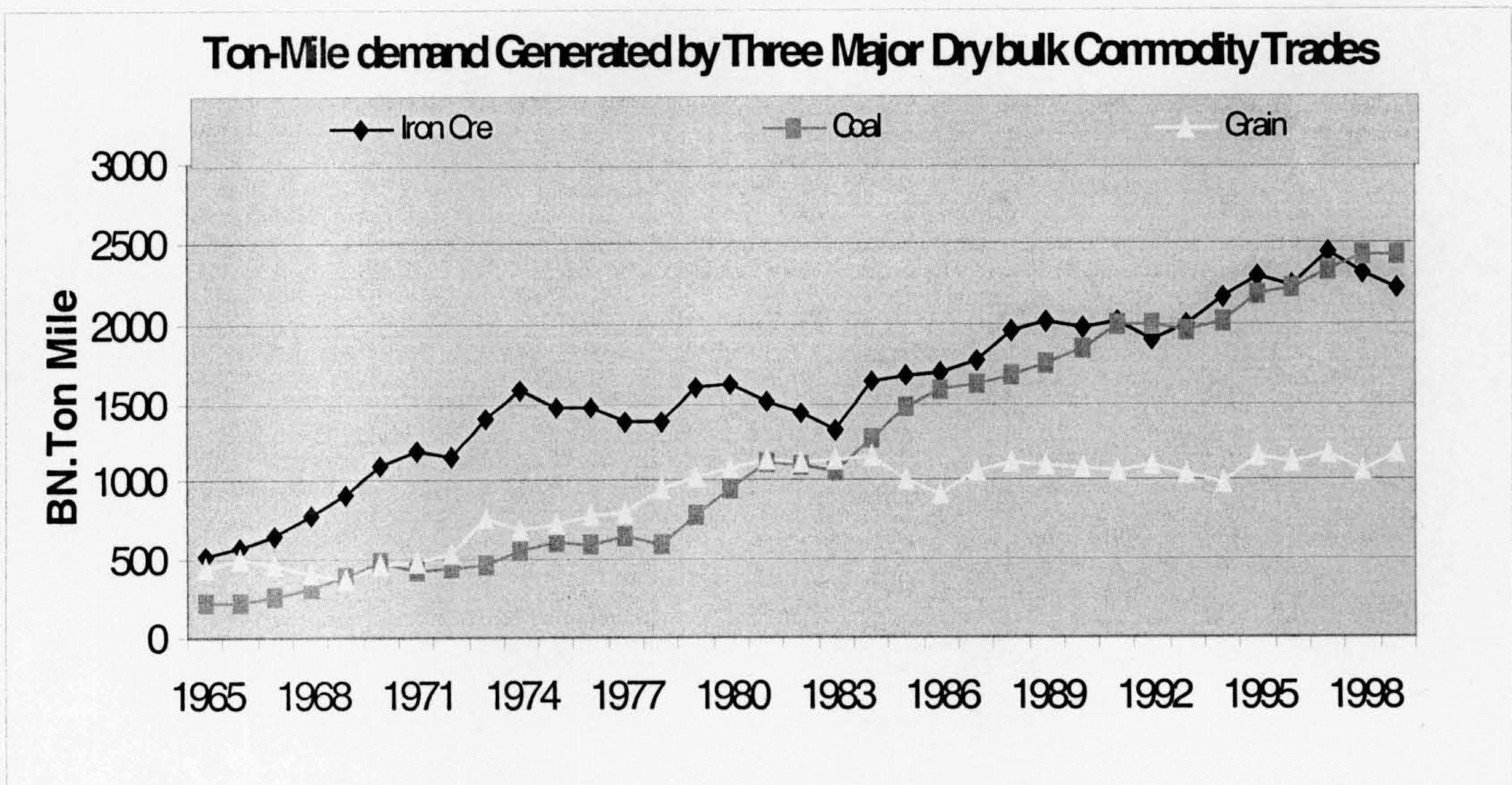
These trends clearly illustrate that the share of grain in the international trade for major dry bulk commodities has reduced. This suggests grain is losing its importance as a major source of demand for shipping transport. It was pointed out that the demand for shipping is a derived demand and thus depends on activities in other sectors or markets in the economy. A major factor which influences activities within any sector or market is the implementation of policy measures. Activities in the international grain market have been significantly affected by the CAP which is a policy measure implemented by the EU.

Figure 1.1: Volume of Seaborne Trade in Three Major Dry Bulk Commodities



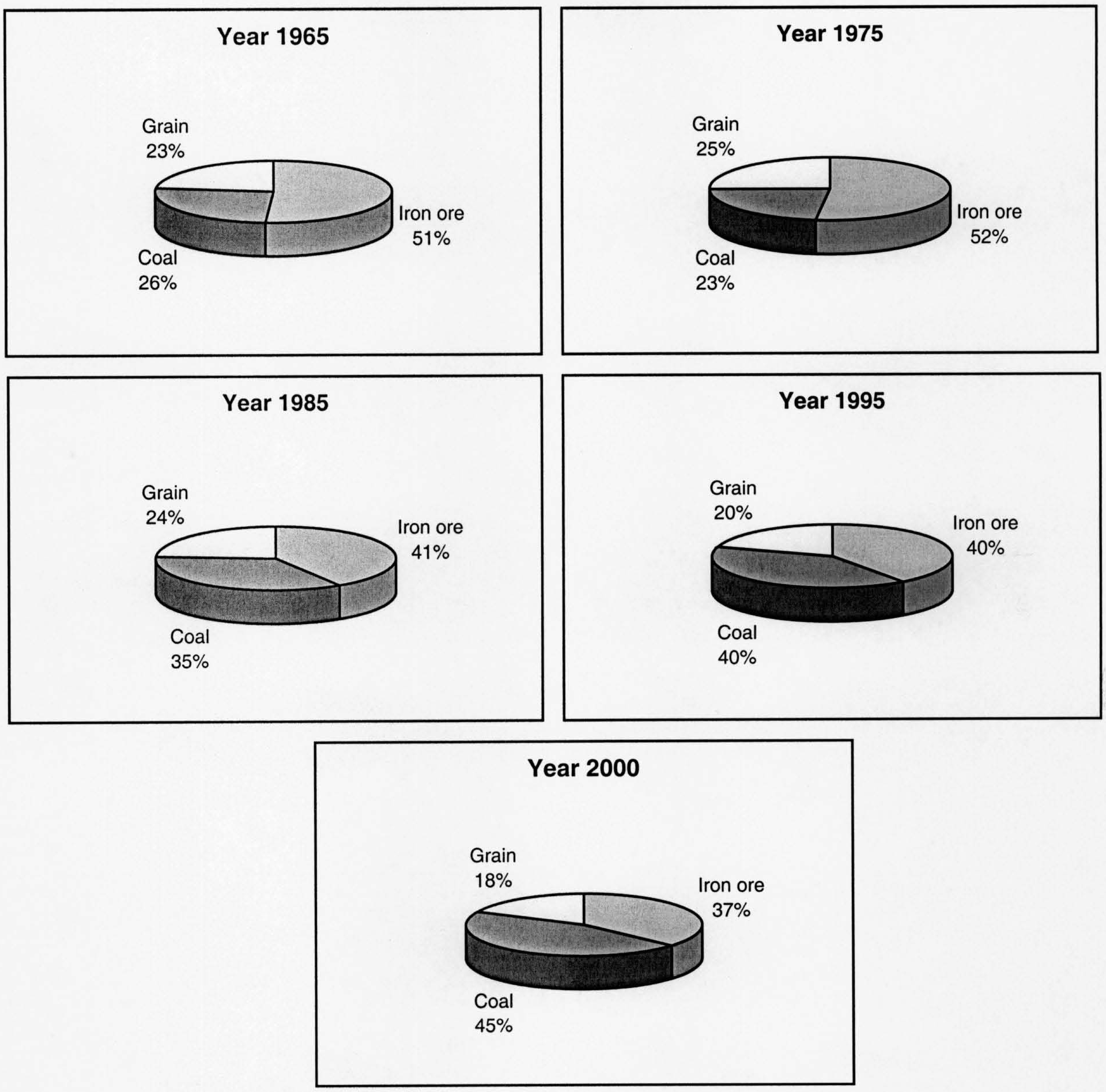
Source: Fearnley (2000).

Figure 1.2: Ton-Mile Demand Generated by Three Major Dry Bulk Commodity Trades



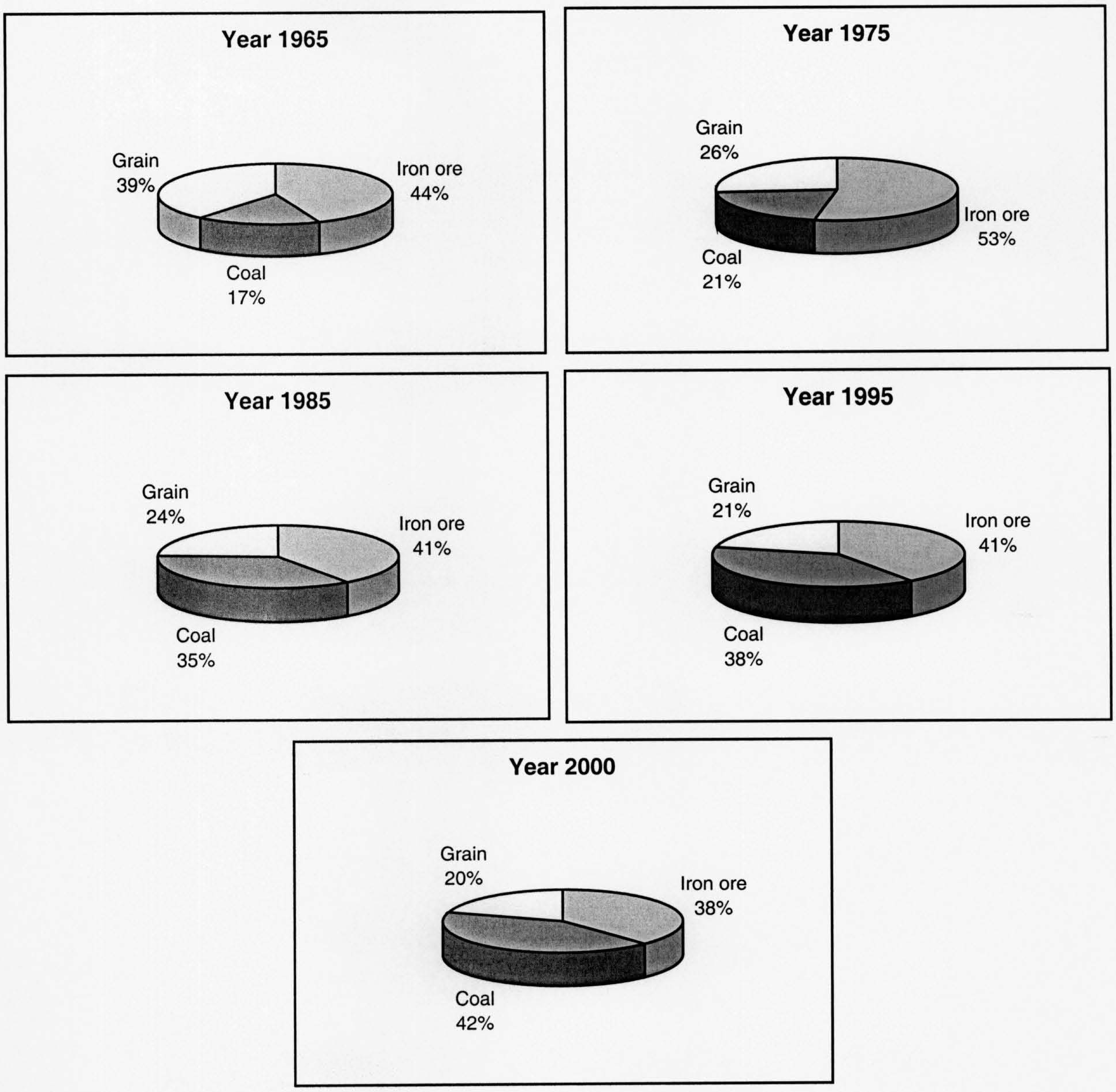
Source: Fearnley (2000).

Figure 1.3: The Major Dry Bulk Cargo Share (Volume)



Source: Fearnley (2000).

Figure 1.4: The Major Dry Bulk Cargo Share (Ton-Mile)



Source: Fearnley (2000).

Policy measures implemented collectively by a group of countries to achieve economic integration, such as the EU, tend to be more influential in international trade than those implemented by individual countries. Regional economic integration is concerned with the discriminatory removal of all trade barriers between participating nations and with the establishment of certain elements of co-operation and co-ordination between them.[1]

The EU is a unique entity, comprising a group of nation states, but also including a supranational organisation with the power to make (and enforce) its own policies. The EU is founded on a set of treaties between its 15 member states, providing a framework for co-operation between national governments and also establishing an economic organisation with a legal identity in its own right. This combination of international co-operation and supranational policy-making is distinctive, and thus difficult to categorise in terms of formal models of regional economic integration. The importance of the EU as a generator of demand for shipping transport is discussed in more detail in Section 1.4.

One of the most important EU policies is the Common Agricultural Policy (CAP). This policy provides a high level of subsidies to farmers to increase production of agricultural products such as grain. This is the most protectionist policy in the EU. On average it has absorbed two thirds of the EU's budget since mid-1980s (Gawei & Addy Suhut, 1996:16). The main objective of the CAP is food security. Cereals as a major food raw material received the highest level of protection under the CAP regime, to satisfy the security of food supply. Classical trade theories argue that protectionism has a strong effect on international trade.

Since the grain trade is mainly seaborne and is also one of the major dry bulk commodity trades, policies and developments in the grain trade affect the aggregated demand for shipping. The shipping industry has a complex structure. It is highly disaggregated by sector (tanker, dry bulk), and differentiated by size into different sub-markets. This complexity is intensified when one needs to analyse the role of each different shipsize in a specific commodity market. "Therefore it is better for analytical purposes that the industry be regarded as a group of related industries with distinct sectors" as suggested by the Rochdale Report (1970). There is a need for disaggregated studies in shipping literature which combine shipsize form and commodities.

---

[1] The co-ordination between the member states depends on the form that integration takes, such as *Sectional Integration, Free Trade Area, Costumes Union, Common Markets, Complete Economic Union or Complete Political Integration*. See Appendix 1 for further detail.

Since grain is a low value commodity, transport cost forms a large proportion of its landed price. Transport cost generally has not received proper attention in new classical models of international trade and few conceptual and empirical studies have realised its importance for internationally traded commodities. The shipping literatures considers the demand for shipping to be totally inelastic and is treated exogenously. Thus the possible effect of freight rate on pattern and volume of international commodity trade has not been investigated strongly. Therefore there is a need for a consideration of this issue in a study of international trade and shipping.

The issues outlined above which this thesis investigates are the role of policy measures in other sectors, specifically the CAP, in influencing developments in the shipping industry; the relationship between the implementation of the CAP and observed trends in the international grain trade in terms of volume; and the importance of regional economic integration for shipping transport via its impact on international trade.

1.2 Research Aims - Theoretical Approach and Methodology

This thesis aims to investigate the impact of the Common Agricultural Policy (CAP) on the structure of demand for shipping transport of grain. This has implications for the importance of trade agreements involving regional economic integration and their policy measures for international commodity trades and shipping transport services.

The thesis addresses a lacuna in the literature in that for the first time it seeks to estimate quantitatively the impact of the CAP on the structure of demand for shipping transport of grain. This thesis focuses on the nexus between agricultural policies and international trade and transport. Increasingly, the process of globalisation is influencing trade and agricultural policies and this is being reflected in the policy making process of organisations such as the WTO and the EU. This thesis also highlights the importance of transport cost for transport of grain as a low value commodity.

The main hypothesis is that the formation and development of the EU together with implementation of the CAP have contributed to the structural changes in demand and production of international grain trade. These structural changes in grain trade altered the pattern of demand for different shipsizes. This arises because of port and routes restrictions for particular shipsize. This hypothesis is principally similar to the Glen (1990) differentiation hypothesis for tanker market. The thesis focuses on the possible impact of the CAP on the structure of demand in the markets for different size bulk carriers ships (Capesize, Panamax, Handysize).

The thesis adopts various analytical tools to achieve the aims and objectives of the study. These include statistical data analysis, conceptual analysis, economic modelling, econometric estimation and simulation analysis. The main hypothesis is developed as a result of the literature review, a conceptual analysis of the CAP and the analysis of shipsize performance in the grain trade. Following the main hypothesis, there are other sub-hypothesis which specify the movement of shipping factors (e.g. bunker price) in grain freight market and how different shipsizes have been affected by the reduction of the EU grain imports and increase of the EU grain exports.

The hypothetical framework is examined quantitatively by developing three different sets of models (each market sub-sector has been modelled separately). The empirical research uses recently developed econometric methods and techniques to model and test the hypothesis. These methods test for the stochastic behaviour of the series and examine the dynamic interrelationships between different variables of the models for different size vessels. This is because the hypothesis indicates a dynamic interrelationship.

Furthermore, simulation analyses are conducted, using the models developed for the study, to quantify the impact of the possible liberalisation of CAP on the structure of demand for shipping transport of grain. The rationale for the simulations is to be found in the WTO negotiations regarding the liberalisation of the CAP. In the Uruguay Round, the EU and the USA had two different proposals for the partial liberalisation of agricultural support on the world grain market. These two proposals are used in this thesis to evaluate the effects of possible changes of the CAP policy measures on structure of demand for ocean grain shipping services.

Annual Data for the period 1970 to 1998 is used in the estimations. There are three reasons for this choice. These are data constraints, the CAP implementation date of 1967 and thirdly the recognisable time for differentiation in bulk carriers market could be referred to the early 1970s, when Capesize appeared in the market for first time.

Most of the shipping data has been collected from different issues of world bulk trades published by 'Fearnleys' and Clarksons. Agricultural data was obtained from the US Department of Agriculture and International Grain Council (IGC). Moreover, disaggregated data has not been easy to collect and collate. As a result of this difficulty, this study constructs a freight rate data set by using time charter rates within the estimation period.[2]

There are many different definitions for grain from different sources. Therefore, grain itself needs to be defined specifically for this work to highlight the accurate impact of the CAP on the structure of demand for shipping transport. Only agricultural products which receive protection under the CAP will be included in this definition.

In the shipping literature, grain is regarded as dry bulk cargo. Without any convention in shipping literature, grain refers to wheat, maize, rye, barley, oats, sorghum, and soybean.[3] Rice is excluded as it is transported in packaging. In the statistics of the UN Food and Agricultural Organisation (FAO, undated), kaoliang is excluded from the grain definition. The statistic by the US department of agriculture and international grain council includes neither soybean nor rice. Soybean is not include in the CAP cereal regimes as the amount and the type of protection which it receives is different with the other cereals (Gawei & Addy Suhut, 1996:18). Therefore, soybean is not included in the grain definition adopted by this work. The definition of grain considered by this study includes wheat, maize, rye, barley, oats, and sorghum.

---

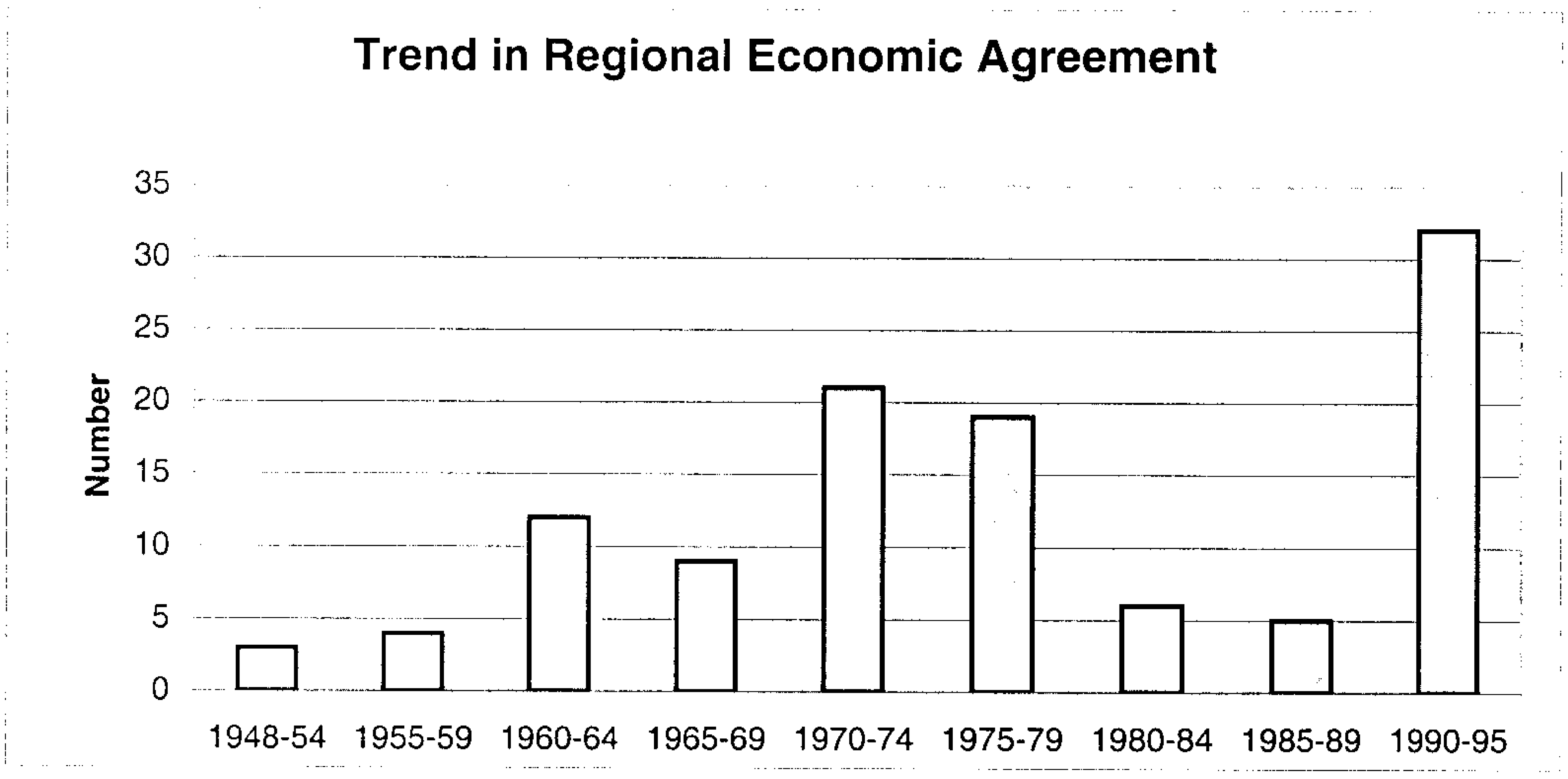
2 This data set is constructed in two stages: firstly, time charter rate for "Capesize", collected from Drewry Shipping Consultant. By using a model based on some assumptions, the data set transformed to spot equivalent (freight rate $/ton). However, since this data set (time charter rate) goes back to 1980, the second stage was introduced to calculated the "Capesize" freight rate back to 1970 (ten years). Therefore, in the regression model, the Capesize spot rate equivalent (produced in the first stage by using the model based on time charter rate), together with the "Panamax" freight rates, were used to produce the "Capesize" freight rate back to 1970.

3 Fearnley (1996), UNCTAD (1996), Drewry (1996), and many other shipping data producers.

1.3 The European Union as a Generator of Demand for Shipping Transport

According to the WTO (GATT) 1996 report, the world is moving towards more regionalism. Figure 1.5 illustrates the trend of the regional agreements from 1948 to 1996. As the figure indicates, the numbers of agreements have surged in the beginning of the 1990s.[4] However these integrations are different in nature. Different stages of integration could create different effects on international commodity trades. As countries move towards full integration and become a political union, their effects on international trade could be considered as one big country.

Figure 1.5: Trend in Regional Economic Agreement



Wijnolst and Wergeland (1997)

In economic regional integration the general situation is that the agreements have some initial, but not lasting effects and the regions are participating less in total international trade (Wijnolst & Wergeland, 1997:49).[5]

Wijnolst and Wergeland (1997) report that only the EU shows unambiguously increased regional trading and at the same time increased importance in

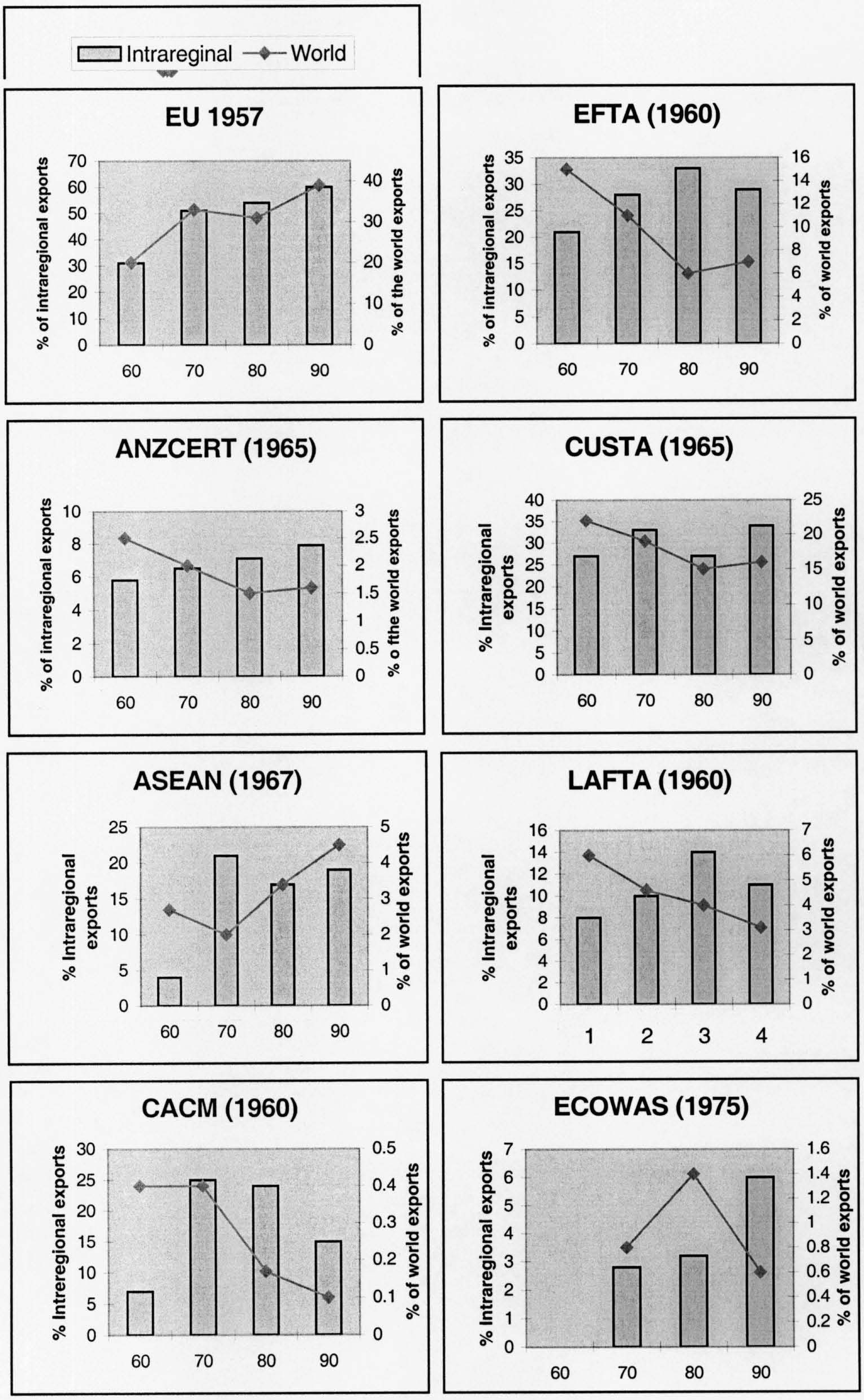
---

4 This is mainly a reflection of the many agreements being signed among the former Eastern European and one between these countries and Western European countries (as many as 20 of 32 agreements is between on Eastern European country and one Western European partner, 4 agreement are between Eastern European countries and remaining 8 are all other types, including the NAFTA and the EU) (Wijnolst & Wergeland, 1997:49).

5 Based on Haaland & Wooton (1993) and Fielke (1992).

international trade. Furthermore, compared to other modeles of economic regional integration, the EU shows extensive progress towards complete political integration. Thus of the eight modeles of economic (regional) integration identified the EU could be the most influential in world commodity trade (Wijnolst & Wergeland, 1997:48).

Figure 1.6: Experience of Some Main Regional Economic Agreements



Source: Demelo & Panagrarya (1992).

By 1968, all tariff barriers to trade had been abolished between the original six European community member states, although many non-tariff barriers were to persist. The available evidence suggests that the removal of intra-community tariffs gave rise to trade creation amounting to a substantial proportion of the community's trade with non-member countries, and that the trade diversion effect was appreciably smaller (Barrass and Madhavan, 1997:23). Therefore the general hypothesis in the shipping literature which argues that "regional economic integration normally leads to relatively less demand for shipping transport services, because of diversion of longer hauls to shorter due to more intra-regional trade" at least could not be valid in the EU case (Wijnolst & Wergeland, 1997:47). This indicates that there is a need for a new theory regarding the impact of the regional economic integration on demand for shipping transport services that incorporate the nature and structure of specific regional economic integration.[6] The impact of such integration on the shipping industry has not been scholarly investigated.

In addition to the removal of barriers within the EU, in the case of agriculture, EU policies serve to protect the EU internal market from international markets. The effects of such protection are amplified if the protectionism policy is implemented by an economic union such as the EU which is effectively involve in international trade.[7]

It could now be argued that the European Union is the most important economic and political integration of the contemporary world. The European movement towards a complete economic union, has led to a deepening and also broadening of the effects of EU policy on international commodity trades. Within the Economic Union, any necessary economic action could only be taken at union level, because national measures would be ineffective. Furthermore, after the disintegration of the former Soviet Union, the political environment changed in favour of European union. Presently, the considerable political role of the EU is recognised by other countries and USA, which means the EU can play an increased role in GATT (WTO) and consequently in international trade.

The classical theory of international trade states that establishment of a customs union results in the removal of trade barriers between the member states. The importance of the customs union for international commodity trades depends on

---

6 This will be dealt with in Chapter Four Section 4.6.1.

7 The Economic Union could be considered as one very big country.

how it creates, diverts or deflects international commodity trades. Trade creation means that a certain quantity of output that is initially produced domestically in a member state is now to be imported from another Member State. The original value of this product is qp_1, where the p_1 is the price in importing member country. The new value of this product in importing country is qp_2 where p_2 is the price in exporting member country. Trade creation means that $qp_1 > qp_2$ i.e. $p_1 > p_2$. Trade diversion occurs when cheaper initial imports from third country are replaced by expensive export from a member state. Trade deflection means that member states that initially imported a commodity directly from an outsider, now import it indirectly via the member states with lower tariff rate, provide the price differential exceed the necessary transport charges (Agraa & Jones, 1981:21).

The importance of the CAP within the EU framework needs to be recognised since its effectiveness as a protectionism policy rests in the unique framework of the EU as well as its measures. Other developed countries, like the United States and Japan, also afford protection to their domestic farmers. Thus the CAP is not unique, but merely the most important protectionist policy that underpins the structure of international grain trades primarily because of changes it has brought to the EU and world grain market.[8]

Since the creation of European integration, a remarkable expansion of trade between member states has taken place. This is largely due to the strengthening of the links within the preferential trading circuits. The effect of the relative diversion from outside sources is particularly marked in agricultural products including grain (Saunders, 1975:19). The specific measures of the CAP also create deflection of investment from other sectors of the economy within the EU.[9] High support prices under the CAP are the major cause of to rising farm output and increasing degrees of self-sufficiency.[10] Self-sufficiency has increased for both individual countries and the EU as a whole. The EU reached this level in virtually all grain products.

According to the statistics provided in Chapter Three, the EU is now one of the world's biggest exporters of wheat and barley. This was achieved because there was no cheaper way of releasing surplus food. This growth in agricultural exports effectively implies a bigger share for the EU in world grain trade.[11] For analysing

8 Many studies which are reviewed in Chapter Two (literature review) have documented this.
9 Different measures of the CAP are explained in Chapter Four.
10 This will be discussed in Chapter Two.
11 See Chapter Three for the different statistics.

the CAP effects on international grain trade, apart from its protectionism nature, there are other specifications related to the EU itself which have to be highlighted. The CAP as well as its protectionism nature carries general characteristics of EU, 'preferential' treatment to member states as discussed previously in this.

It was mentioned earlier that the general shipping hypothesis concerning the impact of regional economic integration on the demand for shipping transport services needs to be revised for the EU case. The above discussion provides a foundation for the argument that there is a need for a new hypothesis regarding the impact of economic integration and its policy measures on shipping transport services that incorporates the nature and structure of the specific regional economic integration.

1.4 Structure of Thesis

Chapter Two presents a comprehensive review of previous studies which model and analyse the shipping market, the international grain trade, including the role of the CAP in this trade, as well as studies which focus on ocean grain freight services. The objective of reviewing this combination of literature is to present a general overview of past research, which touches upon areas of the relevant aspects of this thesis, and supports the research theme in this thesis.

Chapter Three discusses the economics of grain trade and the role of the EU in this trade. This chapter provides statistical evidence together with a historical interpretation of the date for the grain trade. This chapter also gives an insight into how the different shipping sectors and shipsizes (such as Capesize, Panamax, and Handysize) can contribute to the grain trade. This is achieved through an analysis of ship handling characteristics, port constraints and vessel size performance in the major dry bulk commodity trades.

Chapter Four provides conceptual analyses of the CAP and the main hypothesis of the thesis together with the sub-hypotheses. The main hypothesis suggests that, structural change in demand and production of the international grain trade has altered the pattern and volume of demand for different shipsizes due to port and routes constraints for particular shipsizes. Following the main hypothesis, there are other sub-hypotheses which specify the movement of shipping factors in the grain freight market and explain how different shipsizes have been affected by the reduction of the EU grain imports and increase of the EU grain export.

Chapter Five presents and discusses the econometrics of the estimation methods and tests which are used in Chapters Six and Seven to quantify the models of the study. The main concern of this chapter is to explain the multivariate dynamic modelling techniques known as Simultaneous models and Vector Autoregression (VAR).

Chapters Six and Seven present and discuss the functional form and results of the models developed to test the general hypothesis, together with results of different statistical tests which were employed to prepare the data for the models and the simulation results. Chapter Six deals with the "Capesize" model. Structural modelling based on the maintained hypothesis was possible in this case. A simultaneous equation framework (2SLS) is utilised to estimate the impact of the CAP upon employment opportunities for "Capesize" bulk carriers in the grain trade. Chapter Seven focuses on models for the "Handysize" and "Panamax" sectors. Since the specific relationships between variables in these models cannot be based (either formally or informally) on a fully specified economic theory, Vector Autoregressive models (VARs) are utilised to estimate the impact of the CAP on these segments. This allows the models to capture the dynamic relationship existing within the model, and the lag structure and dynamic adjustment process, as important aspects of the model's specification and testing.

Finally Chapter Eight offers a brief summary and conclusions to the thesis.

1.5 Conclusion

Grain, as an important source of demand for shipping transport services, generates about 20% of total demand generated by three major dry bulk commodities in 1995. However, its volume of trade and ton mile has been unchanged since early 1980s. Consequently its share among other major dry bulk commodities, whose seaborne trade shows an increasing trend, has been reduced.

Grain also is a primary agricultural product, whose price affects other agricultural products' prices. Furthermore, final grain price as a low value commodity is extensively influenced by changes in freight rates.

Since the aim of this study is to investigate the impact of the CAP on the structure of demand for shipping transport services through grain seaborne trade, the definition of grain for this study should be used to highlight this impact. Thus in contrast to definition of grain in the shipping literature, soybean is excluded from the definition of grain used by this study, because soybean does not receive similar (high) protection level under the CAP as cereals such as wheat and barley do.

The CAP as an agricultural protectionism policy, implemented by the EU (which is efficiently involved in international trade) is an important element for international agricultural commodity trade and consequently for shipping transport. This chapter revealed that the general hypothesis in the shipping literature, that argues that economic (regional) integration normally leads to relatively less demand for shipping transport services because of diversion of longer hauls to shorter due to more intra-regional trade, is not valid in the EU case.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

The aim of this chapter is to review the literature, which is useful in analysing the impact of the CAP on the structure of demand for shipping transport of grain. There is no single theory or model that deals specifically with this subject. In the light of this, it is necessary to draw insights from theoretical and empirical works which have attempted to model the demand for and supply of sea transport, the literature on the grain trade and the role of the CAP in international grain trade, the market for ocean grain freight and how bulk carriers perform in this market. The structure of this chapter is as follows:

Section 2.1 surveys previous studies regarding supply and demand in freight and ship markets. The role of this section is to provide an understanding of shipping variables and their relationship, and how they may be affected by exogenous factors (e.g. the CAP). Therefore, this section mainly focuses on models and theories rather than methodologies and results of previous studies.

A specific aim of Section 2.2 is to review previous studies regarding international grain trade. Government intervention has been and continues to be a highly influential factor in grain trade.[12] This section is designed to provide an understanding of the effects of government intervention on the level and volatility of grain prices, the volume and pattern of international agricultural trade and the important influential role of the CAP in this trade. Thus the main concern of this section is theories and results rather than models and methodology.

Section 2.3 looks at studies which have dealt with ocean grain freight services and the interdependence of ocean grain freight with the actual grain market. This section looks at models and theories as well as methodologies and results of previous works.

2.1 Shipping and Ship Market Models

The objective of Section 2.1 as outlined at the beginning of this chapter is to review the economic and econometric models of shipping and shipbuilding industry. The

---

12 Knudsen & Nash (1990) noted that "agricultural policy in developed and developing nations is a tangle of contradiction. Through out the world, governments have one foot on the accelerator and one foot on the brake, simultaneously encouraging and discouraging increased farm production".

structure of demand for shipping services is complex, including a wide range of commodity trades. The complexity dictates a development in the ship building industry to construct of specialised ships which can be employed for certain types of commodities and/or routes.

This led the shipping industry into an area in which the shipping market gradually started to become disaggregated by sector (tanker and dry cargo) and differentiated by size in to different sub-market as Glen (1992) outlined for the tanker sector. Specific ship types and sizes are involved in a wide range of commodity trades.[13] There are similarities among the different ship size and shipping sector, therefore, there is some degree of substitutability between them. This implies similar economic functioning in different shipping sectors and various sizes, and consequently the existence of substitutability and spill over effects.

On the other hand the extent to which these ship categories are not substitutes may suggest that they react differently to external influences such as the CAP. Due to these similarities among the shipping sectors some theories could be extended from the tanker sector to the dry bulk and vice-versa. However, there is always a need for some modification due to the extent of differences in economic behaviour.

Moreover, since grain is one of the main seaborne commodities, any changes in volume and/or pattern of this trade may effect shipping services as whole.[14] On the other hand, grain only accounts for a portion of total dry bulk trade. Consequently the supply function of shipping capacity for grain is subject to changes as events happen in other dry bulk commodity markets.

This section deals with three categories of works which are introduced in both shipping sectors (tanker and dry bulk). The main concern of the review of shipping literature in this section is models and theories without considering the different shipping sectors. This is because as outlined previously the theories and models which have been used in one sector could be implemented in the other sector subject to modification and adjustment. The three different categories are as follows:

- Basic shipping models which define demand and supply in shipping in terms of influential variables such as: aggregated shipping tonnage, fuel price,

---

13 For instance, a "Panamax" bulk carriers may carry coal on one voyage and grain on the next voyage.

14 Grain is categorised as a major dry bulk commodity in shipping literature.

freight rate, aggregated shipping demand and fleet performance. These are the factors which influence aggregated shipping supply. Reviewing studies which attempts to model an aggregated shipping market provides an understanding of general factors influencing the shipping market, including sea transport of grain and how these factor may be affected by changes in grain seaborne trade.

- Disaggregated and interrelation models which analyse the shipping market in terms of individual shipping routes and commodities. In those models the behaviour of the ship-owner is assumed to be determined by his expectation of the market. These models outline the influential factors for specific sectors of the shipping market and the close relationship between shipping freight market and ships market. These factors are crucial to understand before modelling any sector of the shipping market.

- Time varying volatility models in shipping, which use a set of observations on the values that shipping variables take at various points in time and volatility of the freight rate in different shipping sub-market. This section very briefly provides the essential knowledge which is needed to understand how characteristics in various shipping sub-markets are different.

2.1.1 Basic Shipping Models

Models reviewed in this section have similar structures, based on the assumption of market equilibrium and that the ship-operator is a profit maximiser. It means that supply is proportional to the size of the fleet and is positively related to freight rates and negatively relative to fuel prices and operating costs. On the demand side, the popular assumption is that demand is treated exogenously and assumed to be totally inelastic to freight rates.

Tinbergen (1931) developed the basic model used in shipping economics. Tinbergen studied the dynamic relationship between shipbuilding and the shipping industry, by means of a series of mathematical equations. He utilised a model which has formed the basis of subsequent studies in shipping economics.

Tinbergen suggested that at time (t) the level of tonnage (L) be negatively related to freight rate (Fr). It means expansion of the fleet size has negative impact on freight rate and visa versa. This would be expressed as:

$$Fr_t = f(\overset{-}{L_t}) \qquad (2.1.1)$$

Secondly, he assumed that fleet tonnage at time (K_t) is equal to the new orders (O_{t-k}) minus losses and scraps.

$$K_t = f(\overset{+}{O_{t-k}}) \qquad (2.1.2)$$

where k is the time for an order to be delivered.

In the third instance he suggests that ordering new ships is positively related to the freight rates.

$$O_t = f(\overset{+}{F_{rt}}) \qquad (2.1.3)$$

Tinbergen and Koopman (1934) investigate the sensitivity of the freight rate to the determinants of the supply (Q_S) and demand (Q_D). They assumed the fleet tonnage (K), fuel price (P_b), and freight rate (F_r) as the major determinants of shipping supply.

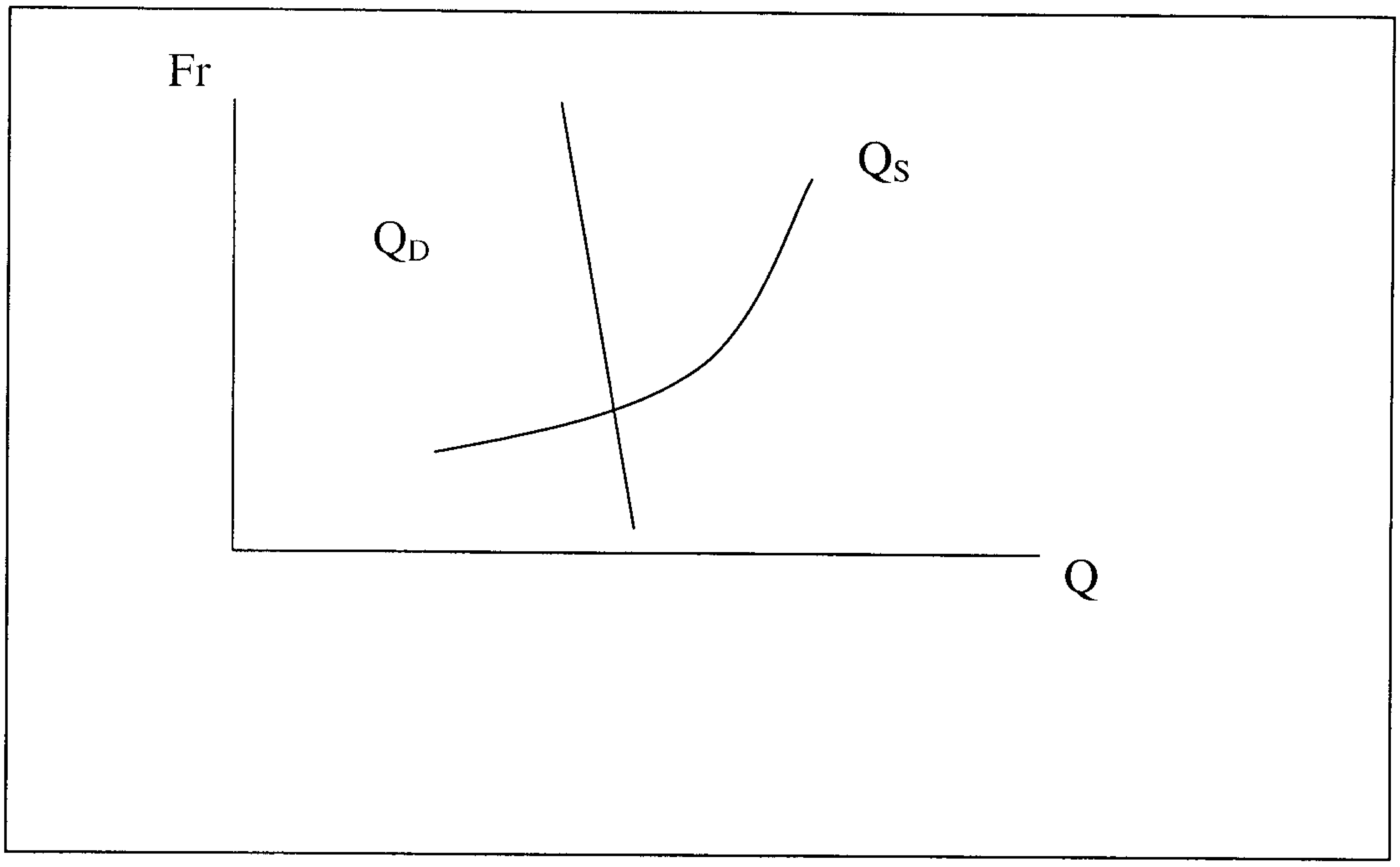
Demand for shipping has been considered totally inelastic with respect to freight rates. Other factors such as operating costs are also specified to influence freight rates, but they consider this factor as a constant factor. Operating costs are assumed to be more or less constant through the cycle in relation to other variables.

$$Q_S = f(\overset{+}{K}, \overset{-}{P_b}, \overset{+}{F_r}) \qquad (2.1.4)$$

$$Q_D = \text{totally inelastic} \qquad (2.1.5)$$

They suggest that there is a positive relation between supply and freight rates. Supply (expressing in ton miles) also shift with change in fleet size. On the other hand there is a negative relation between bunker price and shipping supply.

Figure 2.1: Supply and Demand Curves According to the Model



The equilibrium freight rates will be achieved when supply becomes equal to demand.

$$Q = S \qquad (2.1.6)$$

They solve the above equation as follows:

$$Fr = f(\overset{+}{Q}, \overset{-}{K}, \overset{+}{P_b}) = Q^a, K^b, P_b^g \qquad (2.1.7)$$

In order to obtain the significance and elasticity of the variables in the model, they estimated equation (2.1.7) in the following log-linear form.

$$Fr = aQ + bK + gP \qquad (2.1.8)$$

Finally, the paper drew conclusions about the important influence of such variables on determination of freight rates, by using an annual data set from 1870 to 1913.

The basic shipping models could be criticised on the grounds that the high level of aggregation makes it difficult to draw a specific conclusion from the results[15]. Further more such models are not able to capture the interactions of the freight markets among themselves as well as the interaction of freight markets and ships market. This problem was subsequently addressed by Hawdon, who introduced his disaggregated shipping model in 1978.

2.1.2 Market Disaggregation and Inter-relation

The difference between disaggregation and inter-relation models and the previous type of models (basic shipping models) are not theoretical . These differences are mainly due to the level of aggregation and the factors and variables chosen by the different authors (e.g. time at port). These factors are of minor importance because they are less volatile over time. Thus, in one extreme their impact could be considered as constant. In addition the modeles recognise the dynamic relationship between the freight market and shipbuilding market, and also the relationship between spot and time charter rate in the shipping market.

The market expectation hypothesis also plays an important role in such models. This hypothesis states that individual economic agents use current available and relevant information in forming their expectations and do not rely purely upon past experiences (Shaw, 1984:47). Expectation theories in shipping have been used to model the relationship between spot and period markets as well as the dynamic relationship between shipping and ships markets.

In the majority of studies that use expectation theory in modelling the shipping activities, the econometric specifications are not always consistent with rational behaviour (Beenstock & Vergottis, 1993b:43). As a result of these the definition of market expectation tends to be arbitrary. Market expectation as outlined by Beenstock and Vergottis (1993b) is very important in shipping markets, because economic life of ships depends on market condition.[16] Therefore, decision making regarding scrapping a ship, ordering a ship or contribution in a second-hand market is influenced by long and short-term expectation of the shipping market. Furthermore, adoptive expectations are generally assumed to be generated by extrapolation of past developments in market factors which would be used to predict the future condition in market. As outlined by Beenstock and Vergottis (1993b) this creates a Paradox in which the model's own predictions will in general

15 For instance, freight rates for specific routes, and commodity and specific ship size.
16 Sometimes extended over 20 years.

not agree with those generated by the extrapolated forecasting mechanism embedded in the models.

Relationship Between Shipping and Shipbuilding Markets

The various models reviewed in this section indicate that considerable differences exist in markets for the second hand, scrapping and shipbuilding structures. Therefore, the dynamic relationship between these markets as well as markets for freight rate is a controversial issue. Furthermore, the levels of disaggregation are varied between the models, which makes a specific conclusion difficult.

Early studies of this kind in the shipping industry were put forward by Koopman (1939). Koopman considered the role of future market expectation of the ship-owners in the determination of the ship prices. He suggested that the expected prices of ship building materials and labour force wages may be the determinants of ship prices.

Beenstock and Vergottis (1989b:49, following Howdon, 1978) bring the interdependency of shipping and ships markets to the fore, in a wider sense. They argue that freight and ships market are so related and interdependent that "a proper understanding of the dynamics of the one can not achieved without an analysis of the other".

Hawdon (1978) in a pioneering study, utilised the first integrated shipping model for tanker freight rates, which assumed that tanker freight rates are a function of world oil trade. This model determined freight rates in the tanker market in the short and long-run. In the short-run, freight rates are determined by contraction of supply and demand in the freight market, and fleet capacity is fixed. In long-run, the fleet capacity changes with market conditions and ships market is considered explicitly. The modification involved uses the proportion of active fleet and the variables in the supply side of the shipping market such as capital and labour costs, the economies of scale and bunker prices. In addition, the dry bulk freight rates are entered into the model as a variable. The idea behind that was that during the estimation period the tanker fleet was engaged in dry bulk market, in the time of the weak tanker freight.

The model has been examined by estimating and rejecting the non-significant variables involved in both tanker and dry cargo freight rates. Furthermore, independent variables in the dry bulk freight rates equation included dry bulk fleet tonnage, dry bulk commodity trade, fuel price tanker freight rates and dummy variables.

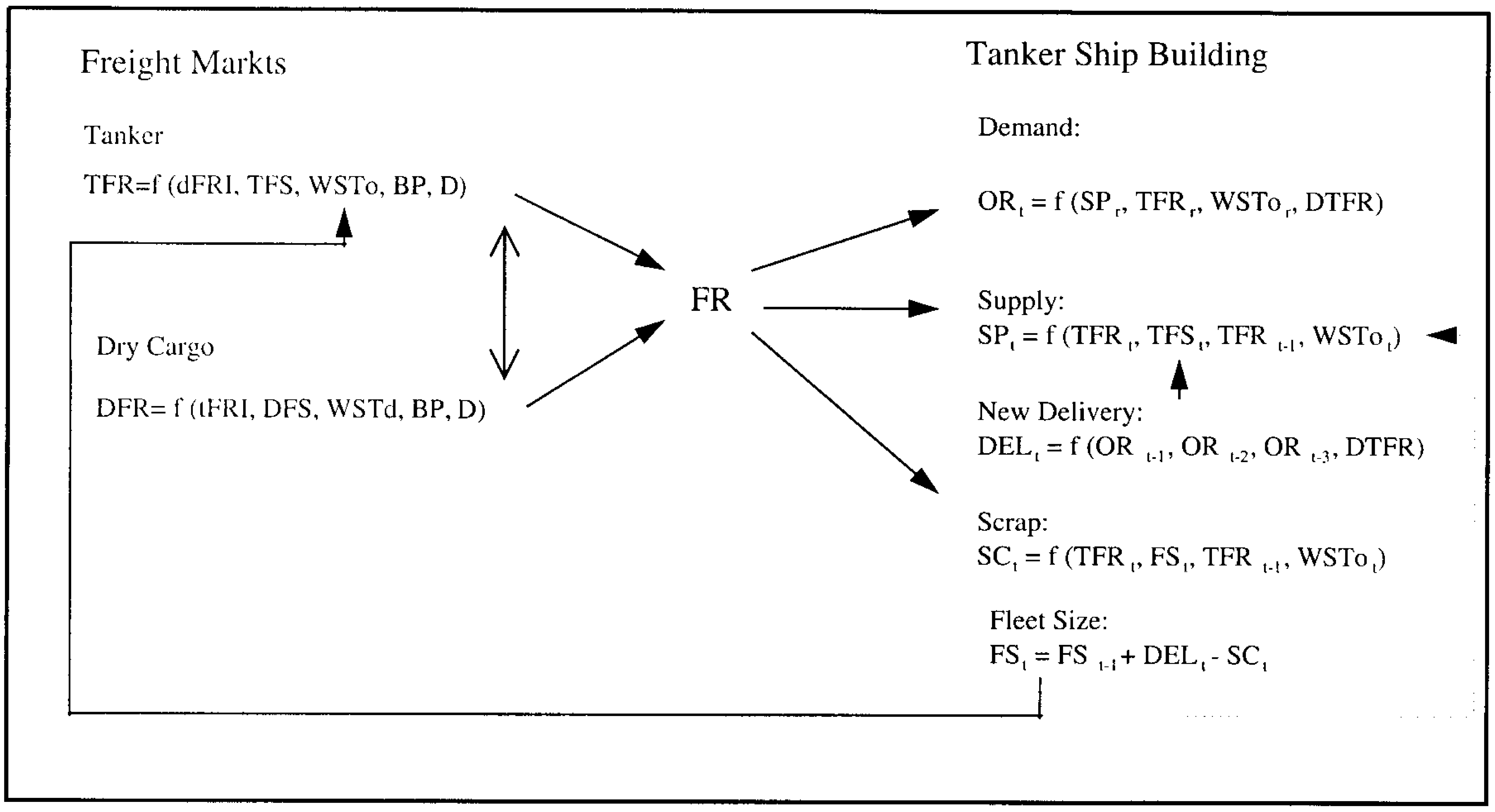
where:

TFR	*Tanker Freight Rates*
DFR	*Dry Cargo Freight Rates*
DFRI	*Dry Cargo Freight Rates Index*
TFRI	*Tanker Freight Rates Index*
TFS	*World Tanker Fleet Size*
DFS	*World Dry Bulk Fleet Size*
WSTo	*World Seaborne Trade in Liquid Commodities*
WSTd	*World seaborne Trade in Dry Bulk Commodities*
BP	*Bunker Prices*
D	*Dummy Variables*
OR	*Order for New-building*
SP	*Ship Price*
DEL	*New Deliveries*
SC	*Scrap Tonnage*
FS	*Fleet Size*

To specify the relationship between the tanker and dry bulk carriers market there was a need to model the economics of shipbuilding industry. This has been done through a five-equation system, namely new building order, ship price, delivery, scrap and level of fleet tonnage. Each of these variables is explained by a series of other explanatory variables. The conceptual model of the work is provided below (Figure 2.2).

Variables included in the model have been chosen through a testing procedure, whereby each variable's parameter is specified and excluded if a low level of significance is observed. The system of non-linear regressions with different growth rate for variables is simulated until the system settles into an equilibrium position. This method allowed for different types of shocks to be experienced (i.e. transitory or permanent) within the system to monitor reflection of different variables with time lag. Three scenarios were put forward. First, in the seventh year, a permanent 10% shock has been applied to the exogenous variables i.e. price of steel, fuel prices, oil trade, and average size of fleet. It suggested that the 10% shock to the system will have maximum effect on the freight rates in the first year and then it dies out, in fact, it will have negative effect on freight rates in the long- run.

Figure 2.2: Conceptual Model of Economics of the Shipbuilding Industry



Source : Hawdon (1978) (Reorganisation of the model)

It has been found that a 10% increase in the bunker price creates a constant effect on freight rates over time. A shock in trade flows within the model will cause the scrapping rate to decrease in the short-run but in the long-run it will be increased gradually.

In the second scenario, the impact of reopening of the Suez Canal on freight rates has been examined. This impact is found to be permanent and more significant on tanker rates rather than dry bulk rates. This is an unexpected result since many large tankers do the round cape trip and dry bulkers are frequent users of the canal.

The third scenario was designed to test the role of the higher freight rates and consequently decisions for new orders on the stable freight markets. The result shows that there is no strong supporting evidence that the freight rates have an impact on new orders in long-run.

Charmeza & Gronicki (1981) introduced a "Shipping & Ship Building Model". This is a remarkable example of a disaggregate and interrelated model in which the authors recognised the existence of two sectors of shipping industry (dry bulk and tanker) as well as two blocks of shipping market and ship market. This article used the dynamic version of supply/demand equations, considers that the demand and supply for shipping services are in disequilibrium and adjust themselves in long-run by a fraction of their corresponding differences each period.

The important characteristic of this model is that the classical assumption of market clearing freight rates determination through equilibrium in a static form is relaxed.

$$D_t - D_{t-1} = \alpha \ (D^* - D_{t-1}), \qquad \alpha \geq 0 \qquad (2.1.9)$$

where D_t is the current demand, D_{t-1} , D^* are last period demand and long run demand for shipping services respectively. A similar equation is defined for the supply of shipping services and changes in the freight rates are assumed to be related to the difference between shipping supply and demand in the following form.

$$D_t - S_t = f(\Delta Fr) \qquad (2.1.10)$$

Beenstock (1985) introduced a " econometric model of ship prices". He assumed the ship as an asset which produces wealth for the owner not only by earning freight but also by changes in its value.

According to the paper, the combination of capital assets speculation and rational expectations assumption in the shipping market direct the ship-operators into the future and they act accordingly. However, it has been suggested that such behaviour could be different for anticipated and unanticipated shocks to the market.

The paper introduced a conventional approach of supply and demand in spot (tramp) freight rate determination equation. The author also utilised a model for the market for ships using the fleet size and its changes through new deliveries and scrap rate. The demand for shipping is positively related to world trade, and negatively related to freight rates. The supply for shipping services can be described as a function of freight rate, bunker price and the size of the fleet.

On the other hand, he modelled the market for ships using the fleet size and its changes through new building deliveries and scrap rate. "Return on capital investment" has played the central role in Beenstock's model. He explained the relation between the demand for ships and return on this investment by rational expectation theory, as follows:

$$ER = \frac{\left[a\left(F - C_1\right) - \left(1 - a\right)C_2\right]}{P} + \frac{EP_{+1} - P}{P} \qquad (2.1.11)$$

where:

ER is the expected return on the investment.
C_1 is the cost of ship operations.
C_2 represents the opportunity cost in lay up.
EP_{+1} is the expected future value of the ship.
F and P represent freight rate and ship prices for the current period respectively.

The expected return on ship investment for specific period of time, *ER*, is explained by the discounted revenues from ship operations $(F\text{-}C_1)$ minus the opportunity costs when the vessel is laid up (C_2).

The proportion of the wealth of the investor invested on a ship is directly related to the return on ship investment and negatively related to the return on other business activities.

The shock to the system will shift the supply and demand schedules in new building and scrap markets to bring back the fleet volume to equilibrium with a new ship price.

In the model the freight rate and ship's price are closely related. Colinearity problems are prevented by the individual determination of both variables. Ship's price and freight rate have been determined by two methods. Firstly, changes in ship's price and freight rates are considered to be *Zero* $(\Delta F=0,\ \Delta P=0)$. This condition is a stationary state. Secondly, price and freight rates could evolve over time from one equilibrium state to another, which express the dynamic situation.

In the first assumption, ship's price and freight rates are considered stationary. The following equations determine the freight rates, ship's price, and fleet size respectively.

$$F = \lambda_1 WT + \lambda_2 P_s + \lambda_3 P_e - \lambda_4 W + \lambda_5 R^* + \lambda_6 C_2 \qquad (2.1.12)$$

$$P = \lambda_7 WT + \lambda_8 P_s + \lambda_9 P_e + \lambda_{10} W + \lambda_{11} R^* - \lambda_{12} C_2 \qquad (2.1.13)$$

$$K = \lambda_{13} WT - \lambda_{14} P_s + \lambda_{15} P_e + \lambda_{16} W + \lambda_{17} R^* - \lambda_{18} C_2 \qquad (2.1.14)$$

Beenstock suggests that, the ship-owners beliefs about future markets (ship and shipping market) are the main elements to influence his future behaviour. Based on rational expectation theory, ship operators use all current information in order to predict the future with a minimum error. The aim of this prediction is profit maximisation and risk minimisation. Based on this assumption, the behaviour of the ship prices over time is captured by adding a subscript of time (t) to the equations previously defined for freight rate (F), ship's price (P) and fleet size (K). The simplification made by the author omits some of the other variables, except ship prices, world trade and fleet size. He assumed that the only important variable to influence ship's prices is world trade. Thus the following equations have been defined:

$$- a_1F_t + a_2WT = K_t + a_3 F_t \qquad (2.1.15)$$

$$K_t = \gamma_1 F_t + \gamma_5 [\underset{t}{E}(P_{t-1}) - P_t] - (\gamma_4 - \gamma_5) P_t \qquad (2.1.16)$$

$$\Delta K_t = \delta_1 P_t - \delta_2 K_{t-1} \qquad (2.1.17)$$

The first equation is derived by equating shipping supply and demand, while the second and third equations are the simplified forms of the equations for demand for ships and fleet size.

Finally based on rational expectation theory and manipulating the variables in the above equation the author derives the following general equation for ship's price.

$$P_t = r_1 P_{t-1} + \theta_4 WT_t + \theta_4(\delta_2 - 1)WT_{t-1} -$$
$$[\frac{\theta_4 \gamma_5}{r_5} \sum_{i=0}^{\infty} r_2^{-i} [E_t(WT_{t+i+1}) + (\delta_2 - 1)E_t(WT_{t+1}) + (\delta_2 - 1)E_t(WT_{t+i}) + (\delta_2 - 1)E_{t-1}(WT_{t+i-1})$$

(2.1.18)

It could be understood from the above equation that if the world trade seems to remain at a constant level, the ship's prices depend only on the current level of world trade. It also could be noticed that the rational expectation theory is valid in ship markets.Current ship's price depends on the price of ship in last period, world trade in the last period and a weighted average of expected future of world trade.

Two scenarios could be introduced in ship's price simulation model by applying the rational expectation theory. This is with contrast with the Hawdon (1978) simulation model. The shocks to the system in Beenstock (1985) model could be considered as anticipated and unanticipated. Unlike the Hawdon model the simulation model of Beenstock illustrates the difference between the behaviour of the prices when the shocks are expected and when there is no possibility to expect them.

Results for 10% increase in world trade and its impact on ship prices under two assumptions (agents anticipated the shock and shock unanticipated by agents) is shown in Table 2.1.

Table 2.1: Effect of 10% Increase in World Trade on Ship Prices

Time	World Trade	P Anticipated	P Unanticipated
0	1	1.0	1.0
1	1	1.0625	1.0
2	1	1.1723	1.0
3	1	1.3558	1.0
4	1.1	1.6845	1.265
5	1.1	1.651	1.258
6	1.1	1.62	1.251
∞	1.1	1.136	1.36

The over shooting effect in the market is greater when the shock is anticipated and both markets reach the equilibrium condition in the long-term. Temporary shocks also have been monitored through a similar table in this paper.

Glen (1990) for first time pointed out that, the tanker market is not homogeneous, and market differentiation by size and by route emerged during the 1970s. However, easy entry conditions ensure competitive structure in the long-run. Four routes were selected by the author to test the differentiation hypothesis.[17] They were chosen to maximise the variation in volume of oil lifted and length of haul.[18] The author defined the volatility as coefficient of variation[19] of estimation gross profit margins, and gross profit margins estimated by utilising a simple model of tanker costs.

The results revealed, profit margin volatility increased with size across three routes under consideration. Caribbean-US Gulf route was exception.

The author criticises himself in his later work (Glen and Martim 1998) by saying, the data used was yearly average and on short time period. Furthermore, he criticise his model as being naive.

Beenstock and Vergottis (1989a) utilised an econometric model of dry bulk shipping. This model is an extension of Beenstock (1985) based on same assumptions. This work utilised a disaggregated and interrelated model for shipping market. In this model the relationship of lay up, second hand and new ship prices fleet tonnage and freight rates are jointly and dynamically determined. This model has been designed in two main part ship markets and shipping markets. These two parts are in interaction and rational expectation theory and market efficiency hypothesis have been applied in different ways to both parts.

In this model the rational expectation hypothesis is applied to shipping freight market and the study is carried out in a sector of the industry (dry bulk). This paper suggests that the time charter rates reflect the rational expectations of spot market's freight rate and cost.

Specification of shipping market sector (dry bulk) in this article provides more accurate results than aggregated shipping market as in the previous attempt by Beenstock. The ships have been considered as capital assets and it is assumed that the quoted price for a new ship is a reflection of expectations of the price of a comparable vessel prevailing at the time of the delivery. Thus the demand for new

---

17 Hypothesis explored that size difference makes the large tanker a more risky asset to keep, because unemployment risks will increase due to less demand on some routes. Furthermore, the growth in tanker capacity is greater than the port capacity. In addition, route differentiation and limitation of large tanker employment results in unfair competition in favour of marginal vessels.

18 Routes are Persian Gulf Japan, Persian Gulf West Europe, Caribbean US Gulf, West Africa and North America.

19 The coefficient of variation is defined as the standard deviation of sample divided by its mean.

ships has been considered to be influenced by the rational expectation of the second hand price in future.

In this work like many other works freight rate determines where there is equilibrium between supply and demand. Among other minor factors supply expressed in ton-miles is proportional, to the tonnage of active fleet and average sea speed of the fleet. Average speed is considered to be same optimum speed at time *(t)* and is the function of bunker prices and freight rates. Thus the supply could be define as follows:

$$S=f(\overset{+}{K}, \overset{+}{F}, \overset{-}{P_b}, Z) \qquad (2.1.19)$$

where S is the supply of fleet in ton miles, K is the fleet size in tons, F is the freight rates in US \$, P_b is the price of bunkers in US \$, Z is a vector of exogenous variables affecting the supply of shipping services.

Considering the above definition the decision to either operate in the market or lay up the ship is related positively to freight rate *(F)* and lay up cost *(Lc)*, and negatively to price of bunker *(Pb)* and operating cost *(Rc)*. Thus the modified version of supply equation is assumed as follows:

$$S=f(\overset{+}{K}{}^{*}, \overset{+}{F}, \overset{-}{P_b}, Z) \qquad (2.1.20)$$

Demand on freight market has been determined by the volume of seaborne trade and freight rates. The world trade is incorporated into world economic activity in terms of industrial production and consumption. In this model, as in many other shipping models, increase in freight rates may seem to have an adverse effect on demand for sea transport. Given that there is no other alternative transportation mode for shipping transport, in the sense of transportation cost and economies of scale, the impact of freight rate on the structure of demand for shipping could be ignored. Thus this paper assumed world economic activities (*WEA*) as a proxy for the demand (*D*) for shipping.

$$D = WEA \qquad (2.1.21)$$

The freight model is fulfilled by considering an equilibrium condition within the freight market, at any time. The freight rates clear the market.

$$D_t = S_t \qquad (2.1.22)$$

or:

$$F_t = f(\overset{+}{K_t^*}, \overset{+}{WEA_t}, \overset{-}{P_{bt}}, Z_t) \qquad (2.1.23)$$

The authors suggest that the fleet tonnage at any specific time is equal to fleet tonnage in the last period plus new deliveries and minus scraps and losses. Thus they defined the fleet size by the following equation.

$$K_t = K_{t-1} + D_t - S_t - L_t \qquad (2.1.24)$$

where K_{t-1} fleet tonnage, at previous period (D_t), S_t and L_t are deliveries and scrap and losses in current period respectively.

Furthermore, similar to Beenstock (1985), the proportion of capital that ship operators are willing to invest on vessels is considered to be a function of profit in the shipping market and expected return on investment through future prices. It will also depend on return on investment in other markets. Thus the following functional forms has been defined:

$$(K^*P/W)_t = f\left(\frac{E_t \overset{+}{\Pi}_{t=1}}{P_t}, \frac{E_t \overset{+}{P}_{t-1}}{P_t}, \overset{-}{R}\right) \qquad (2.1.25)$$

Where the left hand side is the proportion of wealth invested in shipping portfolio, the first term on the right hand side is expected return on investment through ship operation. The second term represents the return through expected capital gain and the third term is the return on other investments which is negatively related to investment decision.

The above functional form allows the authors to estimate a dynamic set of simultaneous relations in the shipping market, which include rational expectations and interaction between two-parts shipping markets (spot and time charter) and ship markets which consist of second-hand, scrap markets and newbuilding.

Beenstock and Vergottis (1993a) investigate the interdependence between shipping sectors. This is an extension study to the authors previous attempts to model tanker and dry bulk sector of the shipping market. This study focuses on econometric analysis of the spill over effects between the two sectors of the shipping market. The authors assumed three forms of interrelation for these two sectors.

Scrap market, ship building industry and combination carriers are three linkage points of shipping sectors. Higher scrap prices in one sector could result in scrap price reduction in another sector. This cyclical phenomenon will keep moving between two sectors. There is a capacity constraint within shipbuilding industry as well as scrap yards and ship's types price also influence the shipbuilders to produce more ships of one type. This causes activities in one sector to affect other sectors.

The third link between two sectors is combination carriers, which has a capability to switch from one sector to other. Ship-operators as economic agents aim to maximise their profit. Thus the combine carriers operators tend to operate in the sector which leaves the ship-operators better off after cost.

This linkage has been econometrically analysed with a simulation, using anticipated and unanticipated shocks on different exogenous variables. The framework in this paper is quite similar to one utilised by Vergottis (1989) and Beenstock and Vergottis (1989a and 1989b).

Relationship Between Spot and Time Charter Market

There is a strong presumption in shipping literature that spot rates ought to be related to time period rates in some systematic way, in which the spot rates are the basis for the formation of the expectation of the period rates.

The existing hypothesis in shipping literature regarding the relation between spot and period rates was realised by Zannetos. Zannetos (1966a) assumed that the period rate is a function of level and changing trend of spot rate. The period rate follows the direction of the spot rate with less volatility. Throughout the regression analysis he examined the level of spot rate's (X_1) effects on period rates, then effect of spot rate changes (X_5)[20] on period have been evaluated. The level of spot market (X_1) and period rate turns out to be positively and strongly related. Furthermore relationship of changes (X_5) of spot and period rate turn out to be negative at 5% significant.[21]

In an another approach Zannetos (1966b) investigates the structure of the oil tanker market. He used pooled, data on spot and period rates 1950-59. Based on "price

---

20 (X_5) is a geometrical distributed lag composite of the spot rate changes.

21 The log form of variables has been used and many other explanatory variables were involved in the regression analysis.

elastic expectations",[22] he suggest that an increase in freight rate causes the casual demand to increase, this is because shippers expect the rate will increase further in the near future and therefore rush to the market to charter ships. On the other hand, ship-operators tend to wait and see, if the rate increases further. This procedure pushes the freight rates up further.

Glen *et al.* (1981) criticise Zannetos work on two grounds. Firstly, they pointed out that the effect of different ship size has not been recognised, consequently the degree of substitutability and various rate formation was not considered. Secondly, they criticise the Zannetos econometric model on the grounds that it was very crude, employing only a one-period lag and fixed weighting system.

Alternatively Glen *et al.* utilised a model based on expectation theory in which ship operators knowledge of current rates form the future rates. It could distinguish different shipsize and allowed for substitutability between these sizes. Furthermore, the models were able to include fixtures of various charter duration (from spot to long-run). Their model was also designed to captured the effect of rate expectation upon rate formation.

Their reduced form model of formation of rate expectations enabled them to also test Zannetos hypothesis of "price-elastic expectations".[23] Results do not provide support for price-elastic expectations hypothesis. They added, formation of rate expectations can be explained on the basis of exponentially declining weight. Thus they comment, other explanations are needed for fluctuation in rates.

Work by Binkley and Bessler (1982) examines the role of the future expectations of shipping operators in freight rate determination. Different charter contracts are compared (trip vs. time charter). They propose that the impact of future expectation on freight rate determination would vary with employment duration.

Following Zannetos argument, on the "elastic expectations" in the tanker market (which could be very similar to dry bulk carriers market), the authors utilised on

---

22 Zannetos argued that if the rates are rising, then charterers try to fix their tonnage requirement to avoid higher rates which itself helps the market to rise further. On the other hand, when the rates are falling ship owners try to hire their vessels to avoid expected future falls while charters are waiting for lower rates. This will lower the rates further.

23 The reduced form model: $R_t = \sum_{\tau=0}^{\infty} \mu_\tau r_{t-\tau} + \lambda + \mu_t$

Where Rt is actual payment, μ_t is random error term, *Ut* is normally distributed error term, μ_t is constant. *r* is ship operator's discount his expectation in spot rate.

auto-regressive equation for monthly dry bulk time and trip charter rates to examine the effect of expectations on their determination. They argued that, with an increase in charter contracts duration, more concern will be on the expected future conditions (cost and rates) than the current conditions.

$$\mathbf{SP}_t = 11.89 + 0.946\ \mathbf{SP}_{t-1} + 0.165\ \mathbf{SP}_{t-5} - 0.185\ \mathbf{SP}_{t-8} \qquad (2.1.26)$$
(2.82) (19.63) (2.65) (-4.31)

$$Te_t = 12.29 + 1.550\ Te_{t-1} - 0.846 \qquad (2.1.27)$$
(2.93) (4.63) (5.31)

Estimation of these two auto-regressive equations revealed that there is a significant difference between the determination of these two freight rates in terms of the dependence on the past values. It has been found that the voyage charter rates are more dependent on the near past than the time charter rates. The data generating process for time charter rates exhibited longer memories than the spot charter rates.

Beenstock and Vergottis (1989) work is based on a profit maximisation model and the rational expectations theory to explain the relationship between spot and time charter rates. The authors assume that the relationship between time charter and spot markets could be defined under two differences. Firstly, the time charter rates in contrast to the spot rates give an opportunity to the ship operators to hedge themselves against the risk of disrupted movements in the market by long-run commitments. Secondly, in time charter contracts the voyage costs (bunker cost) are associated. Thus the ship operator's profit in time charter contracts is determined differently by spot market.

Based on rational expectation theory the authors argue that the first difference expresses the notion that the future spot rates will influence the current time charter rates. The second difference implies that the future voyage cost (bunker price) is an important variable to determine current time charter rates.

Thus the following forward looking relationship for time charter rates and bunker prices has been introduced:

$$F_t^* = \mathrm{f}\,(E_t(\overset{+}{F}_{t-1}),\ E_t(\overset{-}{P}_{bt-1}),\ \overset{-}{K}_t) \qquad (2.1.28)$$

where F_t^* assumed to be one year time charter rates,[24] $E_t\ (F_{t+1})$ and $E_t\ (P_{t+1})$ are one period ahead spot rates and bunker price respectively.

Hale and Vanags (1989) used the expectation hypothesis which is explored in the financial literature to explain the relationship between long and short-term interest rates. Based on modification of the bond market model, they suggest that the changes in the one year time charter rate could be a function of the market spread between the long and short-term rates. Their model has some similarity with Glen *et al.* (1981). Hale and Vanags (1989) allowed for shipsize differentiation as Glen *et al.* did. However unlike Glen *et al.* (1981) they used a model where time horizon is finite. The authors used the following models to investigate their hypothesis.

$$(1-L)\,R_t = [(1-\delta)/\delta)](R_{t-1}-S_{t-1}) - \alpha(1-\delta)\,u_t \qquad (2.1.29)$$

$$R_t = (1/\delta)(R_{t-1}-S_{t-1}) + S_{t-1} + \alpha(1-\delta) + u_t \qquad (2.1.30)$$

Hale and Vanags (1989) provide little or no support for the expectation hypothesis in the dry bulk market. For 30,000 DWT shipsize, results led to a clear rejection of hypothesis. The 55,000 DWT hypothesis was also rejected and the result for 120,000 DWT are less clear in rejection of the expectation theory.

A study by Evans (1994) could be a good representation of such view. He suggests that in the short-run, the market for bulk carriers (including tankers and dry bulkers) are efficient. However, in the long-run it is argued that the market is far less efficient with many factors combining to prevent levelling of supply and demand.[25]

Regarding the short-run market efficiency, Evans attempted to answer this question: "does the bulk carriers market operate in such way that the freight rate is equal to the marginal cost?"

He answers this question by using the equation that marginal cost is equal to marginal revenue. He explains the mechanism of the market such as how optimum ship speed is determine, the effect of change in fuel prices and capacity utilisation. The model ignored the port stay time. The author concludes that in the short-run, according to the model of perfect competition, there is good knowledge of the

---

24 Since the author used annual data, one period ahead meant next year and time charter rates are annual.

25 Such factors cause difficulty in controlling tonnage to be ordered, so anticipation of increase in demand would always result in a capacity surplus.

market through many organised exchanges, such as Baltic Freight Exchange. Many inter-related markets exist in which rates are determined by interaction of supply and demand.

In the long-run, demand increases generally in a secular fashion. Demand is related to increases in economic growth in developed countries and world population and consequently the commodity trades. However, the ship-operators act rationally but do not seem able to organise the level between supply and demand in efficient manner.

Andreassen (1996) classifies the hypothesis regarding the relationship between spot and time charter in shipping literature under four different groups. Namely: Zannetos hypothesis, applied Zannetos hypothesis, rational expectation hypothesis, conventional wisdom hypothesis. These hypotheses are tested for three distinct market and shipsizes in 40 quarters. He used cointegration analysis to test the hypothesis, utilising both the Dickey-Fuller method and Johansen likelihood ratio tests.

This is additional to a previous hypothesis which reviewed Koyck Lag Hypothesis introduced by Koyck (1954) on distributed lags and investment analysis considered by Andreassen (1996). The linear version of this theory is normally abbreviated to a function of the lagged dependent and the contemporary explanatory variables. In a shipping context it means that the time charter rate is a function of the lagged time charter rate and contemporary voyage cost.

Another hypothesis which is recognised by Andreassen (1996) is the so called Conventional Wisdom hypothesis. It defines the time charter rate as a function of only the changes in the short-term spot rate. A set of models design to test each hypothesis which are as follows:

$Y_{it} =$ Time charter freight rate in market i in period t ($/dwt/month),
$R_{it} =$ Time charter freight rate in market i in period t ($/day),
$S_{it} =$ Spot freight rate in market i in period t ($/ton).
$Z_{it} =$ Spot freight rate in market i in period t ($/day),
$V_{it} =$ Voyage cost in market i in period t ($/day).

The Zannetos hypothesis:

$Y_{it} = f(S_{it}, \Delta S_{it}) where \Delta S_{it} = S_{it} - S_{i,t-1}$ or in logarithmic analytical form

$$y_{it} = \alpha_{oi} + \alpha_{1i} s_{it} + \alpha_{2i} \Delta s_{it} + e_{it}$$

The conventional wisdom hypothesis:

$Y_{it} = f(\Delta S_{it}) or$

$y_{it} = \alpha_{0i} + \alpha_{1i} \Delta s_{it} + e_{it}$

The lagged Zannetos hypothesis:

$Y_{it} = f(S_{i,t-1}, \Delta S_{i,t-1}) or$

$y_{it} = \alpha_{oi} + \alpha_{1i} s_{it-1} + \alpha_{2i} \Delta s_{it-1} + e_{it}$

The Koyck-Lag hypothesis:

$R_{it} = f(R_{i,t-1}, V_{it}) or$

$r_{it} = \alpha_{0i} + \alpha_{1i} r_{it-1} + \alpha_{2i} v_{it} + e_{it}$

The rational expectation hypothesis:

$R_{it} = f(R_{i,t-1}, -Z_{i,t-1}, Z_{i,t-1}) or$

$r_{it} = \alpha_{0i} + \alpha_{1i} rZ_{it-1} + \alpha_{2i} Z_{it} + e_{it}$

where $rZ_{it-1} = ln(R_{i,t-1} - Z_{i,t-1})$

Results suggest that Zannetos and lagged Zannetos hypothesis were rejected, the result of Koyck lag and rational expectation hypothesis shows all of the impact on time charter rates come from the lagged dependent variable in Koyck lag. Thus, the Koyck lag hypothesis has been rejected. In case of rational expectation, the results of two tests are inconsistent. Results from Dickey-Fuller confirm the hypothesis but Johansen χ^2 statistic reject it.

Rational expectation hypothesis includes the lagged dependant variable and that the Johansen test has been found to be the better of the two, therefore the author accept the Johansen results and reject the rational expectation hypothesis. Both Dickey-Fuller and Johansen test clearly accepted this hypothesis for three markets under consideration. Thus he concluded that the conventional market wisdom is correct. The change of trend in spot rates is important to obtain the period rate but levels of spot rates are not.

2.1.3 Time Varying Volatility Models in Shipping

In regression analysis, the residuals i.e. the error terms are normally distributed, with constant mean and variance. Then the OLS estimates of parameters are BLUE.[26] Problems arise when residual and error terms are not normally distributed (heteroscadasticity exist in the residual). Thus the estimates of the parameters of regression by OLS are not BLUE.

To examine the error terms of the regression for heteroscadasticity, different tests are developed by statisticians e.g. Park(1966), Glejser (1969), Goldfeld and Quandt (1972), Breush and Pagan (1979), White (1980), Engle (1982) and Bollerrslev *et al.* (1988).

To explain the behaviour of the variance of the regression over time, various repressors have been used (e.g. independent variables, the past value of error term or lag variance itself) in different form[27]. In the shipping literature, time varying volatility model has been used to examine the time varying behaviour of the freight rate in different sector of shipping markets as well as aggregated time and spot rate and price changing behaviour in ship market.

Kavussanos (1996a) applied such a model to analyse the time varying behaviour in freight rates for dry bulk of different size, as well as aggregated spot and time charter rates. First he modelled the conditional mean of the series, then conditional variance and finally the conditional density of the error term in the regression equation using ARCH and GARCH model.

He defined the conditional mean of the freight rate as follows:

$$FR = f(\overset{+}{IP}, \overset{+}{Pb}, \overset{-}{K}) \qquad (2.1.31)$$

26 BLUEs are the best linear unbiased estimator of the parameters.

27 Details of time varying volatility models are available in Appendix 1.

Where FR is the freight rate, IP is index of industrial production and K is the capacity of the shipping fleet.[28]

Time Charter rate *(TC)* by size is defined as function of current expectations of the spot rates and cost (bunker prices).

$$TC = f[\overset{+}{E_t(FR_{t+1})}, \overset{-}{E_t(BP_{t+1})}] \qquad (2.1.32)$$

The above relationship translates into a general regression equation with corresponding maximum likelihood functions as follows:

$$Y_t = B\,X'_t + \varepsilon_t \qquad \varepsilon_t \sim N(0,h) \qquad (2.1.33)$$

$$LL = -(T/2)Inh - (1/2h)\Sigma\varepsilon_t \qquad (2.1.34)$$

When the variance of the error term is time invariant, maximum likelihood or OLS estimate of the above provide BLUE estimators. However, if this is not the case, the estimators are still unbiased and consistent but they are not efficient.

The ARCH model approach for testing the hypothesis of constant variance in OLS regressions rejected the hypothesis. Thus the GARCH models approach utilised in following form.

$$Y_t = D + e_t \qquad e_t \sim N(0,h_t) \qquad (2.1.35)$$

$$h_t = a_0 + \sum_{i-1}^{p} a_i e_{t-i}^2 + \sum_{i=1}^{q} b_i h_{t-1} \qquad (2.1.36)$$

$$LL = -(T/2)In\,h_t - (1/2h_t)\Sigma e_t \qquad (2.1.37)$$

Firstly, OLS regression estimations of the conditional mean have been utilised. Secondly, simultaneous estimations of the conditional mean and variance have been analysed. Then the results of these two different approaches are compared.

This study by Kavussanos, apart from its result, is important in that, ARCH and GARCH models are implemented in the shipping literature for first time. Furthermore, results revealed the significance of ARCH and GARCH parameters

28 Data used in this study was monthly, which could not allow for using the world trade. Thus, the alternative OECD industrial production index was used.

and a better fit when a better compression made on two alternative approaches of modelling the freight rate (i.e. classical linear model and GARCH model). Additionally, the result of this study suggest that the variances should be modelled with means for monthly series of different shipsizes freight rates and time charter rates.

Based on the above argument, Kavussanos concludes that the risk in dry bulk freight market is time varying.[29] Finally, he noted that the time varying risk in various dry bulk sub-market (freight rates) can be different. The result specified that freight rate in market for large ship is more volatile than the smaller sub-market. He also noted that period rate is more volatile with wider fluctuations over time than the corresponding spot rate. The results also support Zannetos (1966) "price-elastic expectation" hypothesis.

In another study, Kavussanos (1996b) analysee the volatility of monthly tanker price changes across three different tanker size (Afarmax, Suezmax and VLCC). The technique which is used in this study is quite similar to one used for dry bulk carriers (Kavussanos 1996a). The methodology in this paper is very much similar to the Kavussanos (1996a). However, some differences in methodology still exist. In this paper the conditional mean is defined as the changes in prices through ARIMA form models. Furthermore, the explanatory power of the conditional mean improved by including structural and seasonal variables to the initial ARIMA models so that they become ARIMA-X. Thorough unit-root tests, the levels of prices prove to be non-stationary *I (1)*. Thus the changes in prices (ΔP_t) which approved to be stationary used for analysis. Then ARCH and GARCH model which are the same as in the previous attempt by the author are implemented. Kavussanos found that, increase in oil price will have a negative impact on aggregated tanker prices and a positive impact on volatility.

He also noted that the inclusion of oil prices in the time varying volatility models will result in more parsimonious models and better specification of the GARCH models. It could be interpreted as showing the importance of oil prices as a determinant of the mean and variance of the changes in tanker prices. In addition the study revealed that there is a positive relationship between size and price variance. The variance of larger tankers prices are more responsive to oil price than the smaller tanker.

---

29 Large shocks tend to induce high volatility, and steady markets have low volatility.

In another attempt Kavussanos (1997) analysed the time varying variance of second-hand dry bulk prices. The size categories are recognised in this model (Handysize, Panamax, and Capesize). The methodology is quite similar to previous attempts by the author, except the seasonal behaviour of the series have been considered and tested (deterministic and stochastic seasonality).

The study suggests that the volatility are varying across the size categories, and the price of smaller vessels tend to be less volatile than larger vessels. Furthermore, he suggests that the conditional variance of the prices of Handysize and Panamax are positively related to interest rates, but the variance of the price changes of Capesize ships are influenced by period rates.

Following Kavussanos attempts, Glen and Martin (1998) estimate the conditional volatility by size categories and between types of period charter in the tanker market. This study replicates Kavussanos (1996a) study. However, the estimation of conditional mean (mean freight rate) has been done by a different model. in which past lagged values of the freight rate and exogenous variables have been used in log form on a monthly basis. Data sources also are different to Kavussanos. However, comparing the result of this study with Kavussanos, they are consistent.

2.2 International Grain Trade

Agricultural trade has been a problem area in international commerce for several decades. Different views on international agricultural trade come from the ideas of free trade and protection. Free trade implies an unrestricted flow of goods across national frontiers, where as protection implies, imports are subject to tariffs, levies, or other physical restrictions in order to protect the domestic products.

The ideas of free agricultural trade suggest that pervasive government intervention in the agricultural sector in many countries has distorted the location of world production and the extent and patterns of trade flows. Such intervention has restricted the gains from trade that accrue to world consumers, arising from differences in the costs of production of agricultural goods between countries. Furthermore, agricultural trade has not been effectively governed by the institutional framework for international trade relations.[30]

[30] This framework was provided by GATT (WTO) in 1947.

Since two main problems of the agricultural industry are farmer's low incomes and fluctuation in this income, there is a strong tendency to support the protectionism view in agricultural trades.[31] Studies for many countries and different periods often show incomes in agriculture as being below those in other occupations. These actual or potential problems of low incomes in agriculture are essentially the result of the industry not being able to adjust itself quickly enough to changed conditions.

Koester (1985) tries to address the question of whether the free trade is always better than protection in agricultural trade. He argued that trade in agricultural products is more affected by national policies than trade in industrial products. This is due not only to specific agricultural policy objectives; it is also due to some specific characteristics of agricultural markets.[32]

He suggests that there is no way to quantify the state of disarray of world agriculture or to assess the likely world welfare loss on sound empirical grounds. However, countries could probably be better off if they chose to intervene differently in agricultural market. It seems to be the consequence of forces on the political market for protectionism.

Agricultural protectionism has increased substantially over the past few decades. However, the costs and distortions associated with intervention fall when world markets are strong and rise when they are weak.[33]

Escalating trade conflict, in combination with growing budgetary costs of agricultural support, brought the issue of agricultural protectionism to the front line of the international economic policy agenda, in the Uruguay Round of trade negotiations in the GATT (WTO).[34] Jabara (1981) examines the relationship between domestic agriculture and trade policies of selected group of grain importing and exporting countries. The author suggests that, because of the strong

---

31 See Chapter Four Section 4.1 for further details.

32 The farmers' income.

33 For instance, during the 1970s, in the aftermath of the commodity price boom, agricultural trade was buoyant and public concern over agricultural support was muted. However, agricultural trade becomes a progressing economic and political issue in 1980s. Growth in global consumption of farm products slackened in the early 1980s under the influence of world recession and macroeconomic instabilities, whilst production kept increasing under the stimuli of technological advances and government support in developed countries.

34 Commenced in September 1986, high priority was given to reforming domestic agricultural policy which distorted agricultural trade. The negotiations aimed (i) to liberalise world agricultural trade, and (ii) to make it more orderly and predictable.

link between domestic and trade policies, it will be difficult to reduce/remove trade restrictions in international grain markets in trade negotiations.

Work by Trela *et al.* (1987) focuses on the nature of international policies and international agreements in agriculture. They emphasised how agricultural policies work in the three major trading areas (the EU, the USA, and Japan). They also discussed how international agricultural agreements do little to fundamentally liberalise agricultural trade.

To a certain extent most of the studies in agricultural market have been motivated by the important role agriculture has played in GATT negotiation. e.g. Cline *et al.* (1978), Valdes and Zietz (1980), Bale & Lutz (1981), Burniaux (1985), Chisolm and Tyers (1985), Parikh *et al.* (1986)and Tyer and Anderson (1991) Josling (1994) Shaffer (1996).

2.2.1 Agricultural Policy in Developed and Developing Countries

Various policy measures apply to agricultural sector in different countries. It is important to realise that different measures have different impacts on international trade and other areas.

One can categorise the policy measures in agriculture, into two groups of polices. The first group that is mostly implemented by developed countries is protectionism measures. The second group includes measures which highly tax agricultural activities to provide financial instrument for industrialisation. The second group of measures is mostly implemented by developing countries.

Early studies in price formation in world grain market outlined two different views. McCalla (1966), McCalla and Joslining (1981), suggest that price formation in the world grain market is largely determined by the major exporters agricultural policies. The alternative view suggests that world grain prices are essentially determined by the grain importers policy. Carter and Schmitz (1985) support the latter view by considering the EU as a major importer.

Comparing the agricultural policies in developing countries with policies in developed countries, they said in general, the agricultural sector in developing countries is heavily taxed while that in developed countries service substantial price protection. Thus the effects produced by these two type of policies are diametrically opposite to each other. Bale and Lutz (1981) estimate the effects of agricultural price distortions on output, consumption, trade and rural employment for nine countries. Additionally, the effect on distribution of income between producers and consumers, on government revenue and foreign exchange and the net social losses of the policies are calculated.

The authors used the standard partial equilibrium comparative static analysis in the Marshallian economic surplus framework. Their results indicate large annual welfare losses due to misapplication of resources in both developed and developing countries. Production in developed countries will be less in the absence of intervention, while in developing countries it is more. The consumption it would be less in developing countries while in developed countries would be more. The effects on trade are merely a combination of the effects on production and consumption. This caused a reduction in exports of developing countries and decrease of imports by developed countries.

2.2.2 Methods To Measure Government Intervention

Since many policy packages apply to agricultural activities over the world, there is a need to translate these various measures to a common measure which could be used either to evaluate the impacts of a specific package or to compare the effects of different packages.

Most of the studies in this field mainly use three different methodologies as a yardstick for measuring government intervention in the domestic agricultural sector, and what will happen with their removal.

The most commonly used methodology is Producer and Consumer Subsidy Equivalents (PSEs, CSEs). The PSE is an estimate of the level of subsidy required in order to compensate producer for a removal of government programmes. This measurement device was written into the Canada-US FTA and it has also been used by the OECD as an indicator of trade distortions and is obtainable by the following formula:

$$\%PSE = 100\,(total\ PSE)/Q\,(P_D) + D - L \qquad (2.2.1)$$

$$\text{Total } PSE = Q\,(P_D - P_W) + D - L + B \qquad (2.2.2)$$

Where Q is level of production, P_D is domestic producer price, P_W is reference price (or world price) D is direct payments to producers, L is producer levies and B is other budget payments to producers.

Another method is Nominal Rates of Protection *(NRP)*. *NRP* is exactly measuring by way of government intervention in agriculture. The *NRP* measures the tariff effects on output price. The *NRP* can be written as follows:

$$NRP = (P^{'} - P) / P \qquad (2.2.3)$$

$P^{'}$ is the output price with the tariff in place and

P is the free trade output price.

The *NRP* is useful for measuring consumption effects of trade barriers but it is a poor indicator of the protective effects on production.

Sampson and Yeats (1977, 1978) measured the level of protection offered to EU producers by imposition of levies on imports of agricultural products. They measured the nominal and effective rates of protection for grain in the EU as a whole. They estimated the *advaluorm* tariff equivalent of import levies on grain in 1969/70 to be 52% and average effective protection rate to be 127%.

In another study, Jabara (1981) by using the same method of translating the variable levies to tariff, examined levels of protection from EU import levies on an individual country basis. He thereby included the effects of border taxes and subsidies (Monetary Compensatory Amounts). This study mostly focuses on the effect of MCA's on EU trade with Third countries.[35]

Trade Distorting Equivalent is another method used to measure government intervention, which is similar in principal to the Producer Subsidy Equivalent. TDE^{p} measures the transfers from consumers and government to producers-and in the case of TDE^{c}, transfers to/from consumers-but gives greater (less) weight to those policies that are most (least) trade-distorting. Algebraically, the *TDEs* can be defined as:

$$TDE^{p} = w_1 Q_p (Pd - Pw) + w_2 D - w_3 L + w_4 B \qquad (2.2.4)$$

and

$$TDE^{c} = w_1 Q_c (Pd - Pw) + w_2 G \qquad (2.2.5)$$

35 Monetary Compensatory Amounts (MCA) applied in addition to import levies in member countries to account for exchange rate fluctuation.

where TDE^p (TDE^c) is the trade distorting equivalents affecting producers (consumers), w_i, $i = 1 \ldots 4$ are the weights to be attached to the individual components of government policies and the other variables are defined as above.

No explicit guidance on the value of the weights has been given. Cahill and Legg (1990) suggest that they will vary between 1 (for the most trade-distorting policies) and 0 (for the least trade-distorting policies). Consequently, given that the trade-distorting effects of agricultural policies can be ranked (McCalla and Josling, 1981), then a reasonable weighting system for the TDE^p would be $1 \geq w_1 > w_2 > w_3 > w_4 \geq 0$ and for the

TDE^c, $1 \geq w_1 > w_2 \geq 0$.

A comparison of each of these measures for selected commodities (wheat and coarse grains) used in the modelling framework is given in Appendix 4. The results show considerable variation between the alternative measures of government intervention. Typically, the PSE measure is greater than both the TDE and NRP measures due to the fact that the NRP ignores all non-market support policies, and, with the TDE, these policies are given a lower weighting relative to the PSE measure. In many cases, the TDE is similar in magnitude to the NRP measure. This arises due to the prevalence of market-price support instruments used in the domestic market in many developed countries (OECD, 1989).

Harling (1983) and Valdes and Zietz (1980) discussed at length the methods of calculating tariff equivalent and ensuring problem. The comparison between these methods has been reviewed by Cahil and Legg (1990) and Schwartz and Porker (1988).

2.2.3 Models for International Grain Trade

As highlighted in the previous section, limited methodologies have been used in existing literature as yardsticks for measuring the government intervention in agricultural activities. However, to model the effects of government intervention on grain trade and other sector of economy, various methods and models have been utilised by many studies.

This section provides general specifications of these models together with their advantages and disadvantages, which will be useful to model the impact of the CAP on structure of demand for shipping transport of grain.

The first series of attempts to estimate the international grain trade flows used methodologies sufficient for long-run projection.[36] McCalla (1966) suggested that the United States, Australia, and Canada, who used to export about 73% of total wheat, should be modelled as co-operating oligopolists when large grain stocks are held. He also suggest that when grain stocks were large as was the case before the event of 1973-74, small price changes would result in compensating behaviour on the part of the major exporters.[37]

Following the McCalla study, Tweeten (1967) point out that with depleted stocks, adjustment in net exports by the major traders must come from extremely inelastic domestic consumption markets. The small trade elasticity of other traders are no longer dominated by large elasticity of the major exporters. Accurate estimation of those elasticity then becomes more important, and the assumption that free market behaviour is sufficient to find the response of a country's net import demand to changes in international prices may no longer be valid.

The projection methodologies in agricultural economics utilise estimates of domestic supply and demand equations by either ignoring or entering exogenously the government intervention into the model.

Coffin (1970) and Blakeslee *et al.* (1973) have analysed international grain trade using projection methodologies. The inadequacy of these methodologies, due to ignoring the government role and imperfections of the market, could clearly be seen in the work by Timmer (1997), where the result indicate that the price of rice relative to the price of fertiliser varies considerably between countries. They suggest that government intervention in domestic market and control the prices, thus international prices are separated from the domestic price due to government policies.

However, the models which have been utilised to estimate grain trade flows, could be classified under different categorise. This categorisation comes from restrictions placed on economic theory and functional specification of the models. Extreme cases for this type of models are spatial equilibrium models and systems dynamic models. Other alternative models which could be placed between these two extremes are (a) straight forward estimation of reduced form equations from a structure that includes import and export behaviour, (b) an allocation system for

36 It was particularly due to the existence of large grain stocks and the potential for oligopolistic behaviour of major exporters.

37 The event of world food crisis.

distributing import among various suppliers, (c) a set of models which distinguish commodity by producers.[38]

Most of the above models used multi-country multi-commodity (agricultural commodity). It differs fundamentally from the simple analysis one product and two country. The world prices are not important in this analysis as a reference point for measuring the cost of the production. Since the home country is large, the price support affect the international prices. The effects of the policy could be estimated with respect to world price without existence of the policy.

Measuring this counterfactual price needs formulating demand and supply functions for countries and commodities involved, then solving the system at a national, unobserved equilibrium.[39]

This analysis is used for the estimation of domestic policies effects on international trade. Once world equilibrium is computed by considering the supply equal to demand, the resulting prices and trade flows can be compared with the actual ones and the distortions implied by the existing policies can be demonstrated. Furthermore, the effects of the policies on the real income of other countries can be calculated.

The most advanced model in this type is Tyers (1986)[40] which is used by the World Bank. It incorporates seven agricultural commodities and 30 countries. The inter-sectoral links are captured by cross-elasticity in both supply and demand.

Furthermore the overall framework regarding the models are either partial or general equilibrium analysis. Partial equilibrium analysis considers that the price of all other goods remain constant. In other words substitutability and complimentarity in consumption and production between the goods studied and other products is ignored. The partial equilibrium framework also assumes that all demand is final. However, the demand for agricultural products in many cases is the derived demand.

Computable general equilibrium models have an ability to capture non-agricultural sectors, macroeconomics factors within the model. The Ohlin international trade

---

38 This model was basically utilised by Armington (1973).

39 This is called counterfactual analysis. This will be discussed in detail in Section 2.3.4.

40 See Tyers & Anderson (1986) and also Tyers & Anderson (1987a; 1987b); earlier versions of the same model are used in Anderson & Tyers (1984), Chisholm & Tyers (1985) and Tyers (1985).

model is the base model for general equilibrium models. However, the general equilibrium models are higher-dimensional analogues. Each country in the model has a production function with primary and intermediate inputs and demand functions derived from utility maximisation. The countries are constrained by their total factor endowments. The balance of payments or parts of it, is modelled explicitly and constrained by external conditions. A global general equilibrium is set by international prices for all goods and factors such; (i) all markets clear; (ii) the zero-profit conditions are met in all industries; and (iii) the external accounts of each country satisfy the constraints. The Armington heterogeneity assumption often made to account for cross- section of globally traded goods.[41] The basic structure of computable general equilibrium models is discussed in detail in Whalley (1984), Whalley (1985a), Winters (1987), Whalley (1985b) outlines some of the methodological problems that applied this type of models.

Spatial Equilibrium Models

The sole idea of spatial model is that, an importer may not consider wheat, for instance, that is produced in Canada to be identical to that produced in Argentina. The theoretical framework of spatial models was utilised by Samuelson (1952) to specify prices, quantities and pattern of the trade.

The products in this model are assumed to be homogeneous so the consumer selects the exporters on the basis of lower price, including transport cost. Thus if goods produced by two different countries are perfect substitutes in consuming markets one could expect those models to predict multilateral trade flows and prices as any alternative model. If different types of goods are imperfect substitutes in consumption market, then one may expect a spatial model to predict fewer and different trades occurring then would actually occur.

The standard form of the spatial equilibrium model is a deterministic description. It can be made stochastic, where the equilibrium price on a market is assumed to be isolated from surrounding markets are determined by local demand and production.

Schmitz and Bawden (1973) used spatial equilibrium model to analyse the impact of different import and export agricultural policies of developed countries. Additionally, the role of developing countries, and the impact of different growth rates of their agricultural productivity were considered. The study projects the world

41 The Armington assumption postulates that similar goods from different countries are imperfect substitutes.

excess supply for 1980 at 1964-66 prices, instead of projecting wheat price for 1980.

This study categorised the world into 15 areas. Eleven were endogenous to the model which wheat price, consumption and trade flows determined for each area. The rest of the world is categorised into other America, other Europe and other Asia. Transport cost between these regions are estimated, determined by the distance between the trade partners.

A study by Johnson (1976) for USDA employed a spatial model to project world grain trade for 1980. Commodities included wheat, coarse grains, and rice and the world is devided into 22 regions. For each region, a separate demand and supply equation was estimated.

The study projects the world excess supply that would exist in 1980 at 1964-66 prices. The precise results depend on the assumed values of exogenous variables.[42] The result of this study corresponds closely to the results of a study by Blakeslee and Heady (1973). The structure of the model is very similar to Schmitz - Bawden. The major difference is that they make a greater afford to diversify trade flows by adding direct restraints.[43]

The problem with the spatial model is the extent to which exporters concentrate their sales in a small number of markets. Spatial models have an inherent bias toward specialisation that results from the objective of minimising transport costs. The implication of this bias is that the trade matrix predicted by a spatial model has many more zero entries than an actual trade matrix. This also creates errors in the predicted direction of trade, since the model predicts that countries will buy primarily from the nearest exporter. This bias stems from the logic of spatial models. That is, they are designed to predict trade flows for homogeneous good. If a good is homogenous, then international price differences for the good result only from transport costs and trade barriers.

If the objective is to estimate production, consumption, prices and trade in world grain market, a spatial model that generates a trade matrix that minimises the transport cost from producers to consumers could be appropriate. Furthermore the trade flows generated by the model could be compared with actual trade flows, and

---

42 Exogenous variables in this study are Green Revolution effects, weather conditions and tariff changes.

43 This numerical restraint they imposed was based on historical trade flows.

deviation of actual trade from predicted values can be interpreted as forecasting errors, and also the result could be use to measure the inefficiency of the actual trade flows relative to the optimal trade flows generated by the model.

Spatial models possess many desirable properties for long-run forecasting purposes. An attempt to modify them to overcome the difficulties encountered in their use for short-run forecasting may prove to be fruitful. However, most of these problems are better dealt with by constructing a model that directly incorporates historical trade behaviour.

Modification of Spatial Models

As mentioned earlier the idea of spatial model determines trade flows by maximising the net social pay off and minimising transport cost. In fact the world does not behave this way. Thus there is a need to adjust such a model to comply with the world market behaviour.

Modification of spatial models could be done by incorporation of trade barriers and government intervention to the model, such models are summarised by Schmitz and Bawden (1973). Another modification could be to impose quantitative restrictions that direct trade flows. The USDA[44] studies by Johnson (1976) adopted such modifications. This study developed such a model for several agricultural products. He found it difficult to estimate demand elasticity from the elasticity of substitution in different agricultural markets.

Work by Abbott (1979) on grain trade could be a good example of such a modified spatial model. The author criticises the use of spatial models for estimating grain trade on the basis that government intervention is often ignored or interred exogenously into the model. Thus it assumes that the market for international agricultural products is a perfect market which is efficient and there is no distortion within the market. Abbott claims that this model is quite inadequate to capture endogenous impact of government intervention on trade behaviour.

The alternative model utilised in his paper considered government intervention as an endogenous variable in contrast to spatial equilibrium trade models. Basically, the structure of this model is the same as one in which supply and demand will be balanced by trade. However the balance is achieved only in a specific part of the national market. International and domestic prices may be separated by many

---

[44] United States of America Department of Agriculture.

barriers, (i.e. tariffs or non-tariffs). The important factor which determines how a country responds to changes in international market is the relationship between world and domestic price.

Instrumental variable estimation techniques were used because estimates of net import demand equations which depend on international market price are subject to simultaneous equation bias. A set of equation models has been presented.

Firstly he attempts to model the grain price behaviour, in terms of relationship between domestic and world price. Abbot uses the spatial equilibrium framework, which assumes that domestic price *(PD)* equals to the international price at that country's border *(PW)*, or the international price times one plus an *ad valorem* tariff (τ).

When the domestic price *(PD)* is not being a function of world price *(PW)*, it means that the country ignores the international market, and government intervenes into the domestic market. This intervention could be undertaken by constant quota, determined from domestic market, or such one operating in the EU by variable levy system. In which $PD = PW(1 + \tau)$, where (τ) is the policy instrument to maintain the desired *(PD)*.

Other factors affecting grain prices have been discussed in the paper. In the case of importing countries in which foreign income constraint is a matter of consideration, low domestic price would be inappropriate for the government. The level of domestic production may affect the level of government intervention. Levels of stocks holding also affect domestic support price producer's price and stock released could also be found.

The next attempt is to show that the effect of international price on consumption is the result of the response of the domestic market to change in domestic price to the world market price. The effect of international market price on supply is the combination of response of producer price and market surplus to international prices.

In the next step, Abbot introduced a supply model. Supply in this model is considered to be only a function of trade and domestic production, where trade is varied and depend upon the volume of domestic production.

A Model of Allocative System for Distributing Import and Export among Various Exporters and Importers

Models for trade flows in non-homogenous goods mean that the products produced by one country are an imperfect substitute for the same product produced in other country. For instance Argentinian grain is not a perfect substitution for Canadian grain in the EU's market.

This differentiation is caused by two reasons. Firstly, the quality of product produced by different countries may be different. Secondly, preferential treatment given either by exporter or importer.

Schmit and Vandenborre (1992) outlined that preferences in grain market are due to price factors (export price and transport costs), quality differences and existing long-run or short-run political, economic and cultural ties.

Cramer *el at.* (1993) utilised a global rice spatial equilibrium model to estimate the impact of trade liberalisation in twelve exporting and forty-six importing countries. The model also recognises product differentiation and allows substitution among various rice types and qualities. The model estimated a large increase in both trade volumes and price for all rice types. The importance of this work to the research is the model itself, which is a special equilibrium model which is modified for recognition of different quality of same products.

Johanson (1973) developed such a model for several agricultural products. The study by Blandford (1983) is a good example of such model in grain trade. This study on the Economics of World Grain Trade aims to examine the determinants of grain prices and the pattern of international grain trade.

In the first instance, they introduced a model for world wheat trade, based on above discussion. In this model the world is divided into six endogenous regions and an exogenous rest of the world. Six endogenous regions are subdivided to two group exporters and importers. Exporting areas are Argentina, Australia, Canada and the United States, importing areas are Japan and the EU.[45]

---

45 This categorisation is based upon the 1970s market situation, in which the EU was a major importer at that time.

Supply is also considered as an exogenous factor, thus the prediction of effect of change supply and other outside variables on world grain trade flows and prices are the main output of the model. Three main assumptions within the model are:

1. The marginal rate of substitution between any two kinds of wheat is independent of any other goods in the consumer's market basket.
2. The elasticity of substitution between any two kinds of wheat in a given market is a constant.
3. The elasticity of substitution between any two kinds of wheat in given market equals the elasticity of substitution between any other kinds of the goods in the same market.

The study outlined that on the import side, the EU's Common Agricultural Policy and Japan Food Agency controls import of wheat by variable levy and currency control. On the supply side the Canadian and Australian wheat Boards are domestic monopolists in the grain marketing system. Argentina has controlled exports through taxes, quotas, and multiple exchange rates. The United States apply export subsidies and limited quantitative controls and wheat policy and the rest of the world treated as exogenous factor. The result of the model is beyond the scope and interest of this work, because the structure of wheat trade has been changed dramatically since 1970s by appearing the EU as major exporter in 1980s and 1990s.

Dynamic Models

Dynamic behaviour of the agricultural market was first addressed by Schultz (1964). Proper consideration of dynamic behaviour as Blandford (1983) suggests is not important just in the evaluation of market performance but also in the analysis of the elective and distributive effects of policy interventions.

Nerlove (1988), outlined that supply in agriculture is represented by a mechanism of partial adjustment of production to prices. It models government action explicitly by using "transmission elasticity" which determines what proportion of a world price shock is passed through to domestic producers and consumers. It includes stockholding behaviour endogenously, and it estimates welfare effects on consumers and producers, and changes in government budgets and stock holders' profits. Finally, he concluded that the market is dynamic in nature. It means that it allows for differences in the short and long run effects of policy.

The paper by Wright (1993) considers models of agricultural markets in which the dynamics run in two directions, forward from current conditions to expectations of future prices, and back from price expectations to current decisions. Thus the policies will be analyse in the way that they could improve the market situation

He stated that the central challenge of market analysis in agriculture is to infer from market observations whether markets are behaving in ways that could be improved upon with the help of government policy. Considering his two ways directions model, the errors in the direction of intervention can often seem as consistent with economic intuition as they are pleasing to those who stand to gain from intervention.

The study by Patterson and Abbot (1994) analysed the relationship between export pricing behaviour and market structure in the US wheat and corn export sectors. The study used a pooled data set.[46] The cross-sectional components correspond to country destinations for US grain export.

The results for both wheat and corn showed that the export price mark-up was positively related to US exporter concentration in foreign markets. Also the results suggest that the pricing behaviour of US grain exporter does not reflect pure competition, as there is systematic price discrimination by destination which is related to the export market structure.

2.2.4 Effect of Government Intervention, Liberalisation and the Role of the CAP

The previous section discussed the studies which attempt to analyse the international grain market. This section provides the results of the models. Reason for models and results presented in separate sections is that, most of the studies are used more or less the same framework with different variables. Thus the results are different. Once the model has been specified the results of the studies could be compared and discussed in more details.

Most of the results confirm that the protectionism policies in agriculture affecte the three areas in grain market. Firstly, the level and patterns of the grain trade have been changed. Secondly, price level and instability of the prices have been affected. Finally, the welfare of both the countries which implement such policies and also other which did not implement such policies have been affected.

---

46 The elasticity of demand, market share and other market structure variables was estimated.

However, as mentioned in introduction to the chapter, these effects are so related and interdependent, that when one investigates a specific effect (for instance the interest of this research is to investigate the effect on volume and pattern of the grain trade) one can not ignore the others.[47] On the other hand, analysing their relationship while they are affected by other factors is very dynamic and complicated.

Existing literature contains a number of studies which provide some indication of the global impact of agricultural protection; and hence the gain that might be involved in liberalisation of agricultural trade. Government intervention in the pricing and marketing of grain has led to increased use of restrictive trade practices to preserve domestic price levels and ensure orderly marketing of domestically produced and imported grain.

The important issue regarding the agricultural protectionism policies is externalities and market distortions. The externalities are the effects of the policy on instability and the level of world commodity prices, the volume and pattern of international agricultural trade and welfare of the rest of the world. Studies regarding each effect are reviewed in this section under different subsection.

The methodological approach that is used in most studies to estimate the price variability, price level and volume of the trade due to protectionism policies is the counterfactual equilibrium analysis. There is no hard and fast rule for the choice of the appropriate counterfactual. Firstly, there was a need to define a measure of variability, then the price variability of counterfactual equilibrium is calculated (for CAP effects, equilibrium calculated without the CAP) and compared to actual price variability. 'Base case', depends on what the specific question addressed is, if the focus is on a cost-benefit analysis of the policy then the free trade competitive equilibrium is the obvious choice. If on the other hand, the objective is an

47 For instance, under the CAP the EU achieved self-sufficiency at the expense of cheaper imports. (i) Many of these imports come from developing agricultural exporting countries. Thus this damaged the export levels of these countries, and their international agricultural market reduced. (ii) High national prices created over-production which need more export subsidies to dump the EU surplus on the world market. Thus the international agricultural market has been depressed and consequently eroded the export earning of the developing countries. (iii) The EU common agricultural policy stabilised inside the union higher price while the instability in the world market has been increased. As price adjustment is prevented by the EU, the burden of adjustment is shifted into world market through exports. Moreover, variation in volume of exports created price shocks to the world market. This phenomenon increases the financial risk of export and can distort the investment in any export sector of exporting counties including port facilities.

evaluation of an alternative policy package,[48] then it is the appropriate counterfactual. The first approach is conceptually simple. The second requires a detailed spelling out of the components of the alternative policy package.

The counterfactual equilibrium analysis is sometimes misleading. Counterfactual world trade equilibrium, due to various factors, which is considered by different authors is calculated differently. Furthermore, counterfactual world price calculated by computations of free trade counterfactual equilibria is very sensitive to elasticity, and are based on various assumptions of demand and supply elasticity in the EU and rest of the world. However, accurate information of elasticity has never been available.

However, the estimates show that without the protection measures, the world prices for all agricultural commodities examined, significantly increased. The effect is more in wheat and coarse grain and dairy products. This is because these commodities received greater protection than others. (Sampson and Yeats 1978; Koester and Tangermann, 1985, p88).

In most studies the agricultural policies in developed countries in general and the CAP in particular have been pointed out as major influential factor within the market. Thus the liberalisation of the market considered by conterfactual equilibrium which either remove the CAP or reduced its support measures.

Trela *et al.* (1987) summarised how agricultural policies work in the three major trading area (the EEC, the US and Japan), with emphasis on their perverse effects on international agricultural trade. They also analysed how international agreements would not liberalise agricultural trade. The authors utilised a general equilibrium model with the world divided into nine regions. Results from this model suggest that the potential for gains from liberalising global trade in grain is large, even more than the gains from further liberalisation among developed countries in all manufactures.

Carter (1988) discusses the prospects and payoffs from more liberalised grain markets. He argued that the basic problems in world grain markets is one of oversupply in the developed world. Agricultural policies in the developed world will have to be liberalised, he argued or alternatively modified to reduce the over

48 Such as maintaining unchanged nominal support price for a certain period of time.

supply. If the EU decide to lower its internal price to world price levels, then its exports would be dramatically reduced.

The paper discusses some alternative approaches to measuring trade barriers. It then provides estimates the potential gains from freer trade in grains. The likelihood of success from agricultural trade negotiations is commented on.

An OECD study (1987a) utilised a partial equilibrium model for estimating cost to the consumer. The study assumed inelastic demand for agricultural products in the EU. Results shows the cost of agricultural policy to the consumer at about $28 billion in 1980 prices.

Tyers (1985) and Tyers and Anderson (1986, 1987a, 1987b) estimate the costs of the CAP alone and of the CAP plus domestic policies respectively. Their study is superior to others because, firstly, government intervention is entered into the model and assumed to be different in short and long-run. Secondly, the degree of disaggregation is higher than the others (24 countries in 1985 and 30 in Tyers and Anderson paper). Stock holding behaviour is also incorporated in the model. Compared to the previously reviewed studies which used partial equilibrium, Tyers and Anderson used a computable general equilibrium model which distinguishs between none, more and less flexible regions.[49] Different degrees of isolation of the domestic market are captured by price transmission equations, estimate significantly higher result regarding effects on GDP and total welfare than any other partial equilibrium study.[50]

Anderson and Tyers (1991) is a work based upon their previous work (Tyers & Anderson, 1986). The proposed aim of the study (partly) is to assess the potential effects of liberalising agricultural trade under Uruguay Round of GATT.

For this propose, the authors have used a simulation model of world markets for seven commodity groups (wheat, coarse grains, rice, ruminant meat, non-ruminant meat, dairy products and sugar). They use a partial, rather than a general, equilibrium model, because there was a need for a multi-commodity model to capture the interactions in production and consumption between these products. Furthermore, the agriculture accounts for less than 5% of GNP and the same amount of total trade volume in many industrial countries.

49 For example, the US and Latin America assumed to separate their markets less than EU.

50 It is 1.1% of GDP of EU-9 in 1980 and 1.3% in 1985. Transfer ratio is 1.88 and 1.2 respectively.

In the first instance the model was used to assess the effects of agricultural protection on price and trade, and then, to assess the impact on welfare in the protected countries and in other countries. The authors set out a number of qualifications to the results of their study, and then discussed the implications of the results for the post-Uruguay Round period. They suggest that a general equilibrium model would probably generate similar effects. But it may provide distortion effects on manufacturing and service sectors, land price, employment, etc.

Comparing this work with their similar work in (1986), the results are different because of the following changes (i) the results in 1991 are related to the years 1980-82, 1990 and 2000 rather than 1985, (ii) the results for the EU in 1991 include Spain and Portugal, (iii) all values are expressed in 1985 rather than 1980 American dollars, (iv) there have been slight revisions to a parameter of long-run price transmission elasticity which, the authors explain, was previously assumed to be unity, but was replaced by econometric estimates, which were typically less than unity.

McCorriston (1992) work is based on the EU's proposal in the GATT (WTO) Uruguay Round in December 1990.[51] He utilised a model of world cereal market. The EU objective to rebalance the cereal substitutes sector (soybean) was assessed by this model. The USA proposal for more reduction of agricultural protectionism was also considered.[52] The results show that the EU would have gained from the more limited reform proposal inclusive of rebalancing, while the US would have benefited more from her radical proposal.

Effect of Government Intervention on International Price Instability

Price instability in agricultural market has been an issue of concern. The main issue is that protectionism policies separate domestic prices from international price movements and tend to increase world price instability. The important feature of an analysis of world grain trade outlined by Blandford (1983) is that government

---

51 The EU proposed a 30% cut in agricultural support in OECD countries to be accompanied by a rebalancing of the CAP. The base year from which these changes were to be initiated was 1986.

52 The US proposed a 90% cut in export subsidies and a 75% reduction in all other trade distortions in OECD countries, with 1988 taken as the base year. For a more detailed review of how the negotiations relating to agricultural trade issues have progressed, see Rayner *et al.* (1990) and O'Connor *et al* (1991).

intervention has often been directed at domestic price stability and the resulting trade controls have reduced the stabilising effects of world trade.

Most of the studies agree that support price and isolation of a market (depending on the size of the market) have a significant effect on the stabilisation of world commodity prices. Furthermore international markets and the welfare of developing countries have been affected by this price variation.

World price variability is defined as the absolute value of the difference between expected and actual price adjusted for mean. This definition is based on the assumption that only unanticipated variations are harmful enough to trigger a surge in protectionism. There is another definition of price variability which is based on the premise that any price variation, expected or not, is associated with higher adjustment costs and is likely to encourage protectionism.

Calculation of price variability has been done by using either the coefficient of variation or standard deviation.[53] The standard deviation depends on the level of the mean (the price level), thus if the prices remain stable after liberalisation, the standard deviation will be different. There is a possibility that the coefficient of variation may be biased. Under the coefficient of variation method, instability is being measured by deviations from linear trend values.

Koester (1982) suggests correcting the coefficient of variation by the explanatory power of the trend regression to obtain a better measure of variability. By using random supply and demand shocks, most of the studies calculated the corresponding counterfactual equilibria and then apply one of the methods of standard deviation or coefficient of variation of the resulting distribution of prices to measure variability.

Yi Shei and Thompson (1977), suggest that price stability in the international wheat market will be achieved by more trade liberalisation. To investigate this, a thirteen-region quadratic programming model of world wheat trade is utilised to simulate three different experiments. The three scenarios are categorised by the level of restrictions, which are imposed by different regions. The mechanism and level of international price reflection into the domestic market are specified for each region. As the number of regions whose domestic markets respond to the world market

[53] Koester (1982:53-4) discusses at length the different measure of variability.

increased in the simulation, the instability of international wheat price is smaller in reaction to a shock.[54]

It was concluded that greater world market price variability results as more countries prevent the world market price from reflecting in their domestic market by various forms of trade restriction.

The share of price variability due to the CAP measures is high, and it is higher in the grain market. Thus the CAP is the most destabilising factor in the world markets. The reasons for the CAP being a major influential factor in grain price instability are that, the major instrument in this policy is variable levies. This instrument isolates domestic consumers from world price variation.[55]

Blandford (1983) estimate transmission coefficients that calculate the extent to which changes in trade rather than in domestic consumption are used to stabilise the domestic market. He concludes that the EU transmits a larger amount of domestic variability in grain to the world market than any other group of countries. This conclusion also implies that the transmission of short-term variability in domestic supply and demand is a major cause of price instability in the grain market.

Ardy (1987) criticises the Blandford's study on the basis that the analysis does not support the conclusion. Ardy rejected the analysis because the amount of instability transmitted seemed to be greater than that absorbed and secondly because the trade equation as specified could not be estimated as each country's production variations must be correlated with world price variation.

The studies regarding the effect of government intervention on international price instability could be criticised on two grounds. Firstly it is not clear whether all price policy measures increase instability, or whether they only increase it to some extent. While Bale and Lutz (1978) show that some protection measures do not effect world price instability, others estimate a different level of transfer instability to world price by different countries.

Secondly, world price in theory can be stabilised even if most countries insulate their domestic markets, as long as countries or private individuals operating in the free market hold enough stocks. Thus the issue is, ultimately, an empirical one.

---

54 The shock such as anticipated change in former soviet imports or U.S. export controls.

55 See Matthews (1985a:211).

Bale and Lutz (1981) using different models demonstrate that various trade intervention policies have very different effects on the instability of international prices. They provide a comprehensive analysis of different trade restrictions and of how and to what extent the protectionism in agriculture affectes price instability.

This study outlined the factors, which may cause instability in the price of agricultural products. The authors suggest that among other factors, such as supply fluctuations due to output variations resulting from natural phenomena, the break-down of buffer stock arrangement and fluctuation in demand over the course of business cycles, government intervention in agriculture is the main factor. It is not only the policies themselves but also the relative size of the countries implementing the policies is an important issue. The study concluded that by substantial liberalisation the stability of the prices would be greater.

Meike and deGorter (1989) theoretically demonstrated world price variability and the protectionism. They also concluded that different trade and domestic policies generate different degree of price variability and that a move away from free trade need not exacerbate price variability.

Anderson and Hayami (1986) looked at protectionism and price variation from different a perspective. They argued express that during the last three decades, the aim of agricultural policies in many developed countries was to raise and stabilise the price for agricultural products. The common approach adopted to achieve such objective is to insulate the domestic market from the unstable world market. Therefore, the "protection level in agricultural policies fluctuate substantially around their long-run upward trends in response to fluctuation in international prices" (Anderson and Hayami, 1986:4). They conclude that the fluctuation in international prices caused agricultural policies to be dynamic changing all the time.

Larue and Ker (1993) investigate the direction of the prima facie causal relationship between unanticipated world price variability and protectionism policy and determined the sign of the effect of protectionism on world price variability. They conclude that prima facie causality from unanticipated world price variability to protectionism especially is significant for the EU and Japan. This is because these two countries attempt to stabilise their domestic prices more than the others. This discussion is similar to the Meike, K. D. and deGorter (1989).

Effect of Government Intervention on International Price Level

A number of empirical studies have analysed the EU and other major traders' agricultural policy. Some of the results which are more specific to the EU are Koester (1982), Sarris and Freebairn (1983) and Anderson and Tyers (1984). They estimate that world wheat prices would increase by 9.6, 17, 9.2, 13 and 9% respectively, with the removal of the EU wheat policy. Sarris and Freebairn (1983) and Anderson and Tyers (1984) conclude that the EU is responsible for 85% and 65% respectively of the decrease in world wheat prices due to the agricultural policies, while Carter and Schmitz (1989) argue that the EU (in conjunction with Japan) depress world prices by up to 50%.

Loo and Tower (1988) argue that liberalisation of agricultural markets will lead to economic gain in the developing world. They estimate that a 10% increase in the price of agricultural commodities would increase the income of developing countries by $26 billion per year (in 1985 dollars).[56]

Carter, Mccalla and Schmitz (1989) reviewed seven different mathematical world trade models. Each model made projections about the impact of freer trade in agricultural products. The models were consistent in that they projected gains to the developed world from trade liberalisation in the developed world in wheat and coarse grain markets. Most of the models predict price increases from a few percentage points to more than 25%.

The OECD (1987) study which utilises a partial equilibrium model emphasised multilateral liberalisation. The study predicts a counterfactual equilibria which is not free trade equilibrium, but a reduction on nominal protection across the world. The study estimates that liberalisation of the EU market would cause prices to fall. This is because of the decrease of demand for feed grain. Thus again the calculation of counterfactual prices is important for estimation of the effects of trde value on world price level in the international grain market. This is because they give a basis for the estimation and also provide the amount of distortion in the world market.

Meilke and Gorter (1988) analyse the impact of the CAP on wheat's international prices. The results of this particular work indicate that the CAP has a smaller impact

[56] Of the $26 billion gain, close to $22 billion arises from indirect effects resulting from a 10% increase in price.

on world price, than is found in previous studies. Many factors has been left unattended in this study. These could be highlighted as; imperfect substitutability in demand between imports and domestic products, the simultaneous import and export of wheat by the EU, the distinct impact of threshold price,[57] monetary compensatory amounts,[58] intervention price policy and imperfect transmission between intervention and market prices.

According to the paper, the simultaneous import and export of wheat by the EU relaxed the impact of the CAP on international wheat prices.[59] Three different policy experiments simulated (1) an elimination of monetary compensatory amounts (2) intervention price set same as international price and (3) both intervention and threshold price set equal to international price. Any changes in wheat price are assumed to be applied into the coarse grain sector.

The effect of the elimination of monetary compensatory amounts (MCAs) is to raise domestic prices in countries with depreciating currencies and high rates of inflation, and lower price in countries with a low rate of inflation and appreciating currencies. This results in an increase of wheat production of 2% and little decrease in consumption.

By a reduction of 15% and 16% of EU's wheat intervention price, the level of EU prices are set to international prices. As a result the EU's production declines by 9%, 5.1 Mt of domestic wheat is substituted for 2.9 Mt of imported wheat, net exports decline by 7.5 Mt (124%) and world price increases by 5%.

By setting the intervention and threshold prices equal to world market prices, when the estimated excess demand elasticity value of -19.1 is used, world market price is slightly higher than the previous experiment. However, the farm prices for wheat declined by a further 5% and production declined by a further 1.2 Mt. Wheat demand increased by 0.5 Mt as imported wheat replaces more than an equivalent tonnage of domestic wheat. Overall results from the simulation model suggest that, the intervention prices have a significant effect on world market prices, but the estimated figures show less impact compared to other studies of EU grain policy.

---

57 Threshold price is the price set at the EU's frontiers which must be reached by imports. It insures that the target price cannot be undercut by importers.

58 Compensatory payments were introduced to compensate farmers for their loss in earnings. Receipt of compensatory payments is conditional upon the setting aside of land. The payment is calculated on the basis of average yields in each farming region.

59 See Appendix 2 for the models.

The higher the domestic reaction to liberalisation the stronger the impact on world price will be. The factors which account for the differences in results are the different country and commodity coverage and the base year. Anderson and Tyers (1984); Tyers and Anderson (1986, 1987b) and Matthews (1985a), all use multicommodity models and estimate that the impact of the liberalisation on individual commodity prices are different. The models which are utilised for few products and which do not consider the market interaction predict higher counterfactual prices. Thus these studies overestimate the effect of the CAP on world prices. Sometimes only a few markets have liberalised, then the pressure from the other(still protected markets) will spill over via substitution, and the observed effects will be amplified.

Effect of Government Intervention on Domestic Welfare

The simplest way to examine the effects of price support on domestic welfare[60] and international trade is the single good partial equilibrium analysis. This analysis assumes that the country is a price-taker in the world market. This "small country" assumption means that, no matter what the level of domestic protection is, the world prices would not influenced by "small country" measures.

Estimation of the effects on welfare has been affected by many scholars with different assumptions commodities and models. In the case of the EU which is a large country, the analys are different.

The basic method of intervention in the EU is price support. This is achieved by a variety of instruments. The price support policies of CAP, where a wide range of commodities is covered, can have a considerable effect at home, such as on total employment and the allocation of capital and labour. This would affect other sectors of the national economy. Such interactions can exert a significant influence on the welfare gains or losses from agricultural policies. Given the range of coverage of the CAP, macroeconomic considerations should be born in the mind. The CAP price support could have sizeable effects on the external balance of the economy and consequently, the exchange rate and/or the relative price of tradeables and non-tradeables and shift the general supply and demand curves.

The majority of the studies treat the community as one entity, although some provide estimates of the effects on a country by country basis. Most of the studies

---

60 Domestic welfare is referred to the country which implies agricultural protectionism policy.

also view the total welfare cost in terms of consumer and government (or taxpayers) loss and producer benefit.

With the exception of Koester and Schmitz (1982) all of the studies used multi-sector models, covering all or most of the CAP commodities.[61] Most of the welfare analyses refers to counterfactual world price under free trade and calculate the welfare costs.

Agricultural lobbies in the EU are always opposed to the liberalisation of the CAP without considering its budgetary and welfare burden (Koester, 1985; Gerken, 1986). Koester (1977) postulate that as long as the member states are able to supra-nationalise costs of national support, radical reform of the CAP measure could not be secured.

Josling (1979) has discussed the Expansion of the EU to southern Europe. He concludes that the CAP's coverage of a wider range of products and shifting the political balance within the EU, increase the CAP's costs, contribute further to a budgetary crisis and increase the international effects of the CAP.

One of the studies which attempts to estimate the effect of the CAP on individual members is Breckling *et al.* (1987). Using a general equilibrium model, they estimate the effects of the CAP on four EU members (Germany, France, Italy, and United Kingdom). They suggest that the CAP's effects extend beyond the welfare framework analysis. For all countries taken together, manufacturing industries lose between 1.1 and 2.5% of potential gross output and between 4.4 and 6.2% of the exports and total employment is reduced by around 1%.

Buckwell *et al.* (1982) also estimate the welfare costs by country. They estimate the transfer ratio as 1.50 for the EU as a whole. It is highest in the UK (2.07) and Italy (1.87). Spencer (1986) ranked the members by their gain from the CAP. By using a general equilibrium model he evaluates which country would do better outside the CAP, and by how much. The only loser was Ireland. Denmark gained the least. Comparing the study by Spencer with the one by Buckwell *et al,* the main difference is Netherlands. In the former Netherlands appears to be losing from the operation of the CAP while in the latter the less than unity transfer ratio indicates that the country is benefiting. The results of the studies of the EU welfare could be

---

61 They examined the effects of the EU sugar protocol (a mixed system of price support and quotas) on LDCs, inter-EU transfers and the EU welfare.

summarised into two categories: a low, with net losses ranging from 0.32% to 0.55% of the EU's GDP.

Morris (1980) using counterfactual free trade prices estimates the effects of price support for the main CAP commodities. The counterfactual free trade prices in this work are not the results of free trade equilibria, but are postulated *ad hoc*.

The market for 16 groups of agricultural commodities was modelled by Thomson and Harvey's (1981). The interaction is captured by a set of cross-elasticity. This study evaluates the CAP with respect to its stated objectives and does not address the wider social costs. Measure of overall efficiency is the transfer ratio of 1.77.[62]

One of the few studies which takes into account intra-EU transfers resulting from community preference schemes, the common financing of the CAP and MCAs[63] is Buckwel *et al.* (1982). Their model also includes many commodities and markets, and the effects of the CAP on these markets which are connected by cross-elasticity.[64] The results in this paper could be compared with Thomson and Harvey's (1981) and the study by the Australian Bureau of Agricultural Economics (1985). However, the latter one treats the EU as one entity but distinguishes between different commodities. Their results imply significant costs from the operation of price support around 0.3% of total EU-10 GDP.

Effect of Government Intervention on Welfare of Other Countries

Studies in this field mostly used partial equilibrium model with different coverage in terms of country and commodity. However, they agree on two issues, a) the amount of the effect on each group country is not large compare to their GDP or their total exports and b) removal of the CAP would results in losses for developing countries and the effect on developed countries is under doubt. Regarding the partial equilibrium model, the result should be treated with caution. Since the secondary effects on the non-agricultural sector have never been under consideration.

As a result of the CAP effects on the international agricultural trade, real income of non-EU countries has eventually been affected. The common view as outlined by many studies is that a unilateral liberalisation in the EU will benefit the exporters

---

62 The transfer ratio is the cost to the economy of an increase in farmer's income by one unit.
63 Monitory compensatory amounts.
64 These study is similar to that of Thomson and Harvey (1981).

and harm the importers of Temperate Zone products by increasing their prices (Anderson & Tyers, 1984; Matthews, 1985a; OECD, 1987). The CAP transfer income from EU consumers and taxpayers to less developed countries through cheaper prices.

Estimation of the effect on non-EU members shows large degree of differences. Studies by Koester (1982) and Koester and Schmitz (1982) show less impact compared to others. This could be due to the commodity coverage by these studies which are cereals and sugar respectively.

Matthews (1985a) estimates the smallest effect on LDC. As he predicts a low amount of commodity protection and smaller supply elasticity than other studies.[65] Anderson and Tyers (1984) adopt a different counterfactual experiment. They predict the effect of a 2% annual decrease in EU support prices from 1981-1990. The results of their study is hard to interpret. However, the final effect of the reduction in support is significant but it was never compared with total liberalisation.

The most detailed model with a high degree of disaggregation was utilised by Tyers and Anderson (1986, 1987a). They estimate the highest welfare loss for developing countries. They suggest in their 1986 study that developed countries will lose due to the increase in grain prices resulting from the liberalisation effect.

Studies regarding the effect of government intervention on the welfare of other countries could be criticised on the basis that, categorising the countries under developed and developing countries and reviewing the effects on each group could be insufficient. There is a need to understand how the gains and losses are distributed among the countries within each group. Distribution of the effects within the groups is dependent on whether the country is net importer or exporter of the product.

There are two other different criticisms regarding the results. Firstly, reliable long-run supply elasticity measures are not available which makes it difficult to measure the potential switching effect accurately. The second criticism is the limitation of the methodology (partial equilibrium methods).[66]

---

65 Extensive empirical research has shown that long-run supply elasticity in LDCs are rather low, fluctuating between 0.1 and 0.3 for grain (see Bale & Lutz, 1979b; Scandizzo & Bruce, 1980).

66 A unilateral liberalization in the commodity trade will also affect other sectors of the economy.

To overcome such problems, general equilibrium model have been used. Burniaux and Waelbroeck (1985) use this model to calculate the effect of liberalisation of the CAP in 1985 would have on the welfare of developing countries in 1995. They suggest that the income of the developing countries would rise by 2.9% by liberalising the CAP. This estimate could be explained under the assumption that developing countries are facing a shortage of foreign exchange. Thus they should rely on agricultural exports. Therefore, the increase in agricultural prices would benefit the developing countries.

There is another view in favour of gains by developing countries which argues that if the EU income rose as a result of a more efficient allocation of resources through liberalisation, developing countries would earn more by increased demand for their export. With the exception of Mathews (1985) many other studies did not consider such effects on the welfare of developing countries. Thus there is a possibility of an underestimating of the effects.

A general summary of the quantitative analysis in this section could be as follows: all countries would not lose due to the price support of the CAP. Thus liberalisation would bring gain to some and loss to others. In particular net importers of agricultural commodities would lose due to removal of the CAP whereas the net exporter may gain. Distribution of gain and losses are differing among the individual countries, although the amount of the effects is small.

Effect of Government Intervention on Pattern and Volume of Trade

Estimation of the volume and pattern of trade, either by multilateral trade liberalisation or abolition or reduction of CAP protection has been done in many studies. With the exeption of one study Tyers and Anderson (1986) all studies report that the CAP decreased the volume of trade by considerable amount and liberalisation of it increases the trade volume. This is due to large increases in EU imports, prompted by lower consumer and higher producer prices. Researchers use different notations to provide their estimations or without any quantitative results, based on different assumptions provide some comments.

There are different results provided by the studies. This is because of the data differences, the methodologies which are used in the studies and the parameters used (e.g. domestic demand elasticity).

The estimation of the studies on the effect of the CAP on international trade could be summarised as the CAP depresses the international agricultural prices. As a consequence of that, trade flows are severely distorted. The EU exports have increased at the expense of net exports of other countries. This process keeps the volume of world trade at a lower level than it would otherwise be. They finally conclude that these effects are more significant in agricultural markets which are heavily protected such as wheat and coarse grains.

Schnittker (1993) suggests that the agricultural trade expansion (including grain trade) does surely not depend on trade liberalisation or free trade,[67] although the rate of expansion does. On one hand, the author refers to the factors which limit free agricultural trade, particularly trade restrictive measures associated with the EU, and Japan's agricultural policy. On the other hand, the factors for influencing expansion of agricultural trade are highlighted by the authors. These are the demand for livestock products, difficulties in former USSR, new relationship of China with rest of the world, and indications that even with Green revolution spreads, the developing countries have difficulty in meeting their food needs.

Roarty (1985) explained that under the CAP the EU reached self-sufficiency in many agricultural products including grain. Moreover the EU began to erode the markets of other countries by becoming a major food exporter. It has achieved this status because there was no cheaper way of releasing surplus food.

The growing volume of subsidised exports reflects a policy of dumping surplus production on the world market which has significantly depressed world prices. Thus hard-pressed exporters in other countries not only faced declining demand due to EU protectionism but also suffered the added disadvantage of lower world prices. An analysis referred to by the author indicates that abolition of the CAP would result in 13% increase in wheat prices and a 14% increase in the volume of world trade.[68]

The paper is emphasises on the changing direction of food trade from developing countries to industrialised countries and *vice versa*. It indicates that "while the industrialised countries spend lavishly on farm subsidies in the quest for self-sufficiency, developing countries tax their farmers in order to finance industrialisation. Weak financial incentives have discouraged food production and

---

67 Mostly depend on population growth.

68 Study quoted in agricultural policies in the European Community, *op. cit.*, p.156.

help to explain why, on, balance, developing countries have become net importers of food."

Roarty (1985) examining the external effects of CAP. Refers to the distorting effects on world trade in general and the damaging effects on the economic development of countries which are largely dependent on agricultural exports. He contends that for many developing agricultural exporting countries, the agricultural protectionism of the CAP has led to the reduction in their share of world trade in commodities like sugar and grains as high-cost EU production displaces lower-cost imports from outside the EU.

A general comment on the studies in this section is that, in the EU self-sufficiency has created a need to find export out lets. As a result of the CAP the EU has emerged as a major exporter of sugar and grains.

Mackel *et al.* (1984) approached the issue in another way. They analyse the CAP effects on many protected commodities. However, they also considered the impact of the CAP on trade of products which were protected. They suggest that the CAP has increased imports of substitute products to the EU. These products are manioc and Soya.

2.3 Relationship Between Market For Ocean Grain Freight and International Grain Trade

In this section of the literature review the studies regarding market for ocean grain freight services and relationship between this market and international grain market are reviewed. The aim of this section is that, through the reviewing the existing literature and their findings one could specify how these two markets may effect each other, and how dry bulk carriers perform in the grain trade. Furthermore it could provide a criticism of the studies which were reviewed in two previous sections.

The majority of the studies in shipping literature reviewed in Section 2.1, attempt to analyse the supply and demand for shipping market, considering the demand for shipping to be totally inelastic to supply and derived by final demand for goods.

On the other hand, new classical models of international trade assume a frictionless environment in which transport costs are not considered in the models. In international agricultural trade models, transport costs are also often ignored. They are considered as a function of distance between trading partners, or alternatively, to be a simply fixed proportion of commodity prices.

How Bulk Carriers Perform in Grain Trade

Bulk carriers are involved in a wide variety of commodity trades, ranging from grain, Iron ore, and coal to semi-manufacture products. Therefore it is important to understand how they could perform in international grain trade. This is essential for a specific analysis of any effects of agricultural policy on the structure of demand for bulk carriers. This section reviws the views of the authors who attempted theoretically to analyse this issue.

Seaborne grain trades are considerd to be transported mostly by general-purpose bulk carriers.[69] Harris (1983) outlined that more than 93% of grain is transported by tramp services. The market is unrestricted and rates are set by bargaining between shipper and ship-operators. Thus as there is no economic or diseconomy regulation, it could be considered as a perfect market. In such a market the supply function for bulk carriers is highly elastic at lower price and inelastic at higher prices.

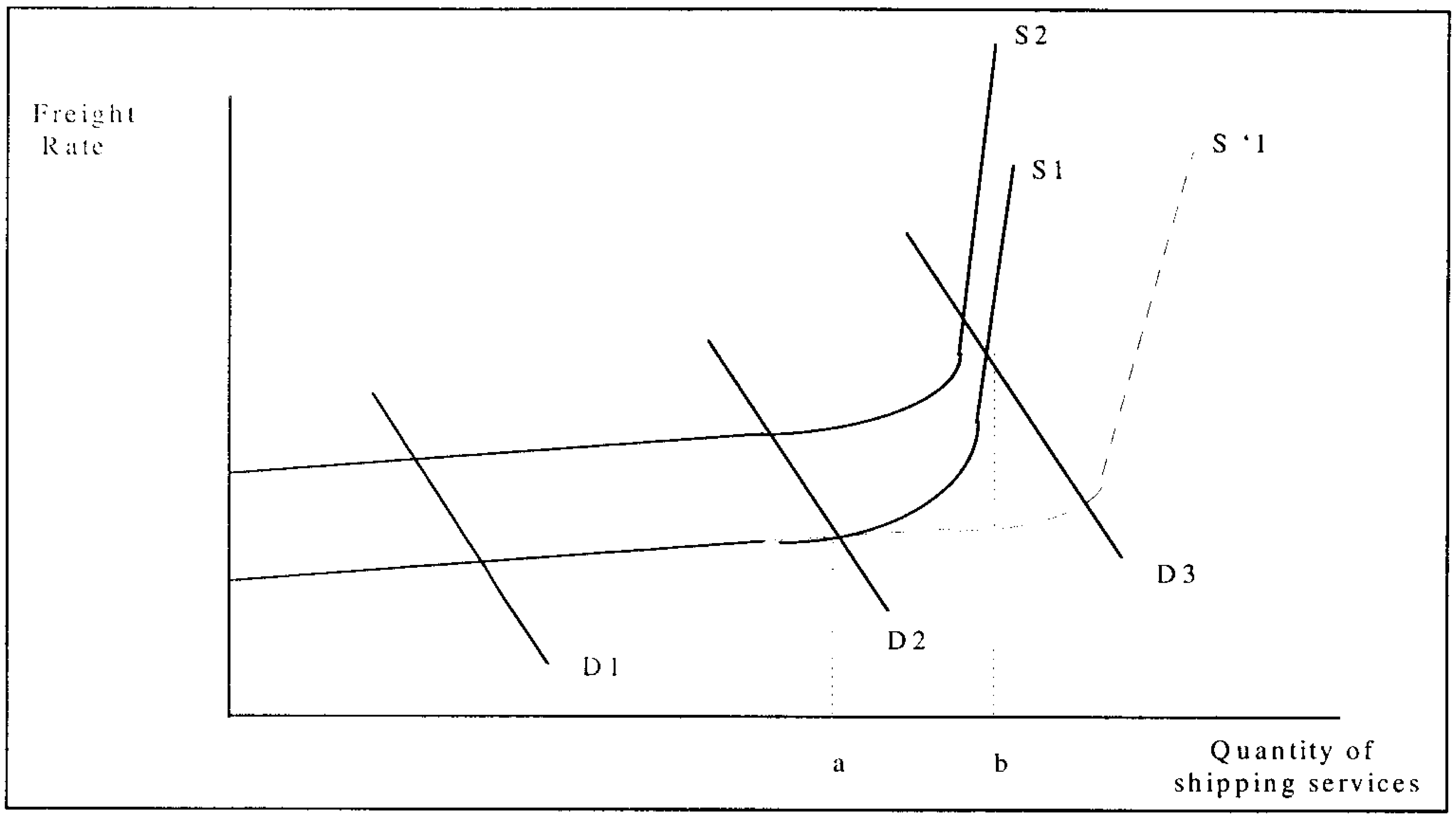
Dunn (1987) assumed that the grain freight market is a competitive market with an asset fixity problem analogous to that of production agriculture, that in the short-term the supply of shipping for grain trade is limited, but high demand induces operators of other bulk commodity markets (e.g. ore, coal or even oil) to penetrate the grain ocean transport market. Furthermore, grain only accounts for a portion of the total dry bulk trade. Consequently, the supply function of shipping capacity for grain is subject to change as events happen in other dry bulk commodity markets.

A model for the ocean grain market based on the above assumption has been exployed by Dunn (1987) and also by Hsu and Goodwin(1995) to explain how bulk carriers perform in the grain seaborne trade. The model is as follows:

---

69 See Binkley and Harrer (1980); Nagatsuka (1986).

Figure 2.3: Model for Ocean Grain Market



Source: Hsu and Goodwin(1995)

The analytical model shows that demand shocks do not produce considerable changes in freight rate if these occur along the flat portion of the supply curve D1, D2. However, if such changes happened to be in the vertical portion, they bring about large increases in freight rates (e.g. D2, D3).

Supply shocks lead to considerable changes in freight rates. These shocks may occur as result of changes in any variable inputs (e.g. fuel prices). Thus the volatility in grain freight markets may result from supply and demand shocks. If the capacity utilisation is relatively low, market demand shocks would be expected to have little influence on the freight rates, while supply shocks significantly influence the freight rate in this market situation. In high capacity utilisation of the market demand shock may influence the rate significantly.

Hsu and Goodwin (1995) developed a vector autoregressive model to evaluate the dynamic elements of the ocean grain transport market. Dynamic relationships are evaluated, using monthly data that include ocean freight rate for grain, monthly grain shipments, idol ship tonnage (in the dry bulk commodity market), new ship deliveries (in dry bulk market) and fuel prices. The data for five variables covers the period Jan 1978 through to May 1990.

The stationary properties of the five variables are considered, using Dickey Fuller unit root tests. The results show that the data are not stationary. Thus Litterman's prior is applied in the estimation and seasonal dummy variables are included in the model to account for seasonal effects not captured by the five variables.

Empirical results of estimation using VAR models such as impulse responses and forecast error variance decomposition are generally not invariant with respect to the ordering of variables in the system. The ordering implies a casual chain, which in turn influences the results.

The results illustrate considerable lags in adjustment to market shocks. Freight rates are not responsive to demand shocks. In the short term freight rates are influence by any shock in fuel price. In contrast freight rates decrease as a result of new delivery.

Generally speaking, the results imply that the adjustment to the market shocks is relatively slow. The other important conclusion could be one concerning the dynamic nature of the freight market.

The Importance of the Shipsize in Grain Trade

Economies of size have been realised in the dry bulk carriers market in the last three decades, when an expansion in market movements of grain (during 1970s) have increased the volume to be transported. Large volume shipments to export destination provide an opportunity for reducing costs of transport.[70] Furthermore, the market has gradually become differential by size. A number of sub-markets has been approved, base on tonnage of the ships[71] (handysize, Panamax, Capesize in dry bulk market). This section provides different views on how shipping cost may influence different shipsize to contribute to the international grain trade.

The discussion of economies of scale for ships has led scholars to investigate the involvement of different shipsizes in grain trade. The main arguments relate to port and at sea cost. Shipping cost should be divided into at sea cost (e.g. fuel) and port cost (e.g. port charges)[72].

---

70 Economies of scale for normal trade practice suggest to use the largest ship that can be accommodated at both origin and destination ports.

71 Glen (1990) and Kavussanus (1996) show that the risk characteristics differ by size, and that profit margins vary across routes. This is taken as evidence of the differentiation within the market.

72 Directly depends on the time a ship spent at port for loading or discharging.

Ships of all size spend a large part of their operational lives in port, and this idle time adds substantially to the cost of providing shipping service. Technological progress has made possible the construction of larger, faster and more economical ships. The argument is that the at sea cost savings achieved by larger vessels are too often negated by excessive idle time in port, during which many costs continue unabated.

Many studies have given general indications of the proportion of time which vessels spend in port, (e.g. Goss, 1967; Heaver and Studer, 1972; Robinson, 1978; etc). Heaver and Studer (1972) focus on time spent in port by each ship size regarding the grain trade. The main argument of this study is that, whether port time increases as ships get larger. The purpose of this study was to investigate this issue for ships which have loaded grain in the port of Vancouver. The data include the 1305 observations on grain loading in the port. This sample data constitutes the entire population of ships which loaded more than 5000 tons of grain between 1964-65 and 1967-68.

The ship's types range from small general purpose tramp ships to the largest bulk carriers and tankers diverted into the grain trade. The actual distribution of load sizes observed in the sample is presented. For each crop year the range of observations is considerable, and can be noticed that the dispersion increases over time. The largest cargo loaded in 1964/65 amounted to some 29,000 tons, whereas the largest cargo loaded in 1967/68 was 84,000 tons.

The main part of this study is the analysis of loading time and rate and vessel size. This part is decomposed into three. Firstly, the relationship between loading days and ship size was examined. Secondly the relationship between ship size and loading rate was examined and finally at this stage the number of berths visited by a ship was introduced as influential factor.

The base hypothesis of this study specifies that larger ships spend more time loading than smaller ships. The evidences in this work supports such a hypothesis based on the average number of loading days which increased from 4.50 to 4.74 days over the first three years but fell to 4.17 days in 1967/68, the year during which average vessel size declined. Regression of ship size against loading time in this particular work showed that the proportion of loading time which can be attributed to ship size is very low.

To produce more significant results the authors regressed ship load against loading time and in this case the relationship improved for 50% of the variation in loading time.[73] The relationship between vessel size and loading rates was quantified by regression analysis. The results reveal that there is a distinct tendency for loading rates to increase with ship size.

In the next step of the study, by combining time costs for different sizes of vessels[74] with the vessel loading rates obtained in this study, the authors estimated the time costs of loading cargo for different size ships. The results support the hypothesis that cargo loading costs decline as vessel size increases. Thus this results supports the notion of economies of scale at port as well as at sea for larger vessels involved in grain trade.

Kendall (1972) introduced a theory of optimum ship size by investigating the market for grain and ore ocean transport. The determinants of optimum ship size have been specified and calibrated for two sample commodities (grain and iron ore) in this study (this review emphasises calibration of grain sample). In addition to basic assumptions which assume normal trade, the practice is to use the largest ship that can be accommodated at both original and destination ports that happens to be available at the time. The author assumes that volume of trade, length of route and value of product could be of importance in determining the ship size.

The optimum ship size for grain is derived by direct observation of the port of Rotterdam, and comparing these observations with the theory of optimum ship size. The optimum ship size defined by the author will be that which minimises the total transport costs. These costs include not only the cost at sea but also the port costs.

The total transport costs is obtained by the combination of shore and ship charges. Before the effects of changes in volume of trade and distance on optimum ship size are investigated. For a given volume of trade and distance, the ships are economically discouraged from being above a certain size by the cost per ton of handling and storage rising faster than the fall in ship costs per ton.

Based on historical observation rather than theoretical analysis, the author suggests that an increase in turnaround time for larger ships would tend to reduce the optimum ship size for a given volume and distance, and *vice versa*.

---

73 This regression was introduced to overcome the problem of partial cargoes loaded.

74 The daily vessel costs used are derived from the cost of bulk carriers estimated by Heaver (1968).

The optimum ship size to carry grain, for a round voyage of 10,000 miles and 1 million tons per year has been established as 40,000 dwt. Finally, the author comments that based on assumptions, trade volume, value and distance are the basic influential factors for the optimal ship size. Ship size could be changed annually on specific routes.

However, there is a strong body of evidence that larger ships have less opportunity in grain trade due to many constraints. These constraints as highlighted by Drewry (1994) are as follows:

The grain trade which is extremely diverse and volatile makes for unpredictable trade patterns which in turn makes investment in port facilities for large vessels uneconomical.

- Small shipment of grain
- Cargo loading/discharging rates restrict shipload size.
- Port infrastructure in many developing countries is unsuitable for vessels in excess of Panamax size.
- The spot freight market nature of much grain business does not offer the same level of employment security as the iron ore and coal trades, which is an important consideration for owners of "Capesize" bulkers.
- The North Atlantic grain trade is unlikely to be the same as in the 1970s, due to high production of grain within the EU.

Therefore wherever and whenever these factors do not exist, the opportunity for large ships in grain the trade will increased.

Impacts of the Freight Rate on International Grain Trade

The previous section suggests that bulk carriers of different size may be influenced by shipping costs in their contribition to seaborne grain trade. This section prepared to outlines how bulk carrier performance in grain trade may affect international grain trade, by referring to previous studies.

Transport costs still play an important role in the economics of commodity markets. There was a big reduction in ocean freight rates due to technological improvement in freight rates by the end of the nineteenth century. During the twentieth century the rate of decrease has been much slower in the 1980s with freight rate representing about 10% to 30% (depending on the destination) of total grain prices.[75]

The importance of transport in grain flows is discussed by Fedeler and Heady (1976). This study focuses on inter-regional transportation (inland transportation) of grain within the USA between place of production and US ports. In this study, they conclude that specific variation in transport costs creates substantial changes in the volume and directions of individual interregional grain flows, but only small changes in the location of production and in the total flows.

Binkley and Harrer (1982) outlined that many factors which are specific to shipping may influence ocean freight rates for grain, and freight rates are not directly proportional to distance. Geraci and Prewo (1977) also note that the use of distance as a simple proxy for transport costs has not proven to be very effective in predicting grain trade flows or volume.

In contrast to the general shipping models which are reviewed, Dunn (1987) suggest that the cost of transport may be substantial in the trade of a commodity. He added that this is specially true for agricultural commodities, which generally are of low-value and bulky, making the transport cost a substantial proportion of the delivery price.

Work by Binkley and Revelt (1981) analysed the major determinants of cross-sectional differences in freight for sea transport of grain. The main focus of this analysis is on the factors which produce rate differences and not on the level of rates. The study differentiated between the effect of port costs and at-sea costs on rate differences. It also estimated the effects of major port areas on rates. Hence the role of these factors in determining comparative port advantage in grain trade is examined. The most important feature of this study is that it shows the relationship between international shipping and the comparative advantage of countries in the world grain trade.

In this model ocean grain trade is considered to be transported mostly by general purpose bulk carriers. Freight rates are specified by shippers and ship owners, negotiating through brokers, and there is no economic regulation governing the market. In a general form, rate differences are defined as following:

---

75 Roehner (1996), also see Appendix 1.

RATE: f(DIST, SIZE, TERMS, QUART, FLAG, VOL, PORT),

where RATE is rate (dollars per long ton),[76] DIST, voyage distance (thousands of miles); SIZE, shipment size (thousands of tons); Terms, loading and unloading terms,[77] FLAG, registry of ships (U.S. or foreign); QUART, quarter in which the shipment occurred; VOL, volume of grain trade on route in question, 1972-76 (hundreds of shipments); and PORT, origin/destination port area of shipment.

This model does not consider input price factor. As these factors assumed are to be sufficiently invariant across routes and therefore have no perceptible impact on cross-sectional differences. Two linear models were estimated using OLS. The first one is designed to analyse the average effect of the variable described previously and the second model examined issues dealing with economies of scale, port costs, and at-sea costs. The dependent variable is freight rates.

The evidence provided, indicated that the average freight rates declined steadily as average shipment size increased. The other interaction effect examined was to determine whether the functions relating rates to distance vary across shipment size class. The results provide support for the diseconomy in port and economies at-sea hypothesis.[78]

The analysis also confirms that shipping distance may be insignificant if large vessels are employed. The author suggests that the grain producer's competitive position depends not only upon production but also on his advantages in shipping. The critical factor in shipping advantage is the nature of port systems at origins and destinations. The results suggest that the rates from port areas near major trading routes[79] are lower than those from areas less favourably located.[80]

The results also showed that less developed countries are at a competitive disadvantage in world agricultural trade regarding shipping transportation. The average rate to less developed countries is more than twice that of North Central Europe and Japan and substantially above the average to other areas.

---

76 A long ton is 2,240 pounds. Throughout the balance of the discussion, the word "ton" is understood to mean "long ton".

77 The loading and unloading terms are described in the contract of carriage.

78 Because as size of ship increases, such factors as horsepower and manning requirements increase less than proportionally, so use of larger ships presents a means of lowering costs, or at least those costs incurred at sea. However, both Kendall (1972) and Janson (1978) have claimed that port costs rise with size of ship.

79 South Africa, the eastern part of the United States and Canada.

80 Great Lakes area, the North Pacific Coast and Australia.

Roehner (1996) analysed the effect of changing transport costs on volume, volatility of prices and levels of spatial prices differentials in various agricultural commodities and compared them. He used a stochastic model rather than a deterministic one to provide prediction for variables (volume, volatility of prices and level of spatial price differentials).

Port fees as a part of the transport cost, play an important role in grain flow to the exporting and importing ports. The extent to which port charges alters the flows of trade seem to depend on the magnitude and the form of the fee. An input-output model was used by Bushnell *et al.* (1984) to analyse the effect of port user fees on various sectors of the economy. They concluded that, the effect of the user charge would be small. The agricultural and other large volume commodity trade market were to be the most affected.

Deaton and Loroque (1992, 1994) noted that in a dynamic model, storage and transport costs play an important role in final agricultural prices, and subsequently on trade volume and flows. Viseencio and Fuller (1986) evaluate the impact of the deepdraft port user fee on grain export flow patterns, and of the marketing system adjustment costs which may result from diverted flows. The result shows grain patterns to be affected by port fee which is largely based on weight .[81]

Barnett *et al.* (1982) used a network model to evaluate US port capacity constrain and its effect on national and international grain trade flows. Koo and Uhm (1986) developed a spatial equilibrium model based on quadratic programming algorithm to analyse the interdependency of trade restriction and ocean freight rate on the spatial price determination for US wheat. Koo and Thomson (1991) analyse the effect of changing freight rates on the US grain industry. Their analysis is based on spatial equilibrium theory and a mathematical programming model developed to evaluate the impact. Their results show that changes in ocean freight rates at a particular route and port affect not only seaborne trade pattern from US ports but also US domestic grain flows.

Most studies have been concerned with the relationship between the efficiency of domestic grain distribution and transportation costs as well as capacity. Trade flows in grain are affected more by changes in ocean freight rates at a particular route than by a uniform change on all routes. If freight rates change uniformly on all routes the

---

81 The port fee might be based on weight or value (*ad valorem*).

trade flow does not change but the overall volume of trade would. Several works also analysed the effect of inland waterway user charges on grain producers and participants in the grain marketing system (Binkley 1983).

The Centre for Applied Research at the Norwegian School of Economics and Business Administration has also undertaken a considerable amount of theoretical and empirical studies on the shipping markets. These include the few works which model the demand side of the shipping market.

One of these studies is Eriksen (1983) which considers different pattern of dry bulk commodity trades in terms of a trade matrix. The *ijth* element of this matrix illustrates the volume of commodities moved by vessels. Average distance is calculated by dividing the total volume of commodities by total distance. He calculated the theoretical ton-mile demand which could accrue if the traditional pattern of every year has been such as to minimise total transport costs. By calculating the ratio of the theoretical 'cost transportation minimising ton-miles' to actual ton-miles for every year, he concludes that when the ocean freight rate is high, the pattern of the seaborne trade tends to be more in short haul and vice-versa. Thus this result suggests that the demand for ocean freight has a negative relationship with freight rates.

In another study by Wergland (1981), an aggregated model of the world freight market for bulk carriers is estimated. The model defined the supply function in a manner very similar to Tinbergen (1934). The demand function, following Eriksen (1983) is considered to have positive relation to the volume of the world commodity trade and negatively related to freight rates.

$$q = T^{\delta} F^{-\varepsilon} \qquad \text{(both } \delta \text{ and } \varepsilon \text{ are positive)}$$

Where Q is demand, T world commodity trade and F is freight rates.

Impact of the International Grain Trade on Freight Rates

Within the international grain market generally grain transport is generally an important and integral part of the marketing system for grain. The major components of the grain marketing system are defined by Binkley (1983) as transport, storage and handling facilities. Those generally need a high level of fixed investment. Thus adjustment to varying demands are made with difficulty and at high cost. He suggests that the inherent inflexibility of the international grain marketing system duplicates the impact of trade instability and leads to higher marketing cost for grain trade. Sea transport as important part of the grain marketing system selected as case study by Binkley, provides a sufficient empirical evidence supporting the above suggestion.

Theoretically, the international grain marketing system is assumed to be perfectly competitive.[82] Thus the long-term supply for marketing system would be infinitely elastic. Demand for marketing services is considered as final demand by grain consumers.[83] Furthermore, he suggests that because of instability in the grain trade, the freight rates would need to be only high enough to provide a normal return on investment, with no costs because of non-optimal vessels capacity. Like Fuller *et al.* (1982), the author suggests that shipping costs for grain can rise as significantly as port costs due to variation in trade.

Zannetos (1966) estimated an aggregate short-run supply function for tankers. He found that if 95% of shipping capacity is being utilised, a 1.66% increase in demand would increase rates by 83%. He outlined that the dry bulk shipping market is qualitatively similar to those for oil, and similar supply and demand relations are probably applicable. Therefore, the influence of changes in commodity trade on freight rate is more when capacity utilisation is high and it is less when utilisation is low.

2.4 Conclusion

This chapter presented the review of the literature that is related to this study in three different areas, shipping market, International grain trade, and the relationship between market for ocean grain freight and international grain trade.

The first section reviewed a number of economic and econometric studies starting with the pre WWII work of Tinbergen and Koopmans. This was followed by a discussion of the work of Beenstock (1985) and Beenstock and Vergottis (1989a; 1989b). The main critique of these studies which adopted simplistic assumptions about market conditions is that the role of expectation theory was largely ignored. This omission was addressed by other studies such as those by Zanetos (1966) and Glen (1981). However more recently authors such as Vanags (1989), Glen (1997) and Veenstra (1999) have debated the relevance of using assumptions related to the Efficient Market Hypothesis (EMH) in studies which investigate ship prices and the formation of period rates.

82 See Binkley (1983) for further explanation.
83 Similar to shipping market.

The literature review in this section revealed that there is little or no consensus in the findings of these econometric studies which test different theories in the formation of ship prices and freight rats. This state of affairs could be explained by factors relating to the data and techniques used. Some of the authors do not recognise that the data used may have a stochastic element which would adversely affect the results obtained from the particular statistical tests and model which were employed. Furthermore, in some cases, one could argue that the use of certain models was not suitable as no regard was given to the possible impact of trade related factors on shipping market conditions, rates and prices.

In the literature regarding the grain trade, different models and approaches have been reviewed. In many studies government intervention is ignored or entered exogenously into the model. Thus these models indicate that the market for international grain is a perfect market. Other studies claim that such an approach is inadequate to capture the endogenous impact of government intervention on trade behaviour.

More specifically, studies related to the CAPS indicate that firstly under the CAP the EU achieved self-sufficiency at the expense of cheaper imports. Many of these imports come from developing agricultural exporting countries. Thus this damaged the export levels of those countries and reduced their contribution to the international agricultural market. Secondly high international prices created over-production which needed more export subsidies to dump the EU surplus on the world market. Thus the international agricultural market has been depressed and consequently eroded the export earning of the developing countries. Thirdly the EU common agricultural policy stabilised higher prices stability within the union while the instability in world market has been increased. As price adjustment is prevented by the EU the burden of adjustment is shifted onto the world market through exports. Moreover, variations in the volume of exports create price shocks to the world market. This phenomenon increased the financial risk of export and can distort the investment in any export sector of exporting countries including port and shipping. However, none of these studies recognise the importance of freight rates and transportation cost for grain trade.

With regards to the relationship between the market for ocean grain freight and the international grain trade, the literature suggested that the grain freight market is a competitive market. In this market the following apply (i) in the short-term the supply of shipping for grain trade is limited, but high demand induces operators of other bulk commodity markets (e.g. ore, coal or even oil) to penetrate the grain shipping market. (ii) Grain only accounts for a portion of the total dry bulk trade. Consequently, the supply function of shipping capacity for grain is subject to change as events happen in other dry bulk commodity markets. (iii) It is postulated that an increase in turnaround time for larger ships would tend to reduce the optimum ship size for a given volume and distance, and *vice versa*. (iv) Specific variation in transport costs create substantial changes in the volume and directions of individual interregnal grain flows, but only small changes in the location of production and in the total flows. (v) The shipping cost for grain can increase significantly ina manner similar to port costs due to variation in trade. The main critique of these studies is that even though the freight rates entered into the models but influenced by distance and not by shipping factors such as fuel prices etc.

This thesis uses a disaggregated multivariate dynamic models which unlike the existing models of international grain trade and shipping models include influential factors in international grain trade specifically protectionism together with shipping factors such as fleet capacity, bunker prices etc.

CHAPTER THREE: THE ECONOMICS OF GRAIN TRADE AND SHIPPING TRANSPORT

3.1 Introduction

As mentioned in Chapter One, data analysis is one of the methodological tools for this study. The main concern of this chapter is to explain the economics of grain trade and the role of the EU in this trade. Furthermore, this chapter investigates the different shipsize contribution to the grain trade. In this respect, the main focus is on volume and pattern of international grain trade and vessel size performance in this trade.

Since different shipsizes are involved in various commodity trades there is a need to analyse shipsize performance in other commodity trades such as Iron ore and coal as well as grain. Additionally, the main factor governing shipsize performance in grain trade is port and route restrictions. Therefore, in a further section the grain ports capacity and facilities will be analysed. This will help in formulating the final model and specifying the influential variables. Appendix 8 also provides information on grain ports capacity.

This chapter is designed to provide the statistical evidence together with a historical interpretation needed to explain the nature of the international grain trade and specific characteristics of this trade in North Atlantic. Similar data analysis is provided for the contribution of different shipsizes to the grain trade.

Statistical evidence reveals that the pattern of the world grain trade has changed dramatically. Most changes happened in the North Atlantic, where the U.S., Canada and the EU were involved in grain trade. To be more specific about the North Atlantic grain trade, there is a need to have a clear definition of this route. Since the aim of this work is to specify the impact of the CAP on the structure of demand for shipping transport of grain, the involvement of the EU in North Atlantic grain trade is a main concern, and the North Atlantic grain could be defined as export of wheat and other coarse grain to the EU from US and Canada. Thus this definition does not include US and Canada export to North African countries and other Mediterranean countries. The North Atlantic grain trade was an important part of the global trade in this product. The North Atlantic trade in the 1970s averaged about 20 M.tons.[84]

---

[84] 10% of the total global grain trade.

On the other hand, the EU became a major exporter of grain since mid 1970s, creating new routes with departure from the EU. Thus in addition to North Atlantic grain trade, these new routes will also be specified.

As Stopford (1997:117) outlined, important factors affecting the demand for sea transport are the volume of seaborne commodity trades, average haul and ton-mile demand, and transport cost. At a more detailed level, changes in volume, pattern and transport cost of the commodity trades could influence the different market sub-sectors supply/demand equation.

Different shipsizes are involved in a wide variety of commodity trades, ranging from grain, iron ore, and coal to semi-manufactured products. Therefore as demand in other commodity market changes, the supply in the grain freight market will be affected. The volume of shipment, distance and freight rate along with port facilities at places of loading and discharging are the factors which are responsible for allocating the vessel to carry a cargo.

In the international market, grain trade is subdivided on the basis of usage, into food-grain and feed-grains.[85] Total seaborne trade in grain as defined in this research relates primarily to shipment of four main commodities; wheat, maize, barley, sorghum and other grains (rye, oats, etc.) representing a mere 1% of total trade per annum (Drewry, 1998a). Wheat is the most important food-grain, although a considerable amount is consumed annually as animal feed. Therefore this chapter looks at each wheat and coarse grain supply, demand and trade to provide more detailed information regarding the contribution of each producing country in the grain market.

Wheat also is the largest and most widely cultivated cereal crop, but the major part, about 60% of the world's cereal production consists of coarse grains.[86] Most of the coarse grains are consumed in some part as human food, usually directly in the country of origin, but the international trade primarily exists to satisfy import demand for animal feed.

As mentioned in Chapter One Section 1.3 the definition of grain in the shipping literature includes soybean. Thus the data regarding the involvement of each

---

85 Grain has been defined specifically for this work in Chapter One.

86 See Tables 3.4 and 3.6.

shipsize in the grain trade also includes soybean shipment among the other grains.[87] Therefore there is a further need for this research to specify the pattern of soybean trade. Since the U.S.A. is the major exporter of this product and the EU is the main importer, focus will be on soybean trade in North Atlantic. This chapter is organised as follows:

Section 3.2 discusses the world grain production, consumption, trade and prices to provide a general view regarding the above issues. Section 3.3 specifies the supply and demand factors for grain to illustrate how grain production, consumption and trade may could beinfluenced. Section 3.4 is concerned mostly with production and consumption by individual countries and their role as producer and consumer. Discussing the trade by country provides essential knowledge of the pattern of trade. Section 3.5 concentrates on shipping demand which could be generated by grain and how it is related to the pattern and volume of trade, and soybean trade will review in Section 3.6. Section 3.7 analyses the different bulk carriers size and their characteristics to specify their potential ability. Detailed analysis of the dimension for each ship size are provided within this section. The allocation of ship size for specific route and commodity trade should be incorporated with on shore infrastructures. Section 3.8 provides an analysis of handling characteristics, port constraints and vessel size performance regarding three major dry bulk commodity trades.[88] Section 3.9 specifies the role of different ship size in grain trade, and Section 3.10 concludes.

3.2 Historical Development in Production, Consumption and Trade (Wheat and Coarse Grain)

Table 3.1 illustrates historical data for total grain, including, consumption, trade, production and stock. Based on these data, world total grain production over the last thirty years grew from a low of 826 M.tons in 1969/70 to a high of 1509 M.tons in 1997/98. Average increase in world grain production was 25 M.tons per year. Consumption rose in line with the production for this period from 880 M.tons in 1969/70 to 1482 M.tons in 1997/98.

Consumption figures indicate that world grain consumption showed a steady upward trend in this period. On the other hand production is somehow volatile,

---

87 This data was produced by Fernely's shipping and has been used in this thesis for measuring the impact of the CAP on the structure of each bulk carriers size.

88 The importance of other two major dry bulk commodity trades (iron ore and coal) for grain is discussed (theoretically) in Chapter Four.

fluctuating year by year, but its overall trend is upward (see Figure 3.1). Carry over stock which is held for security of the supply and prevents strong fluctuation of price, was only 201 M.tons in 1969/70 in major producing countries. It increased to 415 M.tons in 1986/87, 200 M.tons more than trade in this year. This forced wheat price down to 110 US$/ton in this particular year, although the stock has been kept at a level of 260 in last 10 years, which helped the price to be higher than during 1980s.[89]

Table 3.1: Selected Historical Data For Grain

	Area	Yield	Production	Trade	Feed use	Total use	Ending stocks	Price $/ton
1969/70	540.4	1.6	826.1	89.1	421.7	879.9	201.4	53
1970/71	530.3	1.63	865.8	101	432.3	903.1	164.1	60
1971/72	537.2	1.79	961.6	101.3	467.4	936.8	188.8	60
1972/73	528.4	1.76	931.7	129	483.4	964.4	156.1	91
1973/74	551.9	1.86	1025.5	134	495.5	1019.0	162.5	177
1974/75	552.8	1.77	977.9	129.3	451.8	969.5	170.9	164
1975/76	564.7	1.76	993.7	141.9	458.9	984.6	180.0	152
1976/77	575.1	1.92	1106.4	147.2	488.8	1045.3	241.1	113
1977/78	570.7	1.87	1068.9	161.7	511.4	1076.8	233.2	116
1978/79	569.7	2.08	1183.1	165.1	556.3	1144.2	272.2	141
1979/80	569.4	2.03	1153.7	185.5	571.6	1164.3	261.6	174
1980/81	577.7	2.01	1159.6	202	560.2	1183.2	239.4	182
1981/82	587.6	2.05	1203.8	198.7	573.8	1179.1	264.0	171
1982/83	575.8	2.17	1248	188.7	591.5	1199.3	312.9	159
1983/84	562.3	2.07	1162.1	196.9	582.9	1218.0	257.0	154
1984/85	566.5	2.32	1315.2	206.2	609.2	1262.0	310.2	148
1985/86	570.1	2.33	1328.6	167.4	619.1	1258.8	380.0	128
1986/87	564.6	2.39	1348.6	173.7	651.8	1313.8	414.8	110
1987/88	543.9	2.36	1283	205.4	662.3	1337.9	360.0	124
1988/89	541.6	2.25	1217.9	202.6	626.7	1312.4	265.6	167
1989/90	547.6	2.42	1326.7	208.4	649.6	1350.2	242.2	162
1990/91	547.6	2.59	1416.6	189.8	665.1	1378.9	279.9	118
1991/92	544.3	2.49	1353.3	206.8	655.7	1365.3	267.9	150
1992/93	547	2.62	1434.1	204.5	665.4	1394.2	307.7	143
1993/94	540.1	2.52	1358.8	186.1	654.8	1401.1	265.4	143
1994/95	538.6	2.6	1398.2	195.6	674.8	1409.3	254.4	146
1995/96	533.3	2.51	1339.4	184.4	639.8	1392.8	201.0	151
1996/97	553.1	2.69	1490.5	190.9	677.7	1459.1	232.4	150
1997/98	544.6	2.77	1508.7	185.8	693.3	1482.4	258.6	152

Source: World Agricultural Outlook and Situation (1999).

89 World's coarse grain prices have moved broadly in line with those of wheat.

Trade in wheat was 50 M.tons when world supply was 304 M.tons representing 16.5% of the production in 1969/70. Production rose to 610 M.tons in 1997/98, trade also rose to 98.1 M.tons 16% of the total world production, however trade was represented 22% of total production in 1980. As Figure 3.2 shows the consumption and production level are very close, with the trade satisfying only about 15% of the consumption of the world total in 1997/98.

The coarse grains market is larger than that of wheat. Production has varied from a low of 558 M. tons in 1969/70 to almost 890 M.tons in 1997/98 with the increase in production averaging 12M. tons a year. However, trade was relatively less important for coarse grains than for wheat; though exports rose from 39 M. tons in 1969/70 to 108M. tons in 1980/81, then reduced to 88 M.tons in 1997/98. Trade in coarse grain only represented about 11% of world production. Stocks have generally represented a smaller share of consumption (11-15%) as compared to the case of wheat.

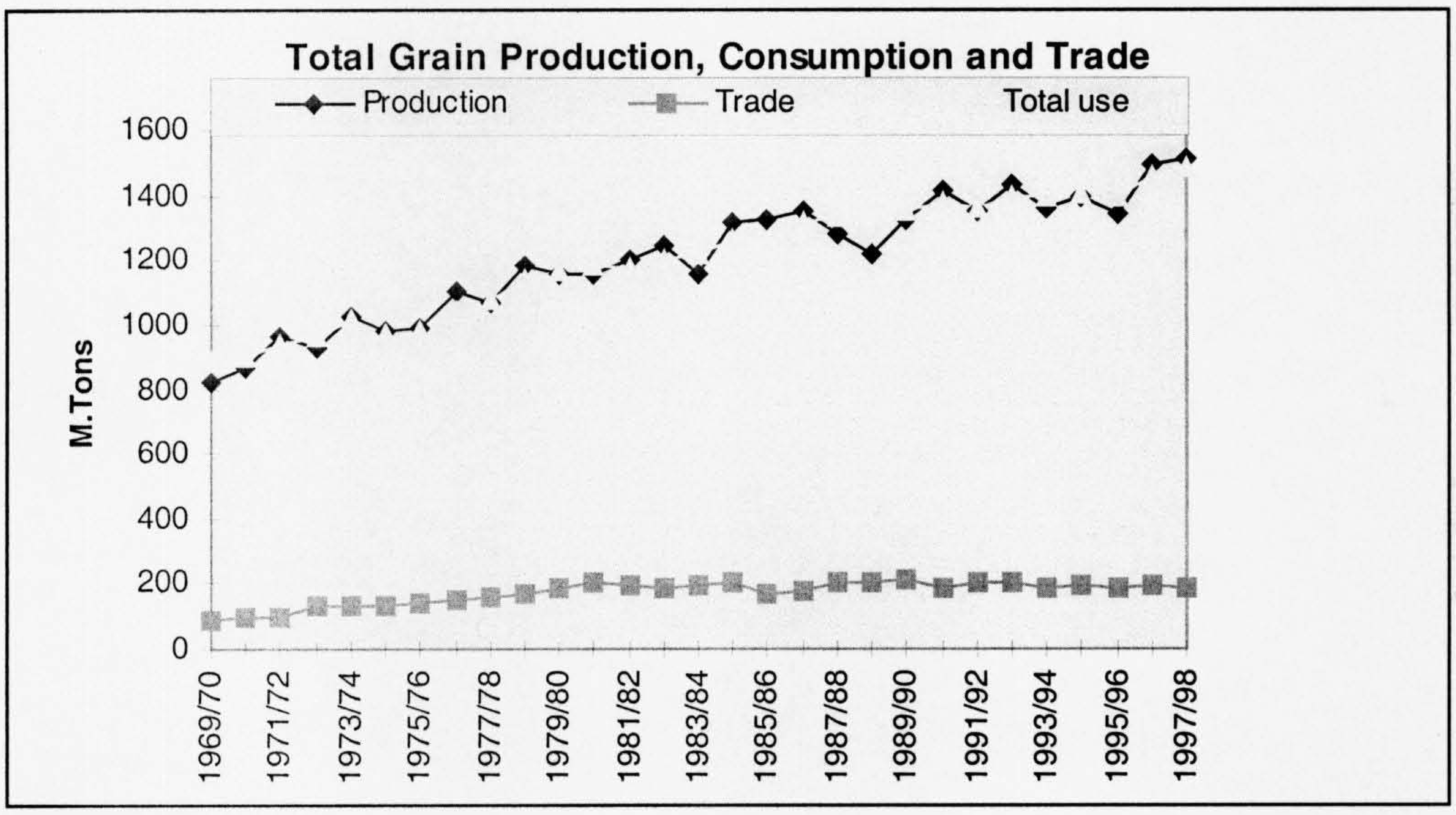
The swings in world prices for wheat and coarse grains are perhaps the feature of these markets of most concern to economists. When prices rise, importing countries, in particular developing countries, face financial problems which may in turn result in shortages on domestic markets. When prices fall, exporting countries run into difficulties, and the desire to keep market share and prevent accumulation of surpluses leads to stronger competition and lower prices. Five such sub-periods can be observed from 1969-1996 in Table 3.1.

(i) The period 1969/70 - 1976/77 witnessed steeply rising prices of both wheat and coarse grains. During this period consumption was higher than production, causing a rundown of stocks. High prices finally curbed consumption.
(ii) The years 1976/77 - 1980/81 were characterised by falling prices of both wheat and coarse grains. Production exceeded consumption over this period and stocks were built up again. Consumption regained its upward movement.
(iii) The main feature of the years 1981/82 - 1985/86 was a steady rise in prices of wheat and coarse grains. Initially consumption grew faster than production leading to falling stocks, but was once again reduced by the price increases.
(iv) The period 1985/86 - 1990/91 was marked by falling prices of wheat and coarse grains. Production once again outran consumption and stocks rose. Consumption by 1990/91 had regained its upward trend.

(v) The period of 1990/91, 1997/98 showed a steady rise in prices and then little or no change. Production and consumption match each other and stock level is kept constant.[90]

Consumption and production figures for wheat and coarse grains indicate the same pattern as total grain. Figures 3.1, 3.2, 3.3 show the trend of the trade, production and consumption in total grain, wheat and coarse grain respectively. They illustrate the same trend and characteristics.

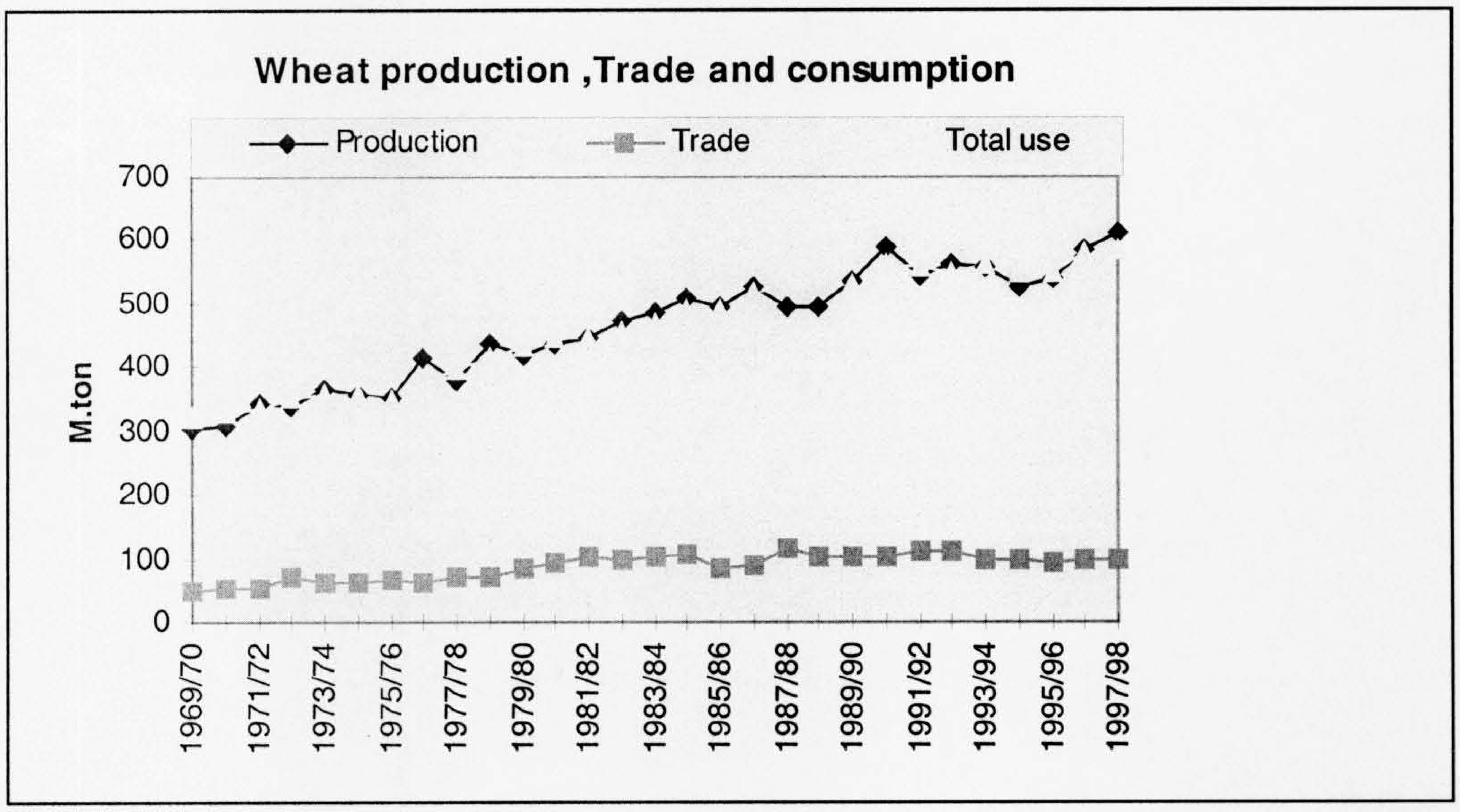
Figure 3.1: Total Grain Production, Consumption and Trade



Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

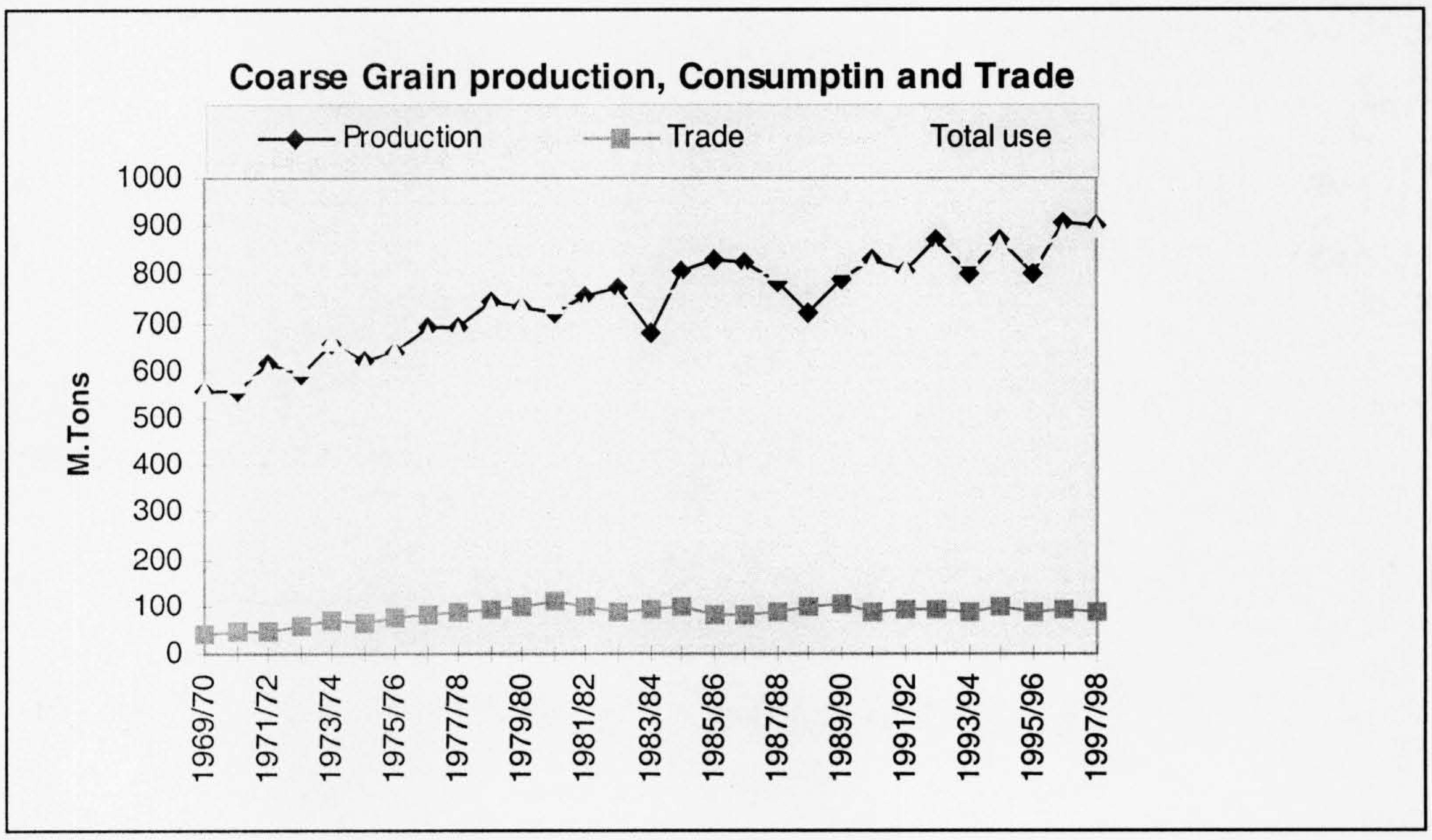
90 These can be tracked in Table 4.1.

Figure 3.2: Wheat Production, Trade and Consumption



Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

Figure 3.3: Coarse Grain Production, Consumption and Trade



Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

3.3 Supply Factors

The supply of grain as it is defined in this thesis comprises a combination of different products. However, the supply of these products is influenced by similar factors. The factors which may influence the supply of these products are: land, yield, prices, government policy and weather. As these factors change over time the supply of grain has been influenced. In this section the supply factors for grain will be discussed. Furthermore, statistical evidence will be provided to see which supply factor has a major influence on changes in supply.

Weather conditions induce actual changes in output. The level of precipitation and other meteorological phenomena are important in growing grain. Weather conditions may affect planting intentions, yields and harvest. In addition to weather, insects and diseases may affect production. Technological improvements and stock holding in major producer countries have helped to prevent significant changes in supply. However, the weather conditions could influence regional year by year productions.

Land and yields are two physical factors which influence the supply of any agricultural products. The land that would be dedicated to grain production mainly depend on grain price, government policy and availability of land.[91]

Yields have increased due to technological improvement in pesticides. The revolution in the technology of agriculture, popularly known as the 'green revolution', has spread to a number of countries in Europe, Asia and Latin America. After decades of experience with a 'green revolution', one learns that modern inputs such as high-yielding varieties of seeds, fertilisers, pesticides and water, if properly applied, are capable of greatly increasing agricultural production. However there is a trade-off between high yield on the one hand, and greater variability of yield on the other.

In many countries the adoption of new techniques has been encouraged by either government guarantee of high output prices or by subsidisation of inputs. The rationale of this policy is that only the expectation of very substantial profits, and not merely a marginal increase in income, will induce the farmers to change from traditional to new methods.

---

91 Land Structural Policy in each country.

Therefore, yields have risen in almost all regions. Three groups of factors affect yield. The first group includes technology, continuance of research programmes, education and advisory services. The second groups of factors are economic, and involve more complex elements, such as the cost-price ratios for grain and alternative competing crops. Under general circumstances economic incentives reinforce the technical trend towards higher yields per acre in most countries. The third group which involves government action is perhaps the most important in many countries.

Table 3.2 illustrates yield trend in the most important producing countries. EU's average wheat yield experienced a growth of 90 kg/ha a year in average, from 1964 to 1999. In the former USSR, yield was very volatile and changed from year to year. Other exporters such as Argentina and Australia also experienced such volatility. However, USA and Canada maintained a stable yield for their production.

Table 3.2: Wheat Yield in Selected Countries (100 kg/ha)

	1964	1970	1975	1980	1985	1990	1995	1999
EU	28.8	31.8	31	37.9	46.6	54.1	50.7	53.8
Former USSR	11.0	15.3	10.7	16.0	14.4	16.1	19.1	15.0
Canada	13.6	17.9	18	17.3	17.7	22.6	20.8	21.4
USA	17.3	20.9	20.6	22.5	25.2	23	26.3	25.3
Argentina	18.4	13.3	16.3	15.5	16.2	21.7	21.6	21.4
Australia	13.8	12.2	14.0	9.6	13.8	14.7	17.8	10.8
World Total	**12.7**	**15.1**	**15.8**	**18.8**	**21.7**	**24.6**	**25.3**	**24.8**

Source: International Grain Council (2000).

* Yield growth in coarse grain shows the similar trend.

In recent decades an increase in yields has been the main physical source of the rapid growth in world grain output. As Table 3.2 shows total yield almost doubled in the EU and other countries also maintain a high level of yields.

Table 3.3 indicates that the area for wheat production in major producing countries increased slightly from 1965 to 1980 but afterwards it steadily decreases up to 1999 when the wheat area is same with year 1965.[92]

Table 3.3: Wheat Area in Selected Countries (000/ha)

	1965	1970	1975	1980	1985	1990	1995	1999
EU	11852	10939	14526	15649	15301	16541	15193	15905
Former USSR	70205	65200	61985	61457	50265	48197	44408	42340
Canada	11453	5052	9474	11098	13729	14098	12377	10919
USA	20056	17630	28125	28783	24185	27964	25378	24997
Argentina	4601	3701	5270	5023	5381	6175	4869	5000
Australia	7088	6476	8555	11283	11736	9218	9523	8176
World Total	**219100**	**211704**	**227100**	**236800**	**230400**	**229587**	**219007**	**212549**

Source: International Grain Council (2000).

The price of grain at the national level influences the total production. Grain policy could be considered the central element in price and farmers income. However, international grain price has played a decreasingly dominant role as a result of government intervention of one kind or another.

The price of grain in the EU plays an important role to increase the output of this product.[93] In Figure 3.4 the producer price in the EU is plotted together with production of grain. It seems the changes in price support in the EU will affect the production in following year (there is a visual correlation). This could be in keeping with cob- web theory.[94] Furtherm,ore it appears that the support price influences production by a lesser amount in latter years as compared to mid 1970s and early 1980s.[95] This could be due to utilisation of resources that may have reached its highest point and/or due to the producers' expectation of the level of consumption.

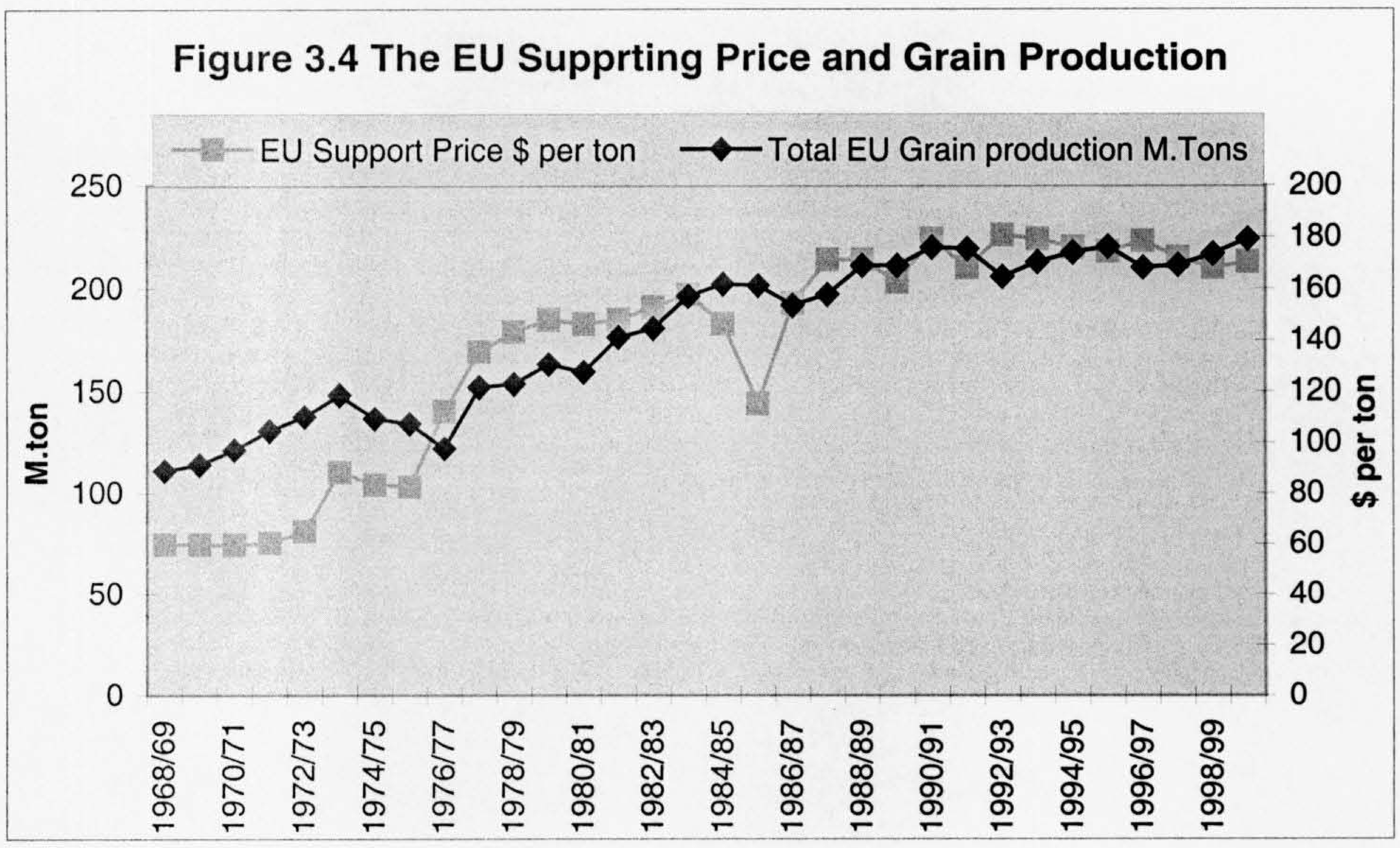
92 The area for coarse grain shows a similar trend.

93 This could be used as an example here. However, the detailed discussion which is beyond the scope of this work is provided in Heid (1993).

94 It states that (a) there is a production period of a certain length, so that supply does not react to price directly, but after a time-lag, and (b) the price is determined by the quantity coming onto the market and reacts immediately to it.

95 Compare the effect of price support reduction on level of the production in 1973-76 to 1985/86.

Figure 3.4: The EU Supporting Price and Grain Production



Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

3.4 Demand Factors

Grain is grown as a food primarily for human consumption but substantial quantities are used also for livestock feeding, seeding and for industrial purposes. Therefore the demand factors are not the same for every type of grain. However the ultimate factor is human population and life style in different areas.

The growing world population has a strong effect on the demand for grain and soybean. Demand varies according to the particular circumstances of each area and the most important single factor is probably income level. The general belief is that less developed countries population increases have been and are expected to be numerically large, whereas in developed countries population increases have tended to slow down or dropped. However the world population may exceed 8 billion by year 2020 (Heid, 1993).

Population distribution also influences total consumption as well as the pattern of the demand for grain. Urbanisation, which is taking place at an increasing rate in the developing countries, has a positive effect on the demand for grain. This is because movement of population from rural areas into towns is often associated with significant changes in food consumption patterns. In developing countries this causes more consumption of wheat and in developed countries more consumption of animal products. Changes in the age structure of population will also affect total demand. The larger the proportion of the population in the economically active age groups the greater, is the calorie intake requirement and therefore the greater is demand (Heid, 1993:61-91).

In addition to changes in population which affect total consumption, the rate of change in consumption is affected by *per capita* consumption. *Per capita* consumption of grain shown considerable variation in different areas. *Per capita* consumption in each country is affected by so many factors, many particular to individual countries themselves. The general assumption is that consumption *per capita* tends to be lowest in the countries with the highest income levels and as incomes have continued to rise, so consumption *per capita* has declined (Heid, 1993:61-91).

Income levels and income growth also affect demand patterns. It means that rising real income in developing countries are accompanied by increasing demand for grain for direct food use. However in developed countries any further rise in real income is likely to be followed by decreased demand for grain as food and an increased demand for animal products, which subsequently influences the demand for feed grain (Heid, 1993:61-91).

Worldwide, the numbers of both livestock and poultry are increasing as economic conditions improve. Changing numbers of livestock and poultry have a major effect on the demand for feed grains. Subsequently, substantial quantities of low-protein wheat, as well as corn and soybean are demanded.

Price and income elasticity of demand for grain is generally low, and it is much lower in rich areas of the world.[96] Government intervention and price support programmes have by and large, less influence on consumption in developed countries than developing countries. However, the income elasticity strongly influences patterns of grain demand.[97] For most goods, the price elasticity

---

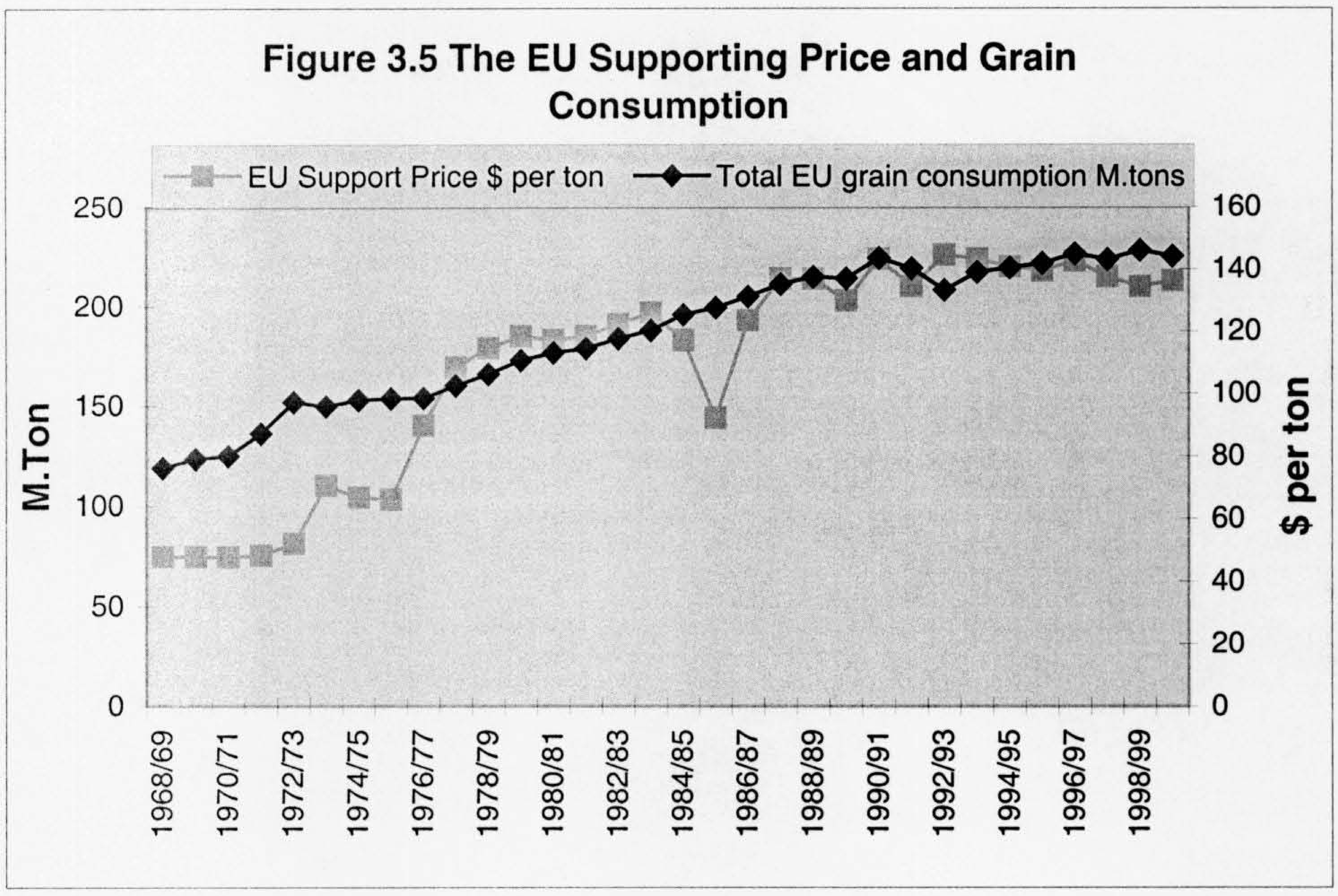
96 Price elasticity of demand is computed as the percentage change of quantity demanded divided by the percentage change in price. The computed coefficient thus measures consumers' responsiveness of quantity demanded to a price change. Income elasticity is computed as the percentage change in quantity purchased divided by the percentage change in income. Measurement of income elasticity requires knowledge of the relationship between changes in the potential buyer's income and the quantity taken.

97 It means that rising real income in developing countries are accompanied by an increase for grain for direct food use, while in developed countries any further rise in real income is likely to be followed by decreased demand for grain as food and an increased demand for animal products, which subsequently influence the demand for feed grain (this has been mentioned in main text, but it is useful to emphasise it here).

coefficient sign will be negative because price and quantity demanded change in opposite directions. Price elasticity of demand vary greatly, both at the farm level and different stages of the marketing process (Heid, 1993:61-91).

Grain use in the EU is divided as follows: about 60% is used for animal feed, 26% for human consumption, 8% for industrial use; and 6% for seed use and losses. Variable levies apply to grain but not to soybean, and other non-grain feed ingredients. As a result, the share of grain in EU feeds has been falling over time (Newman, 1993:397-422).

Figure 3.5: The EU Supporting Price and Grain Consumption



Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

Figure 3.5 illustrate the EU support price and EU consumption. There is visual correlation between production of grain and the price in the EU, but there is not such a visual correlation between the price of grain and consumption in developed countries. This could support the general notion that price support programmes in developed countries has less influence on consumption.[98]

98 This is an example of where grain prices have little influence on consumption in developed countries.

The demand for grain in industrial use and beverages accounts for a small proportion of total demand. There seems to be some correlation between income and the demand for grain-based industrial productions.

3.5 Grain Production, Consumption and Trade by Major Exporting and Importing Countries

As mentioned before, as a result of the rising trend of yield, the volume of world grain production has steadily increased. However the growth of production has shown considerable regional variation and the composition of total world production has changed over the years. From the post-war period to 1960, South America and Australia increased their proportion of the grain production, while production level was low in Europe. Thereafter, production in Europe expanded while production in the South America and Australia was constant.

When one turns to the production and consumption of different types of grain by country, the situation is different. Since 1940, world grain supplies have been dominated by USA which in 1997 produced 11% of the world wheat outlay, 40% of the global maize harvest, 32% of the sorghum harvest and, though less important, 6% of barley. The EU is another significant contributor by producing 15% of total world wheat production and 33% of total barley. Other players are former USSR, Australia, Argentina and Canada which produce 16%, 5%, 6%, 7%, of world wheat production respectively.[99] Other important grain producing countries including Brazil, India and China.

Table 3.4 illustrates wheat production levels of major producing countries. The EU's production increased from 34 M.tons in 1964 to 87 M.tons in 1999. The EU is now ranked first among other producers. The former USSR experienced volatile production through the years, falling from 100 M.tons to 60 M.tons, The former USSR production was the major short term influence on world total production. Canada maintained a steady upward trend in her wheat production, and achieved an ability to respond to the market accordingly, she produced 16 M.tons in 1964 which increased to 23 M.tons in 1999. Her record product was in 1990 by producing of 32 M.tons. U.S.A. was the main producer with the former USSR up to 1980 but after that the EU increased its production and came to the top of the producer list. Argentina and Australia are ranked fifth and sixth among the word exporters, their productions are varied from one year to another.

---

[99] It can be tracked in Tables 3.4-3.11.

Wheat is classified as a basic staple food of every developed country and most developing countries, but significant quantities of wheat are used also for feed in the United States, the former Soviet Union, the EU, and the Eastern Europe.[100] Comparing Table 3.4 with 3.5 it appears that the major producers of wheat are also major consumers, and as their level of production increased their consumption also increased. In some countries the level of production increased more than their consumption such as the EU, the U.S.A., Canada, Argentina and Australia. The excess supply of wheat in these countries gives them an ability to export their surplus production.

Table 3.4: Wheat Production in Major Producing Countries (000 Tons)

	1965/66	1970/71	1974/75	1980/81	1984/85	1990/91	1994/95	1998/99	1999/00
EU	33764	34807	44987	61453	71248	84653	90630	84831	87523
Former USSR	74399	99664	66224	98182	72600	101891	73735	89595	63557
Canada	16341	9022	17081	19158	24252	32098	31946	29871	23354
United States	34928	36783	57886	64799	65973	74473	53914	66923	68235
Argentina	11260	4920	8570	7780	8700	11350	9883	9700	11100
Australia	10038	7890	11982	10856	16167	15066	10557	16184	9000
World Total	**276904**	**318874**	**359200**	**445300**	**500431**	**592378**	**543099**	**561470**	**596320**

Source: FAO (1999); USDA (1999); International Grain Council (2000).

100 Most of the wheat that is diverted for feed use in these countries is either denatured or of low quality.

Table 3.5: Wheat Consumption in Major Producing Countries (000 Tons)

	1965/66	1970/71	1974/75	1980/81	1984/85	1990/91	1994/95	1998/99	1999/00
EU	27726	31023	39937	44132	58950	63640	62340	60300	66060
Former USSR	---	---	---	116500	96000	112700	101600	98900	92000
Canada	4270	4244	4607	5180	5249	6130	6800	7310	9090
Mexico	---	---	---	3798	4291	4380	4150	4460	4730
United States	19900	21424	18506	21296	31390	37150	30800	30690	33740
Argentina	2522	2494	4596	4403	4940	4520	4580	4500	4300
Brazil	---	---	2813	6802	6528	7500	7180	7600	7500
China	---	---	---	70000	90000	106000	111700	109000	112000
India	---	---	25839	33445	43369	51480	56360	55560	56510
Japan	---	---	5517	6054	6164	6160	6210	6410	6500
Australia	2522	2594	3031	3466	2919	3790	4100	4040	4100
Africa	---	---	4792	23500	29800	33500	35300	34100	34300
World Total	**284000**	**342000**	**363000**	**451000**	**497200**	**570500**	**590200**	**621500**	**666000**

Source: USDA (1999); International Grain Council (2000).

As mentioned before total production of coarse grain consists of different products. These different types of grains could substitute for each other to some extent.[101] Maize, barley and sorghum are the most important coarse grain, production of these three crops accounts for at least 85% of annual course grain output and some 97% of the world trade in coarse grains (FAO 1999). Countries specialise in producing specific types of coarse grain.

Table 3.6 shows total coarse grain production in major producing countries. The most important producers are the U.S.A., China, former U.S.S.R. and the EU. The EU productions rise from 49 M.tons in 1969 to almost 90 M.tons in 1999. Production in U.S.A. also shows considerable increase. China's production has doubled since 1968.[102]

101 Substitution mainly arises in the feed market, and depends on the national price of the product (which is often cheaper for the type of grain produced by the home country) and the livestock policy of the country.

102 This will be discussed in more detail in the next section.

Table 3.6: Course Grain Production (000 Tons)

	1965/66	1970/71	1974/75	1980/81	1984/85	1990/91	1994/95	1998/99	1999/00
EU	49324	66100	60800	69500	89182	85339	90584	84843	89836
Africa	37265	40100	50500	52300	60173	54784	55780	63321	59328
China	56326	68000	73200	82600	84220	112786	112920	117440	114640
F. USSR	95695	102500	66600	81800	91700	104133	81843	99379	85275
USA	156230	186800	185500	198100	274795	230736	218611	186712	284975
Canada	16230	20400	20000	21900	24872	24678	21763	24606	22781
Australia	3652	4700	5400	4900	8157	6964	8157	10112	4948
Brazil	12654	14500	16700	20700	23326	23897	32163	30805	32805
India	24231	28800	30400	28300	26730	32753	26284	33710	34900
Argentina	14236	17000	14100	10400	18221	10888	14728	13613	14160
World Total	**563250**	**668200**	**654000**	**718000**	**864128**	**825488**	**805438**	**794104**	**867222**

Source: FAO (1999).

Table 3.7: Course Grain Consumption (000 Tons)

	1965/66	1970/71	1974/75	1980/81	1984/85	1990/91	1994/95	1998/99	1999/00
EU	48458	56954	61958	70658	83156	80456	73365	73365	73965
Former USSR	83526	93489	100154	112256	123125	118451	105452	10395	11232
Canada	9569	10125	13125	15325	18214	19125	19125	19250	19658
United States	99236	115215	126235	142145	155256	178123	185125	190212	193232
Argentina	1512	2236	3325	4256	5562	5456	9261	10632	11032
Brazil	8326	13215	15256	20255	23425	25326	32235	36523	38232
China	46125	55125	59236	74523	84236	100125	108256	123253	132621
India	9211	12215	17215	24215	31214	33125	34215	36222	38232
Japan	13215	14326	16236	19266	22255	21112	22154	23256	23895
World Total	**557235**	**613265**	**637523**	**739365**	**798255**	**817326**	**897839**	**920232**	**954542**

Source: FAO (undated; Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

The important point to note in this section is that the main producer of each type of grain is also the major consumer of that type of grain. In the US a very high proportion of the grain which is used for feed is maize, whereas in the EU barley produced accounts for a high proportion of feed grain. Each major grain producer specialises in producing a specific type of grain more than the others.[103]This is due to some constraints with the producing country, such as land limitation and the traditional pattern of production and consumption.

3.5.1 Structure of the Grain Trade

This section will present the statistical figures regarding grain trade by products. Knowledge regarding grain trade by products will be useful for analysing the ultimate level and the further contribution of each major producer in this trade.[104]

Wheat has traditionally been the principal commodity in the grain trades and seaborne trade in grain is dominated by shipment of wheat. However, the proportion of trade represented by wheat has gradually declined as demand for coarse grains are growing.[105] On average about 15% of total world wheat production enters international trade. World wheat trade amounted to 49.8 M.tons in 1969/70, increased to 94 M.tons in 1980/81 and totalled 98.0 M.tons in 1999/00. World coarse grain exports increased more than two and one-half times from 1968/69 to 1980/81, increasing from 37 M.ton to 108 M.ton, but decreasing to 93.8 M.ton in 1999/00. Table 3.8 illustrates world wheat and coarse grain trade with coarse grain share of total world grain trade.[106]

---

103 For example, the EU is producing more barley, and the U.S.A. producing more corn.

104 For instance, if the corn trade is declining and barley is expanding, the barley exporters will be expected to increase their share in the market while the corn exporters are expected to reduce their share.

105 The reasons have been discussed in Section 3.3.

106 Since the 1980s, increased wheat production in many countries, and thus decreasing demand for import and growing demand for coarse grains, reduced the share of the wheat in total grain trade.

Table 3.8: World Wheat and Course Grain Trade (M.Tons)

	1969/70	1970/71	1975/76	1980/81	1985/86	1990/91	1994/95	1999/00
World WheatTrade	50	55	66.7	94.1	84.7	100.7	98.2	97.7
World Coarse Grain Trade	39	46	75.2	107.9	82.7	89.1	97.5	93.2
World Total Grain trade	89	101	141.9	202	167.4	189.8	195.7	190.9
Coarse grain %	43.8	45.5	53.3	53.4	49.4	46.9	49.8	48.9

Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

Since definition of grain in this work includes various products, there is a need to understand that the pattern of the total grain trade will be influenced not only by government protectionism policy but also by production of specific type of grain in different countries.

The amount and type of grain exported to or imported from a nation depends also on many factors other than price, such as national policies on red meat production.[107] Countries will export only that output in excess of domestic requirements plus carry-over. Exports are used to reduce domestic supplies to maintain prices and incomes for domestic producers.

Table 3.9 illustrates the export of wheat by major exporters. A major expansion in export volume of the EU is visible. The EU wheat exports rose from 4.3 M.tons in 1968/69 to 18 M.tons in 1999/00. The U.S.A.dominates the export market. Argentina, Australia and Canada are other exporters. Considering the total and sub-total figures, it is apparent that these figures have not been changed since 1980. During this time, the export of the EU has increased considerably and other exporters also managed to increase their exports but not significantly. The other important feature in the wheat export market is the decline of the U.S.A. export since 1980.

However the world's leading wheat exporters are the United States, the EU, Canada, Australia, and Argentina, accounting for 91% of all the wheat that is

107 The type of coarse grain mostly used as feed grain within a country is the one mostly produced at home.

exported. From 1988-1999, the US exported 56% of its total wheat production, Australia 76%, Canada 71%, Argentina 47%, and the EU 25%. Over this period, the United States accounted for 30% of the world's wheat trade, the EU 24% Canada 14%, Australia 12% and Argentina 5%.

Most of the US wheat exports go to Brazil, Israel, Pakistan, Tunisia, China, Japan, South Korea, Philippines, Algeria, Morocco, and the former Soviet Union. Canada's wheat markets are Belgium, Luxembourg, Italy, United Kingdom, the former Soviet Union, China, Japan, Algeria, Bangladesh, Indonesia, and Egypt. Australia exports grain to China, Indonesia, Japan, and Egypt. Argentina exports wheat to Iran, the former Soviet Union, Indonesia, and China. Most EU countries are trading wheat among themselves, with some considerable amount being exported to African nations, Asia, and South America.[108]

The US share of total wheat trade was 30% (14.8 M.tons) in 1968-69, 43% (31.9 M.tons) in 1975/76, and 25% (32 M.tons) in 1999-00. Though a regular supplier of grain accounting for up to two-third of all international movements until 1980, the United States has since suffered a progressive loss in its share of the world market. This could be due to many factors. Firstly the U.S.A.'s exports to the EU fell, and secondly, the EU became an exporter to compete with USA over many markets, particularly in the last decade. This is the result of the growing extent of undercutting of US grain prices in world markets by the EU.

Table 3.10 shows wheat import by major importing countries. EU imports reached its peak in mid 1970s, and after that it declined. Former U.S.S.R import is volatile changing year by year. Explanation of this volatility could be found in the method of production which is dry farming, which is mostly dependent on weather conditions. Another reason could be the unstable agricultural policy and economy after disintegration. China and Japan import considerable amounts of wheat among other Far East countries.

---

108 Trade matrix produced by IWC (International Wheat Council).

Table 3.9: Wheat Exported by Major Exporters (000 Tons)

	1968/69	1970/71	1975/76	1980/81	1985/86	1990/91	1994/95	1999/00
Argentina	1370	1704	3111	3932	6197	4940	4493	4123
Australia	7011	9492	8072	11088	16014	11925	12771	13202
Canada	8902	11561	12136	17015	16821	20721	18169	17892
EU	4350	3105	7729	12684	15638	19712	19124	18323
U.S.A.	20198	19821	31522	42077	23495	28893	32941	32124
Sub-Total	41831	45683	62570	86795	78164	86191	87497	85573
World Total	**50823**	**53706**	**66523**	**94052**	**83722**	**92460**	**92608**	**92452**

Source: International Grain Council (2000).

Table 3.10: Wheat Imported by Major Importers (000 Tons)

	1967/68	1970/71	1975/76	1980/81	1984/85	1990/91	1994/95	1999/00
EU	3494	4122	6435	4841	2701	1670	1628	1592
Former 'USSR	1534	315	10096	14912	16465	14750	6267	7823
China	400	687	2287	13775	6908	9444	4483	5982
India	6697	2377	6427	385	7	146	47	85
Japan	4028	4834	5923	5930	5579	5482	5979	6235
World Total	**94052**	**100420**	**98261**	**94052**	**82470**	**92460**	**92608**	**92985**

Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

The coarse grain export market is very much dominated by the U.S.A. Her total coarse grain export reached its peak in 1980 which is about 62.3 M.tons of various type of coarse grain, after which her exports reduced. The EU's coarse grain export shows an increasing trend, but the increase in wheat was more than coarse grain. This could be due to the earlier argument that in developed countries demand for coarse grain is increasing, and thus most of coarse grain productions in Europe are consumed within the EU. Argentina, Australia and Canada also export coarse grain. China entered into the export market when her production was high and there was an excess supply.

In the import market the EU was the major importer until 1980 when her import reached to 17 M.tons, thereafter her import shows a decreasing trend and in 1999 she only imported about 3 M.tons. Other major importers are China, Japan and F.U.S.S.R. The EU is the world's largest barley exporter, accounting for about half of world trade (9.5 M.tons in 1999) (USDA, 1999; International Grain Council, 2000).

It is estimated that in 1998/99 about 67% of total coarse grain output was used as livestock feed. About 85% of world coarse grain exports is used as livestock feed (Wilson, 1993:229-274). Historically, coarse grains were traded among developed countries, but recently many middle-income countries have increased their use of grain for feed.

Corn is the most important feed grain traded, accounting for 68% of all coarse grains exported in 1998/99. Barley was second with 21%, then grain sorghum at 9%, small amounts of oats and rye are exported.

The major exporters of coarse grains are the United States, Argentina, Canada, South Africa, EU, Australia, Thailand and China. The United States, Argentina, South Africa, Thailand, and China are the main exporters of corn. The Unites States and Argentina together supplied more than 90% of the world's grain sorghum exports in 1998/99. Despite the overall dominance of the United States, perhaps the most prominent feature of the grain export market since 1980s has been the decline in its market share.[109]

The large barley exporters are the EU, Canada and Australia. The expansion of the EU's barley export is caused by two factors. Firstly, surplus has been created by use of low-grade wheat in place of barley as feed. Secondly, the reduction in exports of barley by Canada which was the main competitor to the EU allowed the EU's exports to expand.[110]

The largest importers of corn are Japan, the former Soviet Union, Mexico, the EU, Eastern Europe, Taiwan, and South Korea. The former Soviet Union, Eastern Europe, Saudi Arabia, and Japan import most of the barley Japan, Mexico, and Israel import most of the grain sorghum. The main exporters of oats are Argentina,

---

[109] As mentioned in the previous section, the proportion of the cone trade is declining in coarse grain export market, and the U.S.A. is the main exporter of the product. Thus, it is obvious that the total coarse grain export has been affected.

[110] The EU became a net exporter of wheat in 1974 and a net exporter of coarse grains in 1984. It means that its total exports were greater than its imports.

Australia, Canada, Finland, and Sweden. The main importers of oats are the United States, EU, Switzerland, Japan, and the former Soviet Union. In fact, the United States has gone from being the largest producer of oats in 1960s to being a net importer of oats in 1982-1983 and to being the largest import market for oats since 1984-1985. The main exporters of rye are Canada and the EU, while the main importers are Japan, the former Soviet Union, and Western Europe (Wilson, 1993: 229-274).

Table 3.11: Course Grain Exported by Major Exporters (M. Tons)

	1969/70	1970/71	1974/75	1980/81	1985/86	1990/91	1994/95	1999/00
Argentina	4.3	4.8	6.2	8.6	9.4	4.7	7.7	11
Australia	2.4	2.8	3	3.1	5.6	2.8	4	4.2
Canada	3.1	3.5	4.1	4.3	4.2	5.0	2.9	3.4
China	0.7	2.2	3.1	3.5	5.7	5.6	0.2	4
EU	4.6	5.3	5.4	6.9	8.3	7.5	4.4	7.6
U.S.A.	20.5	27.7	41.3	62.3	42.5	51	57.6	52.2
World Total	**39**	**46**	**75.2**	**107.9**	**82.7**	**89.1**	**88.9**	**93.2**

Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

Table 3.12: Course Grain Imported by Major Importers (M. Tons)

	1969/70	1970/71	1974/75	1981/82	1985/86	1990/91	1994/95	1999/00
China	5.2	3.1	3.5	9.3	0.66	0.9	2.3	1.8
Japan	8.6	9.1	12.8	11.8	6.5	3.9	3.6	4.1
EU	16.4	16.9	17.3	17.1	6.4	3.7	4.3	2.9
Former USSR	8.5	12	25.3	15.4	12.4	10.98	3.5	4.2
World Total	**39**	**46**	**75.2**	**97.4**	**82.7**	**89.1**	**88.9**	**93.2**

Source: Bureau of Agricultural Economics (1985); USDA (1999); International Grain Council (2000).

The international grain market, as any other market, may be simply described as including a potential buyer(s) and seller(s) engaged in the possible exchange of products which is called trade. As supply and demand are increased within the market, trade will expand.

In the last three decades the international grain market has witnessed an increase in the level of production and consumption in the same manner, but the volume of trade as it is outlined was not changed in the same way. Due to some specification of the international grain market, increase in production and consumption changed the pattern rather than volume of the trade.[111] This section will provide evidence regarding the above discussion in more detail.

The structure of the international grain trade has changed since it became stabilised at the end of the second world war. As shown by Table 3.13, the US was not the leading exporter of grain until after the 1930s. Most countries were exporting to Europe at that time, with Latin America the leading exporter. More recently, the US, Canada, the EU and Australia have dominated grain export.

Table 3.13: World Net Importers and Exporters of Grain (M. Tons)

Region	1934-38	1960-63	1969-72	1972-73	1975-76	1980-85	1990-95	1995-00
North America	5	43	55	91	100	137	111	104
Latin America	11	9	1	3	0	1	-8	-2
W. Europe	-23	-26	-22	-18	-18	-7	22	21
E. Europe & F. U.S.S.R	4	0	-3	-27	-33	-47	-36	-34
Africa & Middle East	1	-4	-9	-9	-14	-27	-46	-49
Asia	2	-16	-28	-35	-36	-41	-62	-68
Oceania	3	7	11	6	12	14	14	12

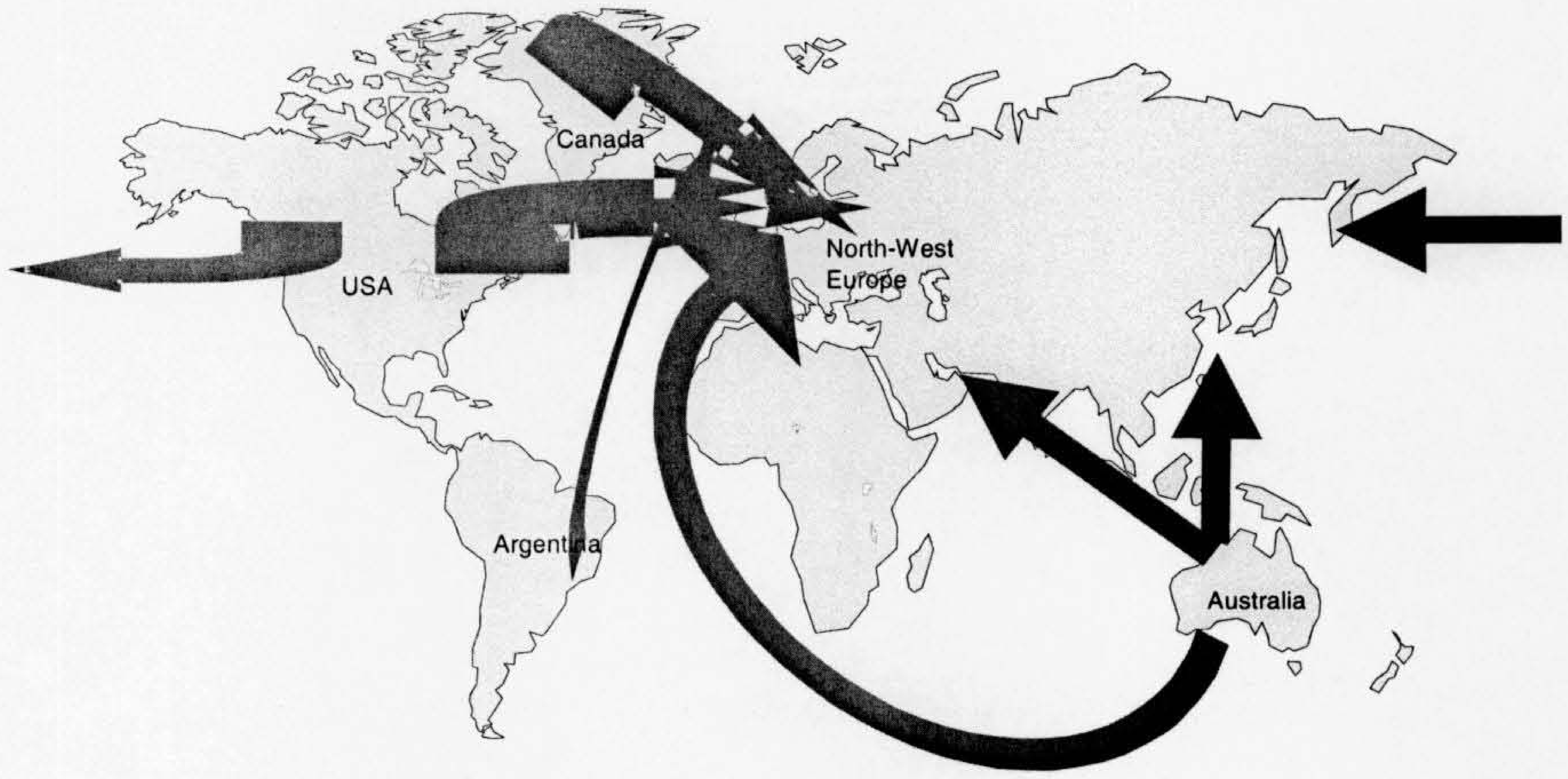
Source: USDA (1996).

The volume of total grain trade has been almost unchanged since 1982. However the pattern of the trade in both commodities terms and country terms have changed dramatically. Figures 3.6 to 3.13 shown the pattern of the grain trade (by region) from 1965 to 2000. These figures are illustrative rather than analytical and the thickness of the lines illustrate the volume of the trade in each route.

---

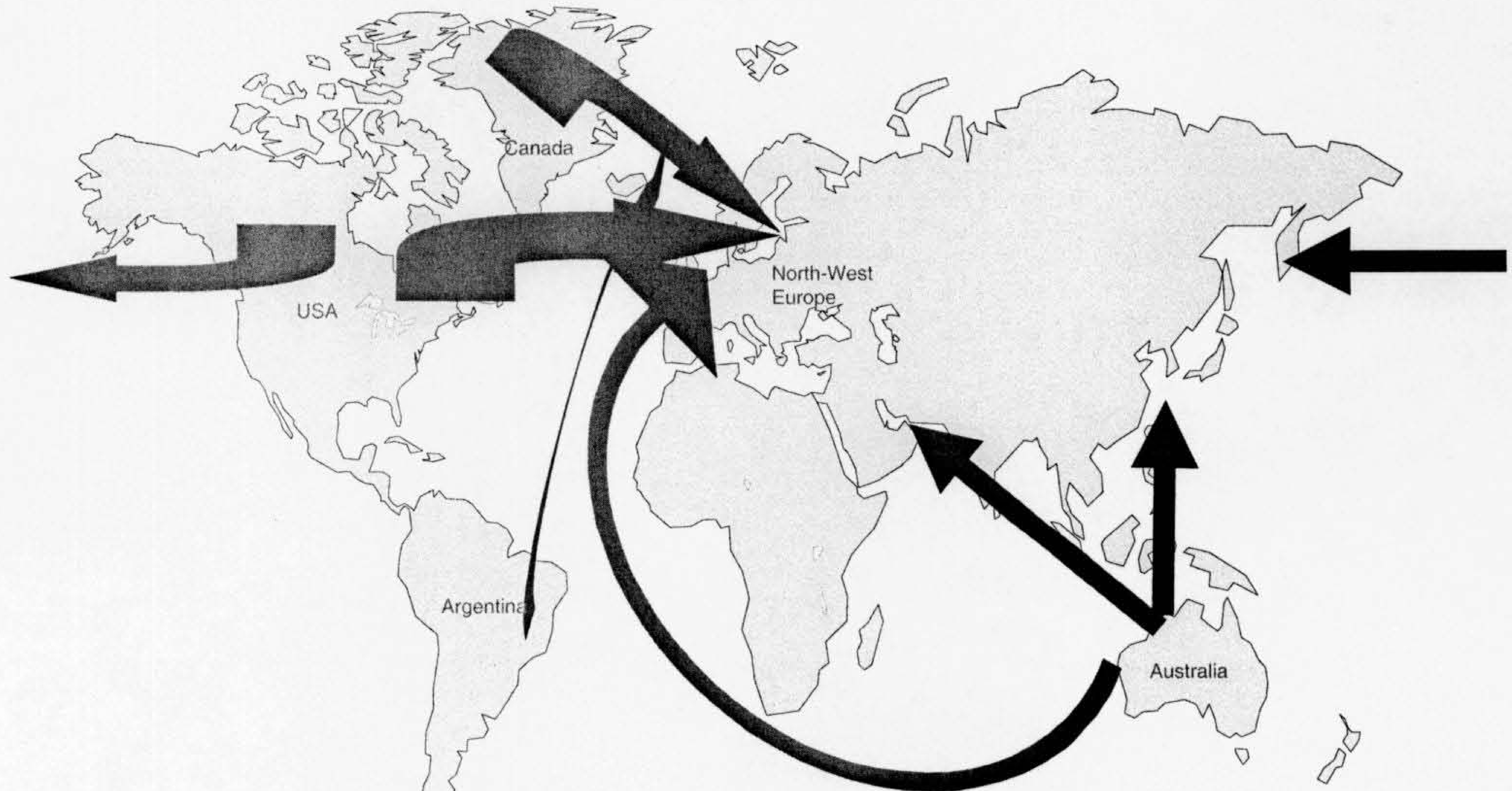
111 Production increased in the same area, for which potentially there was more demand. It means the major producers are also the major consumers.

Figure 3.6: Pattern of the Grain Trade By Region, 1965



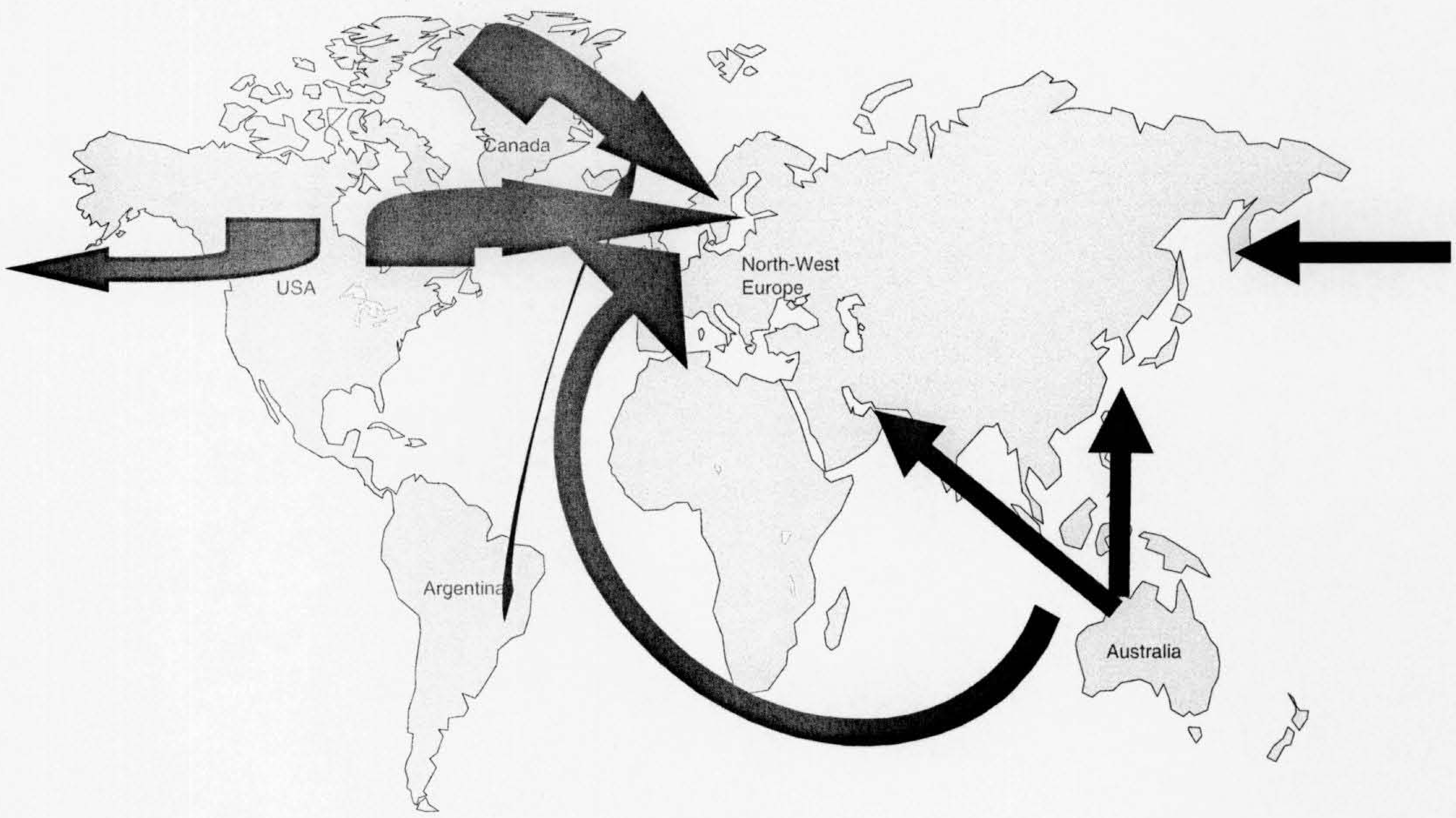
Source: Based on Fearnley (1965)

Figure 3.7: Pattern of the Grain Trade By Region, 1970



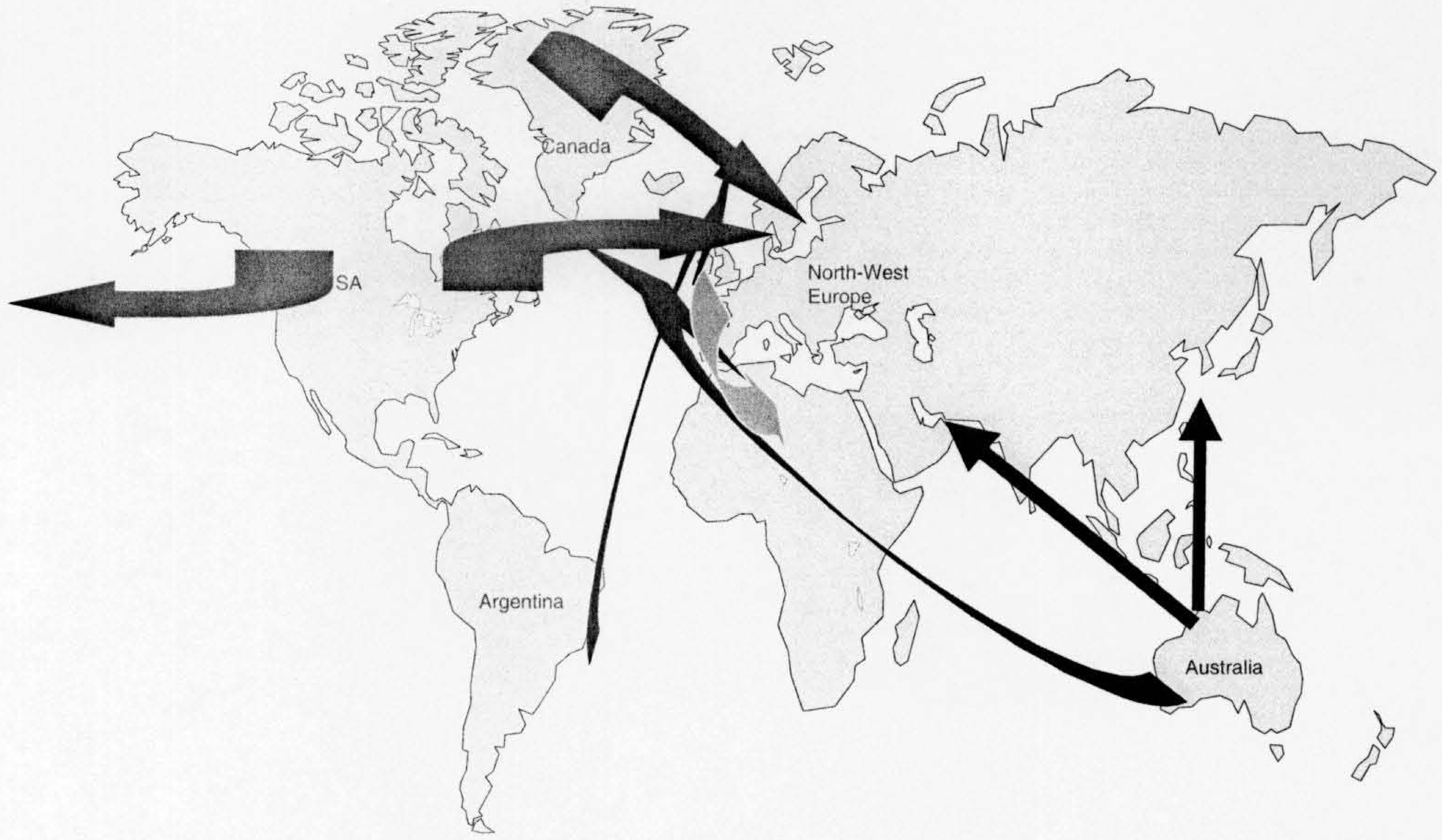
Source: Based on Fearnley (1970).

Figure 3.8: Pattern of the Grain Trade By Region, 1975



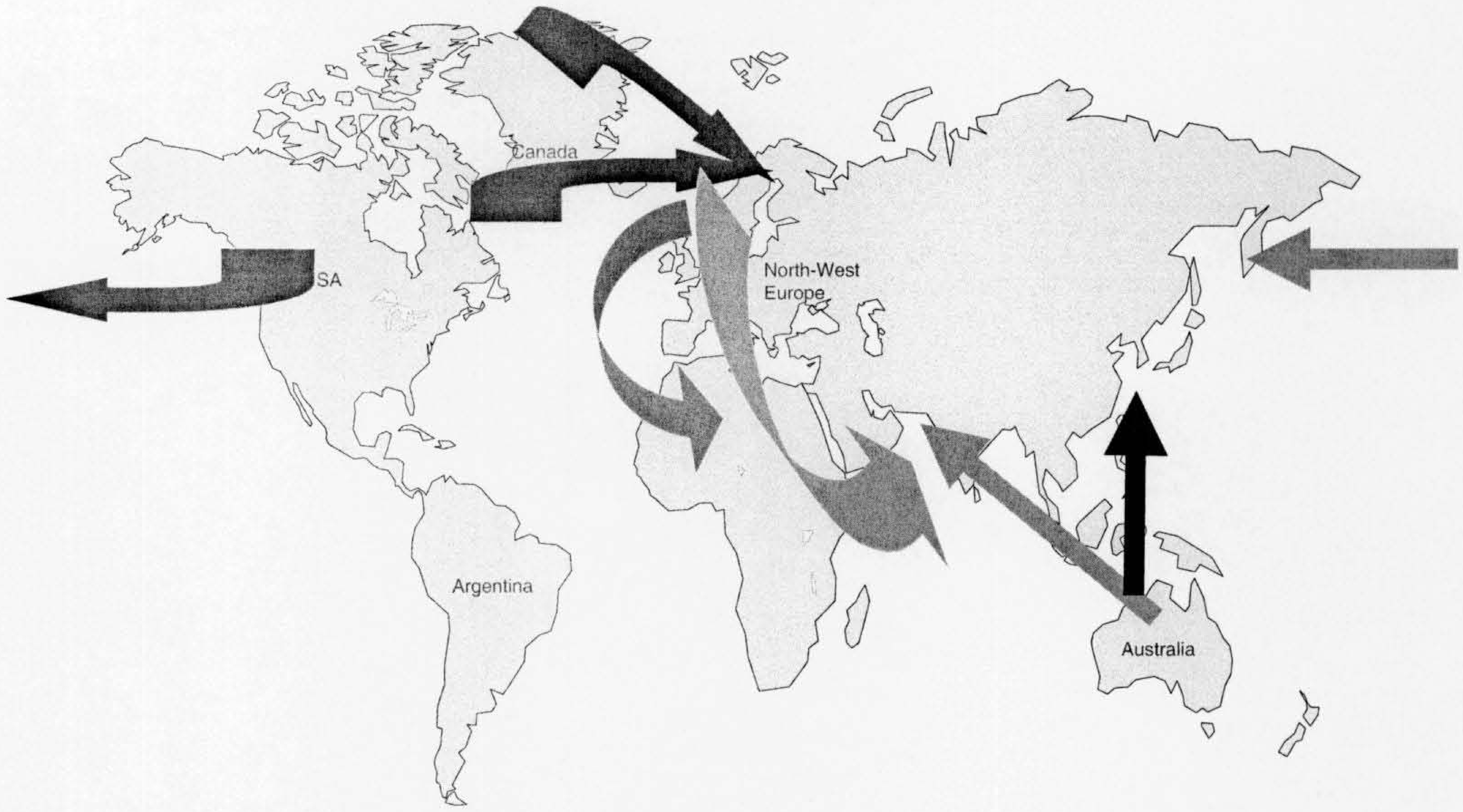
Source: Based on Fearnley (1975).

Figure 3.9: Pattern of the Grain Trade By Region, 1980



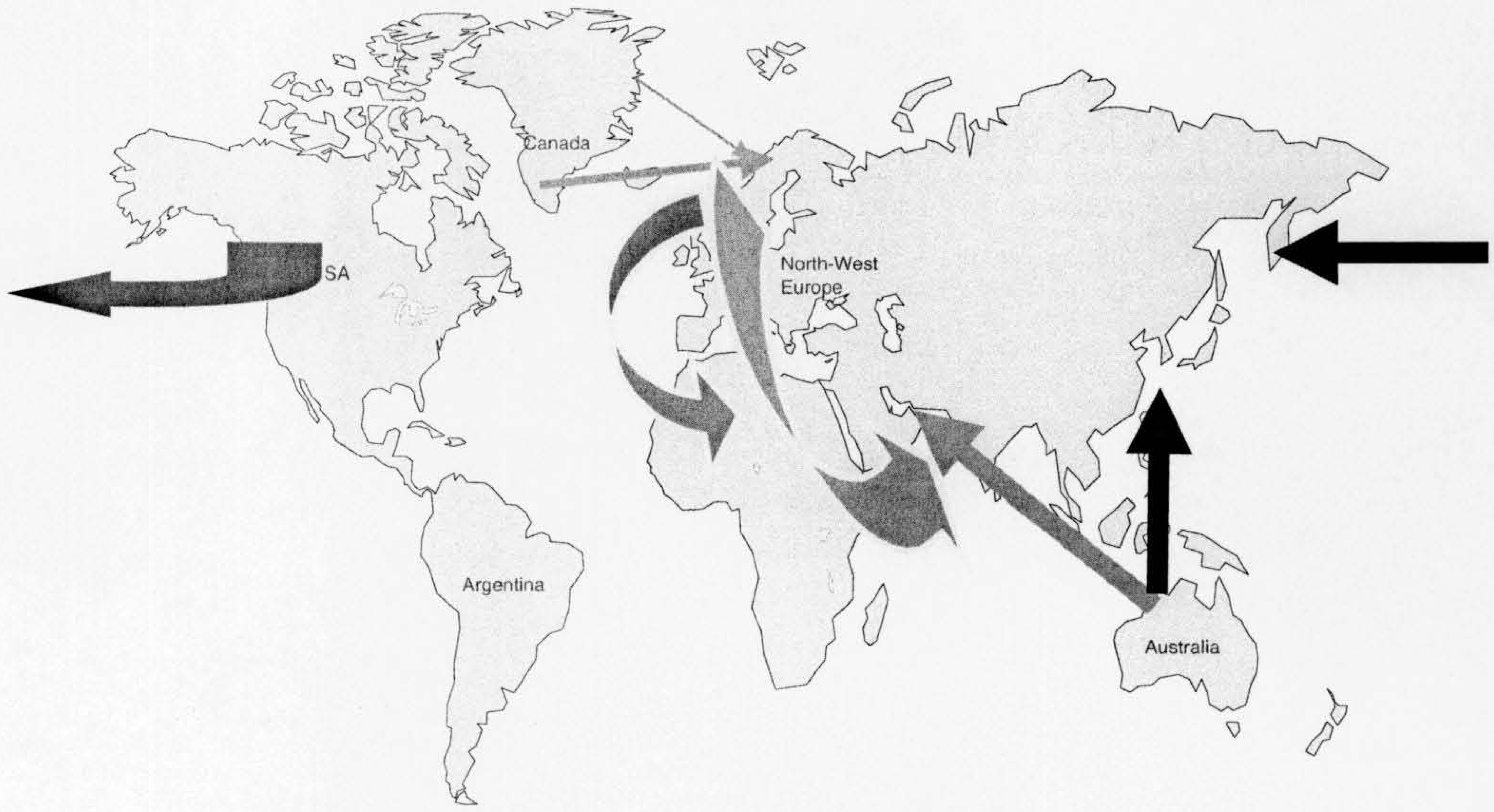
Source: Based on Fearnley (1980).

Figure 3.10: Pattern of the Grain Trade By Region, 1985



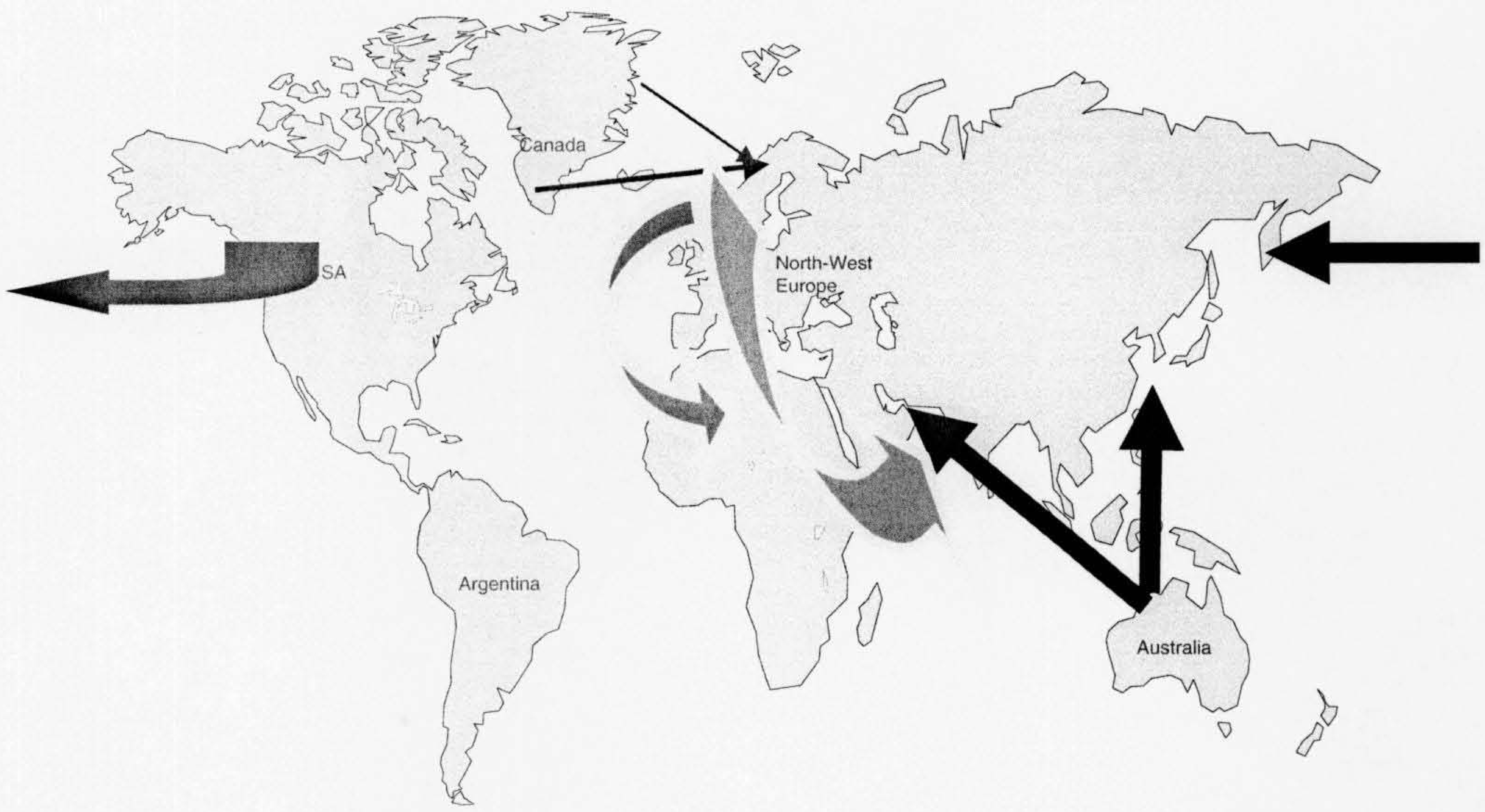
Source: Based on Fearnley (1985).

Figure 3.11: Pattern of the Grain Trade By Region, 1990



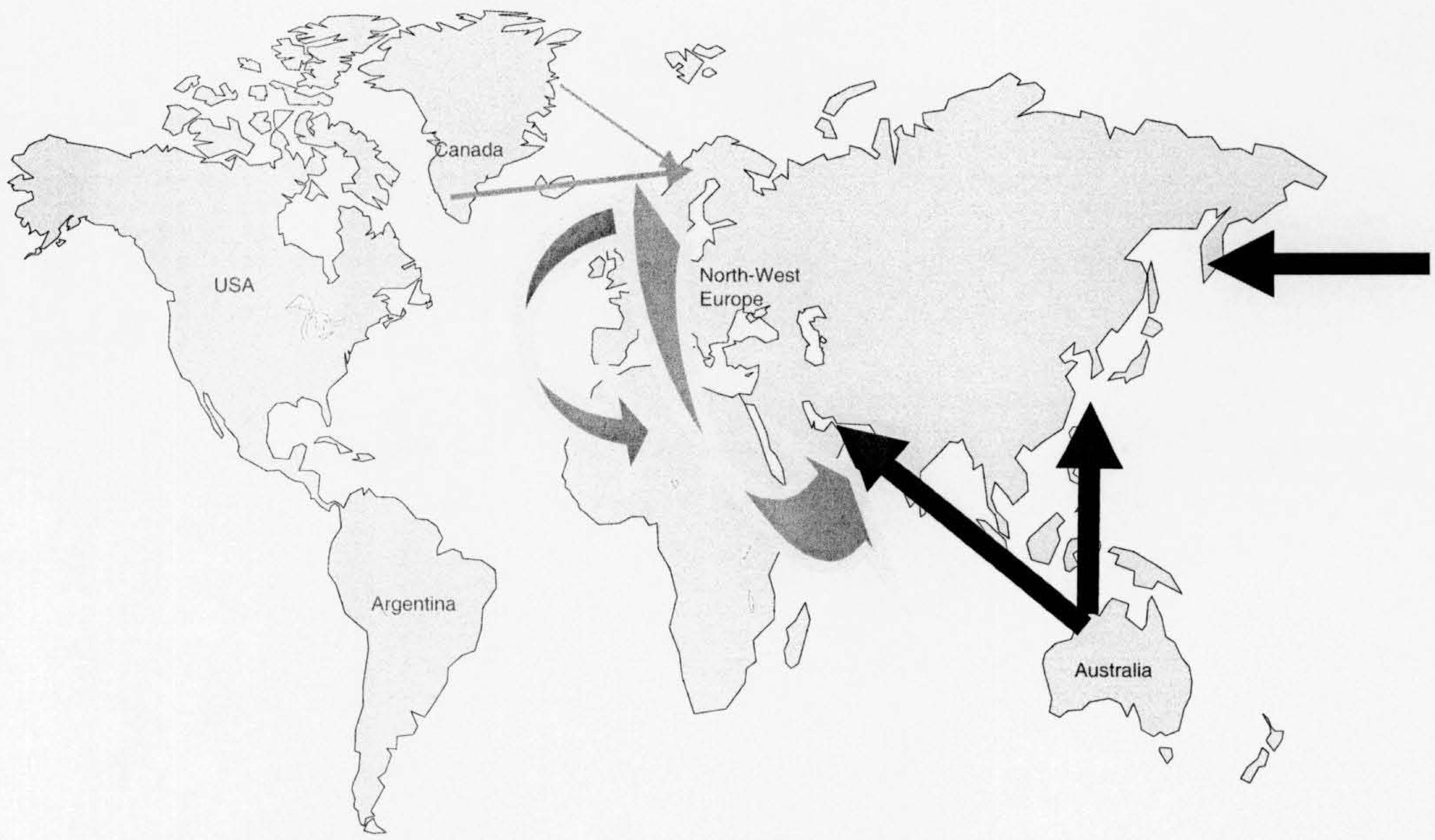
Source: Based on Fearnley (1990).

Figure 3.12: Pattern of the Grain Trade By Region, 1995



Source: Based on Fearnley (1995).

Figure 3.13: Pattern of the Grain Trade By Region, 2000



Source: Based on Fearnley (2000).

Increase in domestic production decreased imports and in some regions created the exports. As a result, trade flows are distorted from the pattern and quantities that would occur under free trade and can even give rise to trade reversal. For instance, the EU changed to being a net exporter rather than a net importer since early 1980s (IMF, 1988).

3.5.2 North Atlantic Grain Trade

Historically, North Atlantic grain trade started few years after the big flow of migrants from Europe opened up the new lands in North America. By 1930 North Atlantic grain trade reached a level of 5 M.tons per year. Since that time there was a steady increase punctuated by some violent fluctuations until mid 1970s and then after that it declined.

As mentioned in the introduction to the chapter, this work defines the North Atlantic grain trade as export of wheat and coarse grain to the EU from the US and Canada.[112]

The EU was the most important market available to grain exporters, particularly exporters in North America. Most of the EU import was from U.S.A. and Canada which was a large quantity. The total grain trade in North Atlantic was 18 M.tons in 1969/70 it reached 23 M.tons in 1975/76 and thereafter fell by 20 M.tons to reach 3 M.tons in 1998/99.

In this particular trading route, Canada produces a small amount of total world grain production, although it rates as the largest exporter after United States and the EU.[113] This is because consumption of grain is low in Canada. This allows Canada to be a major exporter in grain despite her low quantity of production. Furthermore, Canada has stabilised its position in the wheat market through consistently high quality products.

Although Canada is a primary exporter of wheat, she also exports substantial volumes of barley. Participation of Canada in the North Atlantic grain trade could be limited to only wheat export to the EU because since 1970 onward the EU has been self-sufficient in barley and the most important barley exporter. Canada's wheat exports to the EU shows a clear decline. Fast rising wheat production of the

112 This is because most of the changes in the North Atlantic grain trade and world grain trade are related to changes which have happened in the EU grain and agricultural market.

113 In the 1970s and 1980s Canada ranked as the biggest exporter of grain after the United States, although its position was lost to the EU in the 1990s.

EU, has reduced Canadian exports to the EU from 3.4 M.tons in 1969/70 to 1.1 M.tons in 1998/99.

The US' role in the North Atlantic grain trade as a major exporter is important. Her wheat export to EU was 3.5 M.tons in 1975/76, also the US exported a volume of 17 M.tons of coarse grain in 1975/76 to the EU. In 1998/99 the volume of North Atlantic grain trade fell to 3 M.tons.

The US is the major producer and exporter of grain. Specific exports of the U.S.A. to the EU consist of wheat and maize in major and some other coarse grain. Until the mid 1970s the major exports of US was wheat. However, as demand patterns for grain in developed countries (including the EU) changed more coarse grain have been exported (specifically maize). Total wheat exports of the USA to the EU was 3.5 M.tons in 1970, and since then has shown a downward trend, which came to 0.3 M.tons in 1998/99.

Table 3.14: North Atlantic Grain Trade

	1968	1970	1975	1980	1985	1990	1995	1999
U.S.A. Wheat Export To EU	2086	3534	2694	1860	906	567	319	310
U.S.A. Coarse Grain Export To EU	8912	8965	17000	9621	3506	1693	1600	1800
Canada Wheat Export To EU	1119	1423	3500	1756	1242	1700	962	1023
Total North Atlantic Grain Trade	**12118**	**13922**	**23194**	**13237**	**5654**	**3960**	**2881**	**31233**

Source: Bureau of Agricultural Economics (1985); USDA (1999).

3.5.3 European Union as an Exporter

Since the mid 1970s, grain production increased in the EU and subsequently there has been not only a declining demand for import but also a growing trend in exporting the products.

As was indicated, the EU has become an increasingly important and competitive participant in the international grain trades over the last two decades. Now the EU is the world's second largest exporter of grain, ranking behind the United States. Its market share was about 22% in 1999 compared to was 13% in 1986 and 9% in 1980. Her share in the import market reduced dramatically from 22% in 1968 to 3.5% in 1999. During this time production in all types of grain has grown progressively. Production advanced in major crops, wheat and barley.[114] Table 3.15 indicates the EU share in the total grain market.

Table 3.15: The EU Market Share in Total Grain (M. Ton)

	1968/69	1969/70	1974/75	1980/81	1984/85	1990/91	1994/95	1999/00
EU wheat import	3.5	4.2	5.7	3.9	3.4	1.9	1.7	1.7
EU coarse grain Import	16.4	16.9	17.3	17.1	6.4	3.2	4.3	2.7
EU coarse grain export	3.8	4.6	6.3	6.9	7.2	7.5	8.1	7.6
EU wheat export	4.3	5.0	5.4	9.1	15.0	20.3	19.1	15.8
EU total grain export	8.9	10.4	10.9	15.3	23.3	28.4	23.6	20.4
EU total grain Import	20.4	21.3	21.9	21	9.9	4.9	5.2	3.9
World trade	89.1	101	141.9	198.7	167.4	206.8	184.4	185.8
Share EU Import %	25.3	21.1	18.7	11.1	8.7	3.6	3.1	3.5
Share EU export t%	9.8	10.1	8.2	8.1	13.1	14.3	22.1	22.1

Source: Commission of the European Community (undated); USDA (1999); International Grain Council (2000).

The main market for the EU exports are shown in Table 3.16 EU grain are mainly exported to short distance destination in North Africa, other European countries, CIS or Middle East. The EU has traditionally been less competitive in other major markets such as South America, Japan and Far East where other exporters have freight advantages. Despite US competition, EU exports to Former Soviet Union and Middle East rose from 1985.

The EU production of wheat and all coarse grain has increased steadily in recent years and subsequently there has been a declining dependence on imported grain. As production has increased, the EU became a major exporter of grain. The EU is now the largest exporter of barley and wheat. These changes could affect the structure of demand for grain transport in many ways.

114 See Tables 3.4 and 3.10.

Table 3.16: Grain Shipments From EU (Metric Tons, 1998/99)

	Wheat	Coarse Grain	Total Grain
Europe	664825	757455	1422280
Former U.S.S.R.	1171174	133807	1304981
N&C America	1348213	544995	1893208
South America	859466	158707	1018173
N.E. Asia	1277489	3399632	4677121
F.E. Asia	1669357	1775011	3444368
Africa	9014482	1009347	10023829
Oceania	43197	40958	84155
Total	**16098078**	**7820481**	**23918559**

Source: International Grain Council (2000).

3.6 Tonne-Mile Demand

Variations in the structure of demand for ships are linked to more than just differences in import and export volumes or tonnage. Changes in the regional or geographical pattern of supply and demand, created by climatic, economic or political factors, are equally crucial since they affect shipping distances. This alters the tonne-mile level of traffic generated and making due allowance for ship productivity - ultimately the number of ships required.

The demand for bulk carriers (same as aggregated shipping demand) is measured in tonne-miles which is determined by tonnage of bulk cargoes to be moved and average distance over which each ton of cargo is transported can be specified in following forms.[115]

$DB = f(Q_t, AD)$

DB = Demand for Bulk carriers (ton miles)

Q_t = *Quantity of dry bulk commodities transported in time period (ton miles)*

AD = Average Distance of dry bulk commodities (miles)

115 The aggregated supply of bulk carriers, measured in cargo ton miles, is determined by aggregated bulk carriers dead weight tonnage and fleet productivity. $SB = f(BP, BF)$, *Where*

Analysing changes in the average haul of a commodity trade could be rather complex, requiring information in detailed matrix form, but the key issue is simply the balance between long distance and short distance suppliers.

The average haul for seaborne grain trade has changed over the time, in conjunction with changes in trade pattern. Figures 3.6 to 3.14 illustrate changes in the pattern of the grain trade. However the average haul has not changed since early 1980s.[116]

3.7 Soybean Trade

The importance of soybean trade for this work is limited to the North Atlantic, because soybean trade in this route is important to model the ship size contribution in the grain trade.[117] Thus this section is mainly concerned about this trade in the North Atlantic.

Compared to wheat and coarse grain, soybean is a new crop. Soybean is known as an inexpensive source of high quality protein. Soybean is mostly used as feed grain, however, human consumption of soybean also increased. Until the 1970s, the US and China produced most of the world's soybeans. In 1975 these two countries produced nearly 90% of total world production. However, a decade later, the situation has changed. Soybean production has risen from 107.4 M.tons in 1991 to 123.7 M.tons in 1999. Brazil and Argentina accounted for over 20% of total world production; the United States about 65%; and China about 8%.[118]

The lack of production in the EU, where demand for the commodity is high and other markets, such as Japan, has led to large increase in trade. Raw soybeans are shipped from the production area in the US and Brazil to EU and Japan. Growing livestock in the EU necessitated more consumption of feed grain and soybean. However, the increase of consumption in feed grain did not increase the import but increased the production, but increase in soybean consumption in the EU creates more import of this product.[119]

BP is Bulk carrier Productivity (ton miles cargo / dwt / annum), SB is aggregated Supply of Bulk carriers (cargo ton miles), BF is aggregated Bulk carrier Fleet (dwt).

116 See Chapter One Figure 1.2

117 This has been discussed in more detail in Chapter Seven.

118 USDA, Agricultural Research Service, Internet homepage, *http://www.ars.usda.gov/*

119 This could be due to the CAP, which covers whole grain products but does not cover soybean.

In 1979 seaborne soybean trade was 19 M.tons, in which US export accounted for 68% of the total and Brazil and other South American countries dominated the rest of the market. The most important market is the EU. In 1979 the EU imported about 9 M.tons of soybean from US. This continued to grow and her import rose to 11 M.tons in 1995, then decreased to 6.5 M. tons by 1999. In the Far East the main import market is Japan, followed by South Korea.

US export of soybean has grown almost to the level of wheat and other coarse grain. It was 15 M.ton in 1979 and rose to 24 M.tons in 1999. The largest proportion of this volume 32% was exported to EU in 1999.

The main reason for the rapid growth in exports until the early 1980s was the fast-increasing demand for high-protein meal for livestock feed in the EU, Japan and other Asian countries. However, after the late 1980s, more countries increase their soybean production or became self-sufficient in other substitutable products which prevented the soybean trade from expanding at a higher rate. Soybean marketing is not as simple as that of grain. Soybean exporters not only compete with other exporting countries but also with other oilseeds and grain producers. Soybeans are also the leading oilseed in world trade and are very important in the world oil and meal market as well as grain market. Soybean oil and meal are joint products from processing operations. Soybean oil is edible oil used mainly in margarine, shortening and cooking oils.

The share of soybean export market in 1999 was as follows: a total of 30 M.ton were exported to world market, the US accounting for 59% of all exports, Argentina 12%, Brazil 5%, Paraguay 5% and China 5%. The major importers are EU 51%, Japan 17%, Taiwan 9%, South Korea 4% and Mexico 4%. The United States exports are mainly to EU (41%), Japan (23%), and Taiwan (13%) (USDA, 1999).

Soybean trade in North Atlantic represents a considerable parts of soybean world trade, about 30%. The only exporter is USA and the sole importer is the EU. Canada also import some from US, but this trade is small in quantity and either transported by land, rail or through waterways. Table 3.17 illustrates the volume of US export to EU since 1969. Comparing the soybean trade volume with other grain (wheat and coarse grain) we could see the soybean trade in the North Atlantic has fluctuated year by year but the overall trend is some how upward. Furthermore, the quantity of the soybean trade in the North Atlantic compared to other routes for grain is quite high.

Table 3.17: EU Soybean Imports From USA (000 Tons)

	1965	1970	1975	1980	1985	1990	1995	1999
EU Soybeans Import from USA	207	229	313	9736	8201	9576	11246	6419

Source: USDA (1999).

3.8 Ship Type and Size Specification

The general-purpose bulk carriers are the main concern of this chapter. This is because this type of ships carries most of the international grain trades.[120] The cargo capacity ranges from 10,000 to over 300,000 dwt.

An important feature of shipping markets is the availability of a wide variety of ships type and size. The Rochdale Report (1970) commented on this diversification within the industry as follows: In other words shipping industry is highly disaggregated by sector (tanker, dry bulk) and differentiated by size, in to different sub-markets. Four principles can be applied to allocate the type of ship required to carry a cargo: "cargo volume, handling characteristics, regularity and stock."

The transport of grain is mainly performed by general purpose bulk carriers. Larger size bulk carriers such as the 30, 60, and 100 thousand dwt class began to be used for transport of grain in response to increase in the volume and distance of the trade in the later half of the 1960s. The loading share of the bulk carrier among the total grain cargo movement was about 20% in 1965, increased to 48% in 1970 and reached about 88% in 1977 and 95% in 1985, improving transport efficiency for specialised carriers (Nagatsuka, 1986:6). This sector of the shipping industry carries more than 98% of the grain trade by 1997 (Fearnley, 1997). Hence any impact of the CAP should be more visible in this sector. Thus the general purpose bulk carriers logically is the main concern of this work.

It should be mentioned that some shipping companies used bulk and general cargo ship for bulk cargo. Shelter deckers, small bulk carriers, and general cargo ships were used for the transportation of grain up until the beginning of the 1960s. At one time also, conventional oil tankers were used for the transport of grain, but their share of 3.7% (5.4 million tons) in 1976 continued to decrease until it reached a

[120] More details are provided within the chapter.

level of 0.2% (0.3 million tons) in 1983. The amount of grain carried by tankers has been statistically negligible after 1983 (Nagatsuka, 1986:6).

As mentioned in the introduction there are three recognised sub-market within this sector, based on dead-weight tonnage (dwt) capacity. These three sub-markets are known as "Capesize", "Panamax" and "Handysize". The definition of each size of dry bulk fleet is some how arbitrary and has been variously defined by different sources. Drewry shipping consultants definition of bulk carriers specify that, "Handysize" include all dry bulk carriers of between 20-49,999 dwt. "Panamax" size has tended to be taken as comprising those vessels offering a capacity of 50-80,000 dwt. The "Capesize" tonnage range from 80,000 tonnes dwt and above (Drewry, 1998a). General factors to allocate ship size for specific route and commodity trade are:

- economies of scale
- the volume of shipment
- port equipment and draught

However the principal consideration in terms of vessel employment is the trading strategy or strategies adopted by the vessel owner. These have influence over the frequency with which individual ships are offered to charter markets. It mainly depends on the relative freight rate in different route and commodity markets.

3.9 Three Major Dry Bulk Commodities, Characteristics and Vessel Size Preferences

Dry bulk commodity trades have been discussed briefly in Chapter One, where the importance of grain among the others was highlighted. However this section discusses the issue in more detail. This is because the supply factors for transport of grain is affected, as events happen in other dry bulk commodity trades.

This section aims to explain the nature and characteristics of three major dry bulk commodity trade by handling facilities needed, port constraints and other factors which are important to select the size of bulk carrier for a specific commodity trade and route.[121]

[121] Port constraints are the crucial factor in selecting bulk carrier size for a specific commodity trade.

3.9.1 Vessel Size Preferences in the Iron Ore Trade

Iron ore sea transport is derived substantially by large-scale operations to reduce the transportation cost. However it is estimated that cost of transport adds between 30 to 40% to the value of iron ore in the market (Drewry, 1998a).

Medium volume shipment over medium distance (4000-5000 mile) is loaded on either "Panamax" or ore-bulk-oil (OBO) carriers. The economies of using "Capesize" vessel for large volume shipment or over long haul (12,000 miles or more) are restricted by handling and port constraints at the origin and destination. Coal is a low priced commodity (Drewry, 1998a).

The largest iron ore ports are open to ships drawing 23m, though facilities offering between 12-18m are widespread. Around 20% of seaborne traffic is worked in ships of over 200,000 dwt. Moreover, about three-quarters of all the tonnage will be in vessels of 100,000+ dwt (Drewry, 1997a).

The market share of the smaller (sub-Panamax) bulk carriers has dwindled to 7% of total seaborne traffic - in tonnage terms - while (c) some 70%+ of shipments are worked by vessels for over 100,000 dwt. Although it now sounds like a cliché, iron ore has always been a big ship trade. The combination of large scale demand, relatively low value material, lengthy shipping distances and global market competition have made this inevitable (Drewry, 1997a; Fearnley (1970-99).

In terms of demand, to fulfil cargo stems (assuming ships are of acceptable "quality" and no "anti-combination carrier bias"), iron ore shippers will be looking for the most economic option. Logically, this will focus on optimising vessel/cargo size selections. Table 3.18 shows Iron ore Shipment by Vessel size in exporting and importing regions in 1999. About 80% of trade is carried out using "Capesize" bulkers. Most exporting countries use large ships for their exports due to their comparative advantage in iron ore trade. Many importers also use large ships for their raw material import to maintain their position in the steel market.

Table 3.18: Iron Ore Shipment by Vessel Size 1999
(% of Total Seaborne Trade in Each Area)

	Group Size (000 Dot)			
	Sub 50	**50-80**	**80-100**	**100+**
Exporting Area				
Scandinavia	30	6	53	11
Other Europe	39	36	25	---
West Africa	9	15	71	5
South Africa	18	3	36	43
North America	2	29	42	27
S. America Atlantic	3	11	29	57
S. America Pacific	15	1	21	63
Asia	17	26	34	23
Australia	7	8	29	56
Importing Area				
UK/Continent	6	10	41	43
Mediterranean	2	9	23	66
Other Europe	26	14	35	25
USA	4	67	29	---
Japan	9	6	28	57
Other Far East	9	15	28	48
Others	17	13	55	15
Total trade	8	12	33	47

Source: Drewry, (1997a).

3.9.2 Vessels Size Preferences in the Coal Trade

It is estimated that approximately half of coal shipments are handled by bulk carriers of less than 80,000 dwt. This is not unexpected, given that the majority of coal loading/discharge ports are designed to handle Panamax and handy class bulk carriers (Drewry, 1998a).

Focusing on specific trade routes, it is known that exports from the principal suppliers to the international market - Australia, South Africa, Colombia - are usually shipped in Panamax and Capesize vessels and that the role of handysize bulkers is limited (Drewry, 1997a).

These vessel size preferences are also a reflection on the import markets which these suppliers serve. While Australian and South African exports are sold primarily into the major markets of Europe and east Asia, which provide sufficient scope to exploit the scale economies of Panamax and "Capesize" shipments, smaller scale exporters serve mainly regional markets. The smaller trade volumes and shorter trading distances involved do not provide the same scope to develop scale economies in shipping (Drewry, 1998a).

When looking at seaborne transport of steam coal, Panamax size lifting is much more in evidence. The utilisation of larger, Cape-class vessel in steam coal trading is evident, especially on routes such as between South Africa and Europe and some of the trades out of Australia, Canada, the USA, Colombia and Indonesia.[122] Power station berths do not operate on the scale and throughput of steel mill berths. Moreover, many of the Japanese coal distribution centres are not equipped to handle ships of above Panamax carrier size limitations (Drewry, 1998b).

Using information compiled by Fearnley's on the size utilisation of the coal carrying fleet, important trends are noticeable. Overall, the majority of coal has been transported in dry bulk carriers which are below 80,000 dwt, with only 30% being transported in Capesize vessels. What such data fails to take account of is the relative importance of specific trades, especially the main export routes (Fearnley, 1970-99).

Exports emanating from the major producers - Australia, South Africa and specially South America - all have strong performance towards "Capesize" vessels whereas the smaller exporting countries such as China, Europe and the former East European states all tend to ship coal out in vessels below 50,000 dwt. This is a reflection of the composition of the markets which these countries service. The likes of Australia and South Africa provide coal to users in Europe and Asia, trade routes which lend themselves to economies of scale. Other exporters tend to service markets which are geographically closer and therefore smaller cargo sizes are more appropriate (Drewry, 1998a).

According to Table 3.19 the trend of using large ships for coal is similar to that of iron ore but the pace of change has been less dramatic. The differing needs of the two product areas - coking and steaming coal - has been influential in slowing the

122 The key to this lies not so much with exporter capabilities but rather with constraints at the discharge end.

overall move to larger ship use. The requirements, and storage capabilities, of power utilities and cement makers have supported the use of smaller carriers (handy-class and Panamax). The progressive load port expansion (in Australia and, especially, at Richards Bay in South Africa) has enabled steam grades to provide "Capesize" cargo openings (Drewry, 1997a; 1997d).

Table 3.19: Seaborne Coal Shipment by Vessel Size 1999
(% of Total Seaborne Trade in Each Area)

	Group Size (000 Dot)			
	Sub 50	**50-80**	**80-100**	**100+**
Exporting Area				
North America	4	32	46	18
Australia	10	30	39	21
South Africa	25	21	34	20
S. America/Caribbean	26	21	37	16
China	52	44	3	1
FUS/E. Europe	81	14	5	---
W. Europe	81	3	16	---
Others	58	32	6	4
Importing Area				
UK/Continent	14	23	45	18
Mediterranean	14	27	45	14
Other Europe	35	32	26	7
South America	15	62	20	13
Japan	19	29	34	18
Other Far East	22	31	29	18
Others	46	20	17	17
Total	21	29	34	16

Source: Drewry (1999)

3.9.3 Vessel Size Preferences in Grain Trade

Considerable changes have taken place with respect to vessel size in seaborne grain trade over the past few decades (1970, 1980s, 1990s). Although the range of ship sizes utilised has increased significantly, there is still a large proportion of grain carried on small ships (under 50,000 dwt). Around 48% of grain trades was shipped in vessels of less than 50,000 dwt compared with 89% traded on the same sized vessel in 1970. In that year only 1% was loaded in ships of over 60,000 dwt, although by 1985 this figure had risen to 40% and subsequently declined to 26% in 1999 (Drewry, 1986; 1997b; 1997c).

The sea transportation of grain is not as open to economies of scale as the other major dry bulk commodities with the majority of grain shipments falling below 50,000 tonnes and most of the grain ports are not capable of handling large vessels. Table 3.20 shows the regional aspect of the ship size performance in grain trade. This table is prepared by Drewry shipping consultant based on reported voyage charters but can be taken as indicative of ship size utilisation as a whole. The North America specifically the US Gulf / US Atlantic area was the most prominent user of large ships to transport grain. Average cargo size for USG/USAC was 48,800 tonnes in 1994 although this belies the true fact that nearly two-thirds of tonnage fixed was in shipments of over 60,000 tonnes (Drewry, 1997b).

50% of grain fixed from the Pacific seaborne grain in 1994 were in cargoes of over 40,000 dwt, while in the Great Lakes/St. Lawrence loading the average shipment size was 37,000 tonnes (Drewry, 1997b).

Brazil loads a significant tonnage of grain.[123] Australian shipments are all under 40,000 dwt and 3% of Argentine shipments are over 50,000 dwt. Shipments from EU are primarily of under 40,000 dwt (Drewry, 1986; 1997c). The principal market for US Gulf grain is Japan. Since this trade is not large scale but relatively stable, it has been possible to justify investment in large ship and port handling facilities on this route.

As shown by Table 3.20, around half of the total grain volume entering international seaborne trade is worked by ships of less than 50,000 dwt. The 100,000+ dwt sector share is small. However, the focus is moving towards lifting in Panamax ships (50-80,000 dwt) with this sector now having a market share of around 45% (Drewry, 1986; 1998a).

123 Brazil's main grain export is soybean.

Table 3.20: Grain Shipment by Vessel Size (dwt) 1999
(% of Total Seaborne Trade in Each Area)

State/ DWT	Under 50	50-60	60-80	80-100	100+	Total
Exporting Area:						
USA	29	8	56	2	5	100
Canada	56	9	21	1	11	100
South America	46	18	35	1		100
Australia	85	4	11			100
Others	79	5	8	2	6	100
Importing Area:						
Europe	26	12	47	3	12	100
Africa	70	7	22	1		100
America	92	3	5			100
Japan	39	5	55		1	100
Other Asia	41	10	41	3	5	100
Total	48	8	37	1	3	100

Source: Drewry (1999).

3.9.4 Loading Ports

In the USA, which is the main grain loading area, there are two main regions for loading grain, the Gulf of Mexico/Lower Mississippi regions and the Pacific ports on the Colombia River plus Seattle and Tocoma. The Gulf region is dominated by the ports on the Mississippi and accounts for over 50% of all USA export (Drewry, 1997a). The main ports in the Gulf of Mexico are Mobile, the Lower Mississippi and Texas ports.

The ports of Mobile (A1) and Pascagoula (Miss) offer an alternative to the lower Mississippi (Louisiana) ports in the New Orleans-Baton Rouge range. Pascagoula traffic is restricted by the channel into Bayou Casotte which, at 11.5m, is shallower than the lower Mississippi ports.

The Mississippi has draft limitations, which mean advantage cannot be taken of larger (100,00+ dwt) vessels except for part loads of up to about 80,000 tonnes. The river is dredged to a depth of 13.7m up to mile 150 and 12.2m from there to Baton Rouge. The facilities attributed to New Orleans cover a large area, populated with a number of grain loading terminals, including Destrehan and Myrtle Grove. The largest grain loading facility in New Orleans itself is the Continental Grain elevator at Westwego. The two berths offer loading at 5,000 tph from four loading belts.

The ports on Colombia River, especially Portland, command a sizeable portion of Pacific trades. The other main grain terminals on the Colombia River are Kalama, Longview and Vancouver. Longview is looking to upgrade its facilities in order to minimise the need to reposition and to speed up loading rates.

The West Coast grain has become increasingly Panamax vessel oriented since 1981 when only two vessels in excess of 11.9 meters draft called at the ports along the Colombia River. By 1990 this figure had risen to more than 100 calls. The Peavey Terminal at Kalama almost exclusively loads Panamax ships sized vessels. The main limiting factor which currently constrains the movements towards Panamax ships on a greater scale is the channel depth. Plans are afoot to deepen the channel depth to 13.1 meters from the ocean to Portland on the Oregon side and to Vancouver on the Washington side (the current draft is 12.2 metres.

Canada

The decline of the St Lawrence/Atlantic loading region for grain export trades started in 1986/87, with the Pacific ports taking most of the Canadian exports from 1987.

By far the largest equipped grain export port in Canada is the Lakes port of Thunder Bay, which has eleven grain berths. Halifax, located in Nova Scotia, is less restricted, with a draft limitation of around 11.5-12m.

The main east coast ports are Vancouver and Prince Rupert, which have the advantage of offering the deepest loading berths in Canada. Loading drafts of up to 15.3 metres are available. The grain traffic at Vancouver in the first half of 1992 showed gains of 20% to 7.9 million tonnes. With five berths Vancouver is one of the largest grain handling ports in Canada.

Argentina

The majority of Argentine grain exports are short-sea, mainly going to Brazil. The ports can be subdivided in terms of location into:

– *Upper*
– *Middle* } *River*
– *Lower*

– *Coastal*

The majority of Argentine ports suffer from low draft limitations due to the Mitre Channel and the Martin Garcia Bar on the Uruguay and Parana rivers. The Mitre Channel has a maximum draft of 8.8m and channel width of 130n metres. The Martin Garcia Bar is often said to command the entrance to the two rivers. It has a maximum draft of 7.92 metres. Shipping practices in Argentinean grain trades, favour tonnage of under 40,000 dwt, because of Parana Rivers passage and port and infrastructure facilities and volume of shipment.

Australia

The main grain loading ports in New South Wales are Port Kembla and Newcastle. Port Kembla can load vessels at a rate of 5,000 tph via two loaders. The loading berth with a draft of 16.3 meters and 290 metres length is one of the largest in Australia. Newcastle's grain berth is situated in the West Basin at berth number three, provides a loading rate of 4,000 tph and silo storage is equal to 170,000 tonnes. Australia's largest export port is situated near Fremantle. The Kwinana Grain Terminal offers a draft of 16.8 meters with a berth length of 291 metres. Other sizeable facilities exist at Brisbane, Albany and Gladstone.

Australia's main ports which have ability to handle large ships are Fremantle and Port Lincoln, and other ports are likely to handle ships up to "Panama" size. Australia's main grain markets are in South East Asia, the Middle East and periodically the former USSR where there are many port constraints.

Other Major Loading Ports

Rouen has been categorised as the main export port for grains in Europe, with annual throughput of 8.5 million tonnes of which over 80% or 6.9 million tonnes are accounted for by wheat exports. Other grains being moved in the port include barley at 1.5 million tonnes in 1991 and maize. The main destination of the grain exports was to the CIS, which account for close to 40% of traffic, an improvement on 1990 of 22%. Rouen has three grain berths, two operated by Socomac and the third by Unacel.

New developments at Rotterdam's GEM Europort Terminal have allowed the loading of Capesize vessel for the first time ex-silo. The loading was partly by transhipment direct to the vessel with the balance coming from silo storage. The installation of a shore based pneumatic unloaded feeding directly into the silo has allowed the larger vessels to be loaded. The vessel, "Flag Diamond", loaded 90,000 tonnes of German wheat, which had been transported in 130 barges and coasters.

3.9.5 Discharge Ports

The importance of the European ports is largely a reflection of their access to inland waterway systems, which allow barges and dedicated vessels to transport the grains closer to the end users. The main European discharge ports are located in the Netherlands, Belgium and Germany.

Rotterdam has four grain discharge berths, three of which also double as transhipment centres. GEM Europort Terminals (European Bulk Services) and Interstevedoring Botlek are the only main grain terminal operators. GEM, which has two terminals, is by far the largest. Terminal 1 has the capability of handling vessels up to 200,000 dwt outside the pier at dolphins or up to Capesize inside the pier (or two Panamax). The Interstevedoring facility can accommodate vessels up to 490m LOA and 13 meters beam. It was the opening up of ports of this size that encouraged the move towards larger vessels for the transatlantic trades, from what had traditionally been limited to Panamax size vessels.

The other notable grain importing port in the Netherlands is Amsterdam, which has tow terminals - the IGMA and OBA Bulk terminals. The IGMA terminal was specially designed for the fast discharge and transhipment of grain and derivatives. The facility can handle vessels up to 84,000 dot fully laden, discharging straight into waiting vessels or into silos. The fast discharge system comprises both elevators, grab and screw unloaders and can handle 33,000 tpd. Both facilities have no length limitations but the OBA Terminal has a lower draft constraint, at 13.7 meters. The OBA Terminal is primarily a coal and ore berth, but can accept grain cargoes, as well as Corn gluten.

The two ports of Antwerp and Ghent are important for European grain trades because of their internal transport links. Antwerp is connected to the Albert Canal while Ghent is linked to the Scheldt river system. Antwerp is serviced by three-grain discharge terminals, the largest of which is the Sobelgra facility at the 6th Harbour Dock. With a draft of 14.6m and quay length of 620 meters, the berth can discharge cargo at the rate of 2,000 tph. Both the Sobelgra and Samga facilities act as transhipment centres.

Ghent has two discharge berths, the Grain Terminal and Euro-Silo at berth 97, which will shortly be able to accommodate "Capesize" vessels when the sea canal is dredged and straightened, allowing vessels drawing 17m to transit the passageway. This is considered the greatest limitation on the port.

The diverse port of Hamburg has a number of grain import berths, the largest of which is at the Neuhofer Pier operated by NHG, with its two pneumatic elevators and mechanical unloader which can handle 1,660 tph. The facility can handle Panamax size vessels and acts as a transhipment berth. The total silo storage capacity is equal to 600,000 tonnes and makes Hamburg the largest grain storage centre in Europe.

With the dedicated grain terminal, Tilbury is the largest grain port in the UK. With the ability to accept both loading and discharge cargoes, Tilbury remains flexible. The main jetty can accommodate Panamax vessels with a discharge rate of 2,000 tph via two marine elevator towers.

Lisbon has four unloading facilities, three of which act as transhipment facilities. Silopor Trafaria is the largest and can handle ships of up to 80,000 dwt, while the two other facilities can only handle fully laden 30,000 dwt vessels.

The main ports directly serving Russia in terms of grain discharge are St Petersburg and Odessa. Vessels discharging at St Petersburg are constrained by the entry channels of the Kronstadt Passage and Morskoy canal, which have been dredged to 11.3m. Grain discharge is assisted by mechanised shore equipment. Ice breaking assistance is, however, necessary between November and Mid April. The port of Odessa, located on the north-west shore of the Black Sea, offers year-round navigation (30 days ice breaking assistance necessary), imposing a depth restriction of 13.8m for vessels entering the port.

Planned construction at the Brazilian port of Suape (near Recife) was supposed to have offered the North-east region a deep water port to enable vessels to partly load before proceeding to other Brazilian ports. With displacement of between 12.5-13.7m, the port has clearly an advantage over other ports which only offer a maximum of 12.2m.

South Africa has responded to the changing situation with facility upgrades and developments. Durban Bulk Shipping (DBS) terminal has increased its present draft limitations to 12.8 meters, which will allow fully laden Panamax vessels to be accommodated. In September the 110,000 dwt "Feax" discharged its maize cargo at DBS, the largest maize shipment in South Africa.

Egypt imports grain via a combination of dedicated grain and general cargo berths, the former covering the ports of Damietta and Port Said and the latter Safaga.

The UAE has two importing berths, the largest of which is situated in the port of Jebel Ali. Here, the facility which spans two berths can handle Panamax vessels, but with only 800 tph discharge, the facility appears to be grossly under-equipped.

Japan, which imports close to 6 million tonnes of wheat and over 20 million tonnes of coarse grains, mainly handles them through the grain discharge facilities of Yokohama. Japanese imports are largely entering the ports in Panamax size vessels, though only the five berths of Kokusai Futo are able to Accommodate such vessels, since all others in Yokohama are in the 9-12 meters range. As a result Japanese imports are frequently shipped in on a combination port basis.

3.9.6 Role of Handysize in Grain Trade

From Appendix 4, it is evident that the majority of grain loading and discharging ports have draft of 12 meters or less which is sufficient for Handysize bulkers.[124]Thus considering the definition of "Handysize" and her dimensional characteristics together with the factors governing the shipsize allocation, "Handysize" by their very nature have no limitations to being employed in the grain trade.[125] Grain is the most important commodity for "Handysize" employment, as many of the sample vessels (Handysize) analysed by Drewry Shipping Consultants in 1997 completed at least one voyage carrying grain (Drewry, 1998a). Furthermore according to Fearnley's World Bulk Trades, 48% of the seaborne grain trade in 1993 was carried in vessels of less than 50,000 dwt, some 98.1 m.tonnes.

Employment of "Handysize" bulk carriers is highest in the grain trades from the USA, Canada and the EU to destinations in LDCs. The nature of this trade is irregular, mainly depending on the year to year production in these countries (LDC) and their foreign currency availability. This trade is also subject to many constraints

124 See Appendix 4.
125 These factors were highlighted in the previous section.

such as draft-limited ports, low capacity shoreside cargo handling and limited port infrastructure.

"Handysize" bulk carriers have gradually been displaced from certain high volume, high frequency grain trades, notably the trades from the USA to Japan (via Panama Canal) and to NW Europe (Drewry, 1992).

3.9.7 Role of Panamax in Grain Trade

In case of "Panamax", the importance of this size vessel varies with individual commodity trades, but developments indicate the growing importance of these vessels to the grain and coal trades and their decline in the iron ore trades. In 1997, coal (105-110 million tonnes/year) provided the loading cargo component followed by grain (85-95 million tonnes/year) and iron ore (now under 50 million tons/year) (Drewry, 1998a).

Grain has become increasingly influential in the employment pattern of the fleet, particularly since the 1980s when the deepening steel industry recession and moves towards larger-ore carrying tonnage began to have repercussions in the "Panamax" market. In addition the regularity and scale of the grain trades between North America and Japan - and then substantial trade to NW Europe, warranted substantial investment in port facilities at both the load and discharge ends.

By the 1980s more than 40% of all voyages of this size were with grain. The most dramatic changes have been those occurring in the grain trade as "Panamax" in late 1997 transported almost 36% of seaborne grain trade compared to the early 1970s with only 4.2% and 1984 when it was 40% (Drewry, 1997a).

The reasons behind this increasing use of "Panamax" in the 1980s are seeking of economies of scale which for the grain trade for most routes is limited to this size of ships, and the existence of substantial large shipment grain trade pattern from North America to NW Europe. The latter no longer exists, but their implications for marketing of the "Panamax" bulk carrier fleet lie in the fact that the grain trades generate more voyage/short-term chartering business than the ore trades (where long-term chartering, contracts of affreightment and direct ownership of tonnage are more prevalent). It is estimated that the "Panamax" bulkers carried more than half of the Transatlantic and Transpacific grain trade by volume in the 1990s (Fearnley, 1970-99).

3.9.8 Role of "Capesize" in Grain Trade

While smaller dry bulk carriers find employment across a wide range of commodities, the "Capesize" sector is almost entirely dependent upon just two cargoes - iron ore and coal (this is shown in Tables 3.21a and 3.21b). This specialisation has arisen because of a number of commercial and operational factors which have combined to exclude Capesize carriers from most other commodity markets. "Capesize" have only a minor presence in the grain trade, and even more limited employment opportunities in the deep-sea tapioca and salt trades (Drewry, 1997e).

The "Capesize" market share in grain seaborne trade rose to a peak of 11% in 1982 but in the middle of 1980s this dropped, and in the 1990s only 2% of total seaborne trade volume of grain were carried by ships of more than 80,000 dwt. The major route for "Capesize" bulkers regarding grain seaborne trade was the North Atlantic (Drewry, 1997e).

This route served the USA and Canada's grain exports to the EU. Both (USA and many EU ports) sides of the route had sophisticated port facilities to handle the big bulkers. Furthermore, the quantity of shipment and economies of scale involved in these specific ships made these vessels very popular in the North Atlantic grain seaborne trade.

Many "Capesize" found employment in the shipping grain across the Atlantic to the deep draft ports in the Antwerp /Rotterdam /Amsterdam. Once this trade folded, employment opportunities in grain were severely restricted. A further factor was the growing iron ore and coal trades which sharply decreased the volume of "Capesize" tonnage seeking employment in peripheral commodities, while during times of weakness in these trades "Capesize" may look for grain employment.

The chief beneficiary of this downturn was the "Panamax" sector which saw its share of world grain trades rise from 14% to 47% between 1980 and 1990 (Drewry, 1990; 1997e). The grain trades play a "fallback" role in the "Capesize" market. In general, the proportion of total grain cargoes carried by vessels in excess of 80,000 dwt rises during times of recession in the Capesize freight market, leading to the conclusion that when such units are starved of their traditional mineral trades, they go in search of grain cargoes as a last resort.

Table 3.21: Capesize Bulk Carrier Contribution in Dry Bulk Commodity

% of Seaborne Shipments

	Iron Ore	Coal	Grain
1975	37	10	7
1976	42	14	8
1977	48	19	7
1978	52	21	7
1979	59	26	8
1980	62	28	10
1981	65	30	8
1982	65	31	11
1983	66	35	11
1948	65	38	6
1985	64	39	5
1986	63	38	5
1987	68	40	7
1988	72	44	4
1989	71	43	3
1990	72	42	2
1991	74	44	3
1992	77	45	5
1993	76	45	9
1994	76	41	7
1995	77	42	6
1996	78	45	5
1997	77	46	7
1998	79	44	9
1999	80	48	8

(a) including combined carriers
(b) estimated percentage

Quantities Shipped in Million Tonnes of Cargo

	Iron Ore	Coal	Grain	Total
1975	108	13	10	130
1976	123	18	12	153
1977	133	25	10	168
1978	145	27	12	183
1979	193	41	15	249
1980	195	53	20	267
1981	197	63	16	277
1982	178	65	22	264
1983	170	69	22	261
1948	199	88	12	300
1985	205	106	9	321
1986	196	105	8	309
1987	219	117	13	349
1988	248	139	8	395
1989	259	139	6	404
1990	253	146	6	405
1991	265	160	6	431
1992	260	165	10	435
1993	267	165	17	449
1994	291	155	13	459
1995	307	166	11	484
1996	312	178	10	500
9997	311	181	14	506
1998	318	179	17	514
1999	324	192	15	531

(a) including combined carriers as well as bulkers
(b) estimated totals

Source: Fearnley (2000).

By 1993, "Capesize" bulk carriers were once again carrying nearly 10% of total seaborne grain trade. This upturn can be linked to the earlier comment that during times of weakness in the iron ore and coal trades "Capesize" may look for grain employment. Reference to Tables 3.20a & b will show that opportunities in both the iron ore and coking coal sectors declined noticeably during the early years of 1990s, thus coinciding with the upturn in the Capesize involvement in the grain market (Drewry, 1997e).

On a region by region basis the "Capesize" share of world grain trades is far more distorted, with few strong patterns evident. What is apparent, though, is that Capesize carriers unit recently had only a negligible role to play in the Southern hemisphere export market, with, for example, such vessels largely accounting for less than 1% of seaborne trade from Australia. Owners of Capesize vessels have traditionally found greater rewards in the export markets of the Americas. It is unlikely the Capesize involvement in grain seaborne trade will reach anything near 10% of its trade again. Many reasons for this can be presented.

- The grain trade which is extremely diverse and volatile makes for an unpredictable trade pattern which in turn makes investment in port facilities for large-vessel uneconomical.
- Small shipment of grain
- Cargo loading/discharging rates restricted shipload size.
- Port infrastructure in many developing countries is unsuitable for vessels in excess of "Panamax" size.
- The spot freight market nature of much grain business does not offer the same level of employment security as the iron ore and coal trades, which is an important consideration for owners of "Capesize" bulkers.
- The North Atlantic grain trade is unlikely to be same as 1970s, due to high grain production within the EU.

It is now very common for "Capesize" vessels to be employed in the grain seaborne trade load only partially. Thus the "Capesize" bulk carrier fleet role is limited largely to iron ore and the coal trade and very little of the tonnage is employed in grain trade.

3.10 Conclusion

This chapter has attempted to provide statistical evidence regarding supply, demand, tonne-mile, volume and pattern of the grain trade. It has specified that despite increasing supply and demand, the volume of the grain trade has been unchanged since 1980. It also comments that this is because as consumption was increased within a region the production also increased in that region.

The pattern of grain trade is found to have changed dramatically compared to the 1970s and 1980s. Since the middle of the 1970s and beginning of the 1980s the pattern of grain trade started to change, North Atlantic grain trade from USA and Canada to Europe progressively disappeared, and new routes were stabilised through and out of Europe, to the Middle East, Eastern Europe, Former USSR, Africa and even South America.

Any changes either in volume or pattern of the trade could influence tonne-mile demand for shipping transport. However the statistical evidence provided in this chapter revealed that tonne-mile demand for grain is also almost unchanged since 1980. At a more detailed level, changes in pattern of the grain trade will affect different shipping market sub-sectors, e.g. "Handysize", "Panamax" and "Capesize" supply/demand equation. This will be analysed in the next chapter.

It is clear that the smaller size of dry bulk carrier, 50,000 dwt and under, is the major size preference for grain shipments. Market differentiation assumption in bulk carriers sector could consider, each size of the bulk carriers dedicated or more favourable to specific dry bulk commodity trade(s) e.g. Handysize to grain, Panamax to coal and Capesize to iron ore. This dedication of bulk carrier size to specific commodity trade could be described as an efficiency element. It means that each size of the bulk carriers is more efficient in specific commodity trade(s).

Factors governing efficiency of ships size in specific commodity trade could be defined as route and port facilities at origin and destination and volume of shipment. The following question could be asked: if the handysize is more efficient and appropriate for carrying grain, what factors cause other sizes of bulkers to penetrate into this trade?

The most important factor to motivate the larger shipsizes to penetrate into the grain trade is the relatively high freight rate for grain transportation. Low volume of demand generated by other dry cargoes could be highlighted as a second important factor and availability of grain shipment ready to load in the nearest or discharging port is another factor.[126] On the other hand penetration of large ships into the grain trade reduced the grain's final prices by a considerable amount.

The discussion presented in this chapter has focused on potential trade prospects and, with no major substantial port projects in the immediate offing, it seems a reasonable expectation that ship size preferences will develop in line with the major driving forces in the trade such as port investment and the CAP.

---

[126] The latter is not measurable, but the fist two factors could be measured.

CHAPTER FOUR: CONCEPTUAL ANALYSIS AND THEORETICAL FRAMEWORK

4.1 Introduction

Governments in developed countries including the EU intervene into domestic agricultural markets mainly to maintain a higher income for farmers, to increase the production level and provide security of the food supply. The Common Agricultural Policy of the European Union (CAP) serves different objectives, firstly, objectives which are related to agricultural production and secondly, objectives related to common market and European co-ordinations.

The CAP has been a major influence on agricultural trade in recent decades and its effects have been a subject of concern to many scholars and also occupied the major part of the WTO (GATT) negotiations. Since its implementation by the European Union in 1967.[127] The EU from being a major importer of grain in the 1960s and 70s up to mid 80s is now the second biggest grain exporter after the United States. This has profound implications for the international grain market that was principally affected in three ways.

- First, the EU's policy of promoting self-sufficiency by means of high guaranteed prices has encouraged greater domestic production at the expense of cheaper imports, reduced the demand and increased the supply in world markets.
- Second, high internal prices have led to over production requiring expensive export subsidies to dispose of EU surpluses on the world market. This has served to depress world market prices.
- Third, stabilising EU farm prices has increased price instability on world markets. As the CAP prevents internal price adjustment, the burden of adjustment is shifted onto world markets via exports. Variations in quantities exported lead to price shocks to the world market.

These effects can be analysed under different categories. The first category comprises effects that would be realised under welfare analysis. Such effects can be further subdivided into EU and non-EU welfare effects.

[127] It took from 1962 until July 1967 to set into operation a Common Market organisation for cereals with unified grain policy prices.

The second group of analyses involves the effects of this policy on international agricultural trade. This group could also be sub-categorised into the effects on: volume of international agricultural trade, pattern of agricultural trade, level of world agricultural prices and the stability of world prices as out lined by Demekas (1988). However, differentiation of such effects is a matter of complication and paradox, because these effects are so related and interdependent as addressed by Anderson and Tyers (1984). However this chapter will present conceptual analyses of these effects.

The usual approach used to model the structural changes in an industry, and the one adopted here tends to investigate the market structure (supply and demand) and hypothesise the possible relationships between different influential variables.

It was established in Chapter Three that the pattern of international grain trade has changed during last decades (1980s, 1990s). The EU's grain imports from North America reduced dramatically. On the other hand, the EU's exports, mostly to developing countries have expanded considerably. Meanwhile, the increasing trend of the volume of international grain trade changed to a constant trend.

Chapter Three also outlined the restrictions for large ships to contribute to the seaborne grain trade by investigating the port and route limitation. It specified that the North American and the European ports can only accommodate large ships to load or unload grain.

In this chapter the CAP effects are analysed, to specify if such changes in pattern and volume of the trade conceptually could be due to the CAP measures. Therefore the aim of this chapter is to hypothesise the possible impact of the CAP on the structure of demand for different bulk carriers market sub-sectors.

Furthermore, there were negotiations in GATT to reduce or even remove the CAP by the EU. The EU's proposal was to reduce the CAP's protection measures by 30%, the USA proposal was to reduce it by 90%. This study will investigate the impact of each proposal on the structure of demand for shipping transport of grain by means of a simulation.

This chapter is structured as follows: Section 4.2 investigates the reason for the CAP measures and the objectives of the CAP. Analysis of different effects of the CAP will be provided in Section 4.3, including its effects on the pattern and volume of international grain trade, welfare analysis, and its effects on world price instability. Section 4.4 specifies the simplifying assumptions for the theoretical approach. Section 4.5 presents the main hypothesis of the study together with its related sub-hypotheses, and Section 4.6 provides a theoretical basis for the simulation analysis regarding possible liberalisation of the CAP. Conclusions are outlined in Section 4.7.

4.2 Reasons for Government Intervention in Agricultural Market

In most countries, including the EU, governments intervene into the domestic agricultural market. This is due to some specific characteristics of agricultural activities. These characteristics could be explained under four broad features. Firstly, farming is generally undertaken in small sized units and gives comparatively little scope for division of labour; thus that part of economies of scale which is typical of industry is less applicable to agriculture. Secondly, in many developing and even in developed countries, agriculture is often regarded as a way of life as well as a means of livelihood, so that sociological, political and sentimental considerations influence its organisation more than that of industries. Thirdly, agricultural products are mainly foodstuffs, which are basic necessities of life. Thus with improvements of life style the demand for food grows less than demand for industrial products. Finally, because of the effects of the weather and biological factors, yield of farm products vary considerably; thus the farmer cannot fully control the amount of their production and consequently their income.

The 'farm income problem', which is the most important factor for farmers and common to most countries of the world, has two distinct components. Firstly *per capita* incomes in agriculture tend to be lower than *per capita* incomes in other sectors of economy, giving rise to the problem of farm income disparity. Secondly, farmers are subject to year-to-year fluctuation giving rise to the problem of income instability. Largely because of these differences and mostly because of farm income problem most governments have intervened to assist agriculture.

Considering the above explanations the Common Agricultural Policy was important to the development of the European Union. The CAP is one of the obligations laid upon the EU by the Treaty of Rome. It is based on six basic principles: (1) a single market area (2) free internal market of agricultural products, (3) a uniform external tariff, (4) common price for main products within the market, (5) preference in agricultural trade for member state, (6) sharing the financial burden of the CAP. These principles could be summarised under three headings: market unity, member state preference, and financial solidarity. The objectives of the CAP as set out in the first paragraph of article 39 of the Treaty of Rome are as follows:

- To increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilisation of all factors of production in particular labour;
- To ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture;
- To create a unified market with common prices. This implied free trade amongst Community members.
- Community preference would ensure protection from imports and fluctuating world prices by a system of variable import levies.
- Financing the CAP would be at the Community level and a new body, the European Agricultural Guidance Fund (EAGGF), was set up for this purpose.

4.3 The Common Agricultural Policy and Its Cereal Regime

The system of support for those products covered by the CAP (it covers all main agricultural products except potato) is based on a hierarchy of price which is reviewed every year and fixed by the Council of Ministers on the recommendations of the European Commission.

The cereals support model as outlined in Chapter Two is of fundamental importance to the CAP. Many different measures particular to wheat and coarse grains could be highlighted as follows:

1. international market and price support
2. import and export pricing
3. secondary market price measures

The first group (internatinal market and price supports) includes Target price, intervention price, and subsidies for private storage, withdrawal price and direct production aid.

Target price is the internal sale price that should be obtainable under normal marketing circumstances. It is set yearly and does not constitute a guaranteed price.[128]

Under the CAP, provision is made for intervention buying.[129] Thus, the EU guarantees to support the market by a system of intervention prices at which farmers can sell their products to the Intervention Boards in the event of low market prices. The role of intervention is twofold. Firstly, it is a means of supporting price and secondly it is also a mechanism for managing the internal market.

The main part of the grain stock is normally sold back onto the EU market at a later data when prices have firmed up. An alternative to intervention price is the subsidies for private storage which is paid to producers. The aim is to level out the pattern of stock release over the marketing year, and prevent over supply to effect the market price.

The second group (export and import pricing) relates to international grain trade measures including Threshold price, variable levy, export refunds.

Figure 4.1 shows how the price and market regime works for cereals. According to the figure, the "target price" is directly linked to the "threshold price" which represents the lowest price at which imports can come to the EU without interfering with the target price. The difference between these two prices are transport and storage costs. When the lowest import price is below the threshold price, a levy, representing the difference, is chargeable. Thus it is equivalent to the differences of world price[130] to threshold price.[131]

The price supporting mechanism is completed by export subsidy, which subsidises EU exports when world prices are lower than EU prices. Export restitution enables

128 This is set at Duisborg, which represents the point of maximum deficit in grain production in the EU, and there are separate target prices for wheat and other coarse grain.

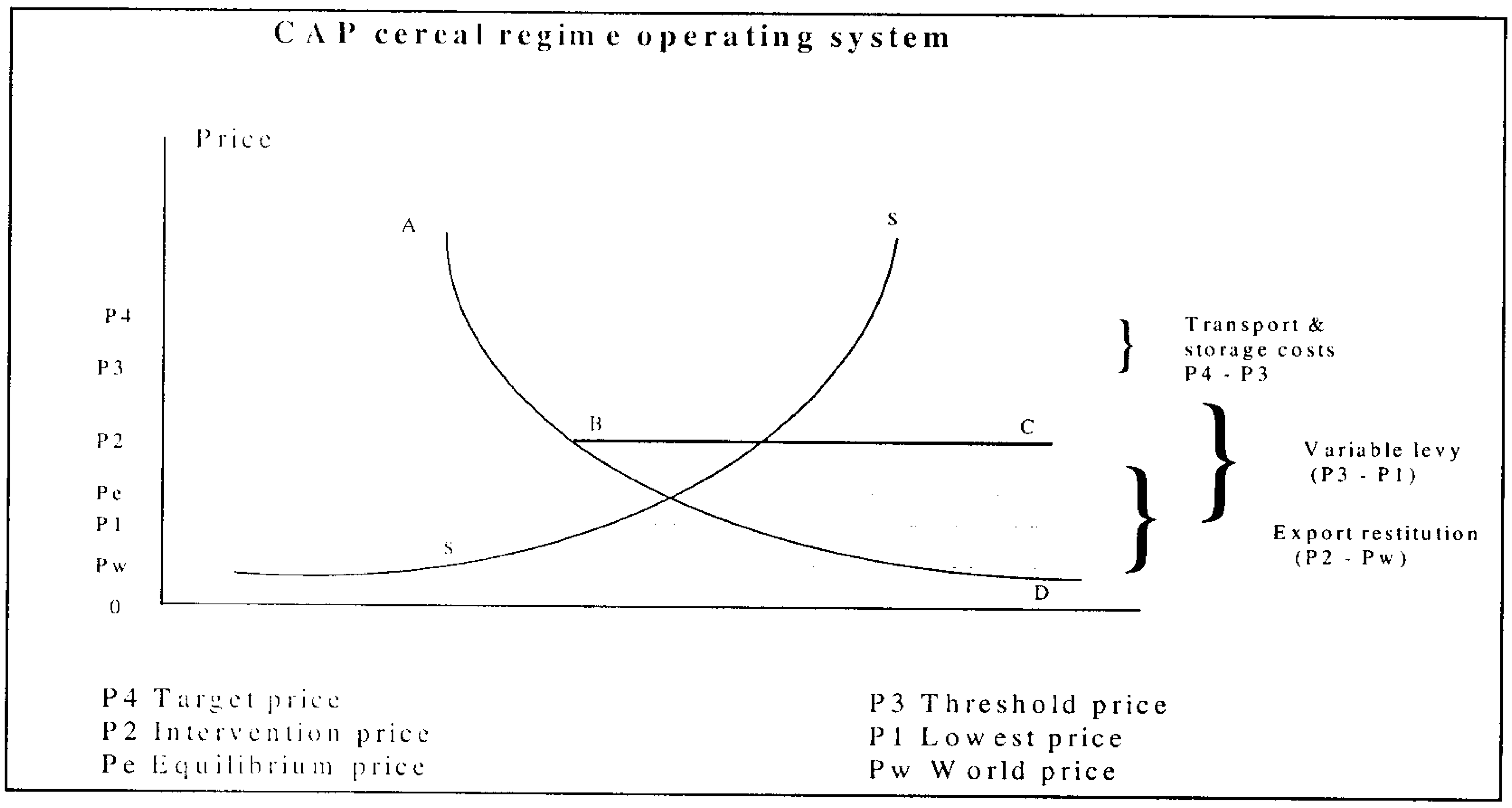
129 The difference between intervention price and target price reflects the transport cost between Ormes and Dusiborg and an element to take into account of the differences between the market price and the intervention price to be expected in the Ormes area in a normal year.

130 The world price defined as the lowest representative offer price corrected for EU standard quality.

131 Every day variable import levies are calculated in Brussels to ensure complete protection for the EU farmers.

EU's farmers to sell at the world price. An export levy is considered when world prices are higher than EU's price (which is not the case normally).[132]

Figure 4.1: CAP Cereal Regime Operating System



The third group of measures (secondary price and price measures) includes production refunds, guarantee threshold, co-responsibility levies and Denaturing premiums.[133]

Production refunds or subsidies to manufacturers are given where there is a tight import regulation and the EU price is very much above the global market price. Guarantee threshold was applied to wheat for many years, when production in excess of a certain tonnage in one year would lead to a reduction in intervention price in following year. Co-responsibility levies were started for cereals in 1986, because of the inefficiency of guarantee thresholds. Under this measure, producers are to contribute towards the disposal excess supplies themselves. Denaturing premiums applied to cereals until 1976. They were subsidies which had the effect of diverting product from an over-supplied market to some other outlet.

In this section the operation of the CAP cereals regime has been discussed briefly. Different measures of the CAP cereal regime created different effects. In next section the effect of this regime will be examined.

---

[132] It is equal to the difference between the average world price and the actual internal EU market price.

[133] Applied to cereals until 1976.

4.4 Analysis of Different Effects of Common Agricultural Policy (Direct Effects)

This section is an attempt to discuss and analyse the different aspects of the CAP effects. The impact of the CAP could be discussed under two broad topics. According to the existing literature, the first area which has been affected is the EU domestic markets, mostly caused by the first and third group of the CAP measures.[134] These effects could be subdivided to direct and indirect effects. The direct internal impact consists of the welfare gain and losses of agricultural producers and consumers. The indirect effects are the effects on other sectors of the economy and dead-weight cost to the EU economy as a whole and taxpayers welfare.

The second area is the international effect of the CAP, caused mainly by the second group of the CAP measures. The international effects are those on the level of world commodity prices, instability of international prices, the volume and pattern of international agricultural trade, and welfare of the non-EU countries (Demekas, 1988).

The aim of this research is partially to evaluate the potential shipping demand which could be generated by either changes or removal of the CAP. Therefore the impact of the CAP on the international grain trade as a major source of demand for shipping transport services is the main subject of concern in this section. The different effects of the CAP are interrelated in many ways. Therefore to analyse the effect of the CAP on the international grain trade, we have to refer to other effects such as that on EU and non EU welfare. However to present a manageable analysis of the CAP effects there is a need to look at each impact individually.

Furthermore before examining the direct effects of the CAP (domestic and international) in more detail it should be recognised that other developed countries like United States afford more protection to their agriculture due to the CAP measures.

Libby (1992) argued that the Export Enhancement Program (EEP) was successful. The EEP adopted by the USA to restore USA grain markets that had been lost to unfairly subsidised European Union grain exports and to increase EU's financial burden under its CAP. This engaged the EU to a subsidy war with the United States, and make the EU compromise on some changes under Uruguay Round of GATT,

---

134 See Chapter Two regarding literature review.

successfully achieved its goal (Anderson & Tyres, 1992:373). This is a good example to support the idea that agricultural protection of the CAP could indirectly affect the world agricultural trade by influencing other countries to adopt more protection measures.

4.4.1 The CAP Impact on International Grain Trade

Grain is the main source of food for the world. The level of grain production is varied in different regions. Yet in many parts of the world there is insufficient food which in turn implies inadequate grain output. The reasons for inadequate grain production are many and varied. However, such inadequacy could be only overcome by international trade.

Trade in grain is more affected by national policies (which are supposed to achieve production, price and income objectives of individual countries) than trade in industrial goods. Policies affecting international trade in agricultural commodities have come under enhanced scrutiny in the academic literature after Schultz (1964).[135] Much of this scrutiny has taken the form of policy analysis using quantitative models of international trade and prices (Sarris, 1981).

The conceptual analysis of the CAP's impact on world grain trade will be provided in this section under two different headings. The first part will be devoted to analysing the CAP impact on the global pattern of the grain trade and second part concentrates on its effects on the level of quantity of international grain trade (volume).

The CAP Impact on Pattern of the Grain Trade

As indicated in Chapter Three the pattern of the international grain trade has changed since the mid 1970s. Most countries were exporting to Europe at that time, with North America being the leading exporter. Since that time, the EU has turned from being a major importer to becoming a major exporter of grain. Table 4.1 shows the EU's self-sufficiency level in grain products.

---

[135] Schultz suggested that the level of agricultural production depend not so much on technical consideration, but in large measure "on what governments do to agriculture".

Table 4.1: EU Self-sufficiency in Grain Product (in %)

Years	60-64	65-69	70-74	75-79	80-84	85-90	90-95	95-99
EU Total	84.0	88.0	89.7	91.2	106.3	127.1	125.8	123.2

Source: Statistical Office of the EU, Yearbook of Agricultural Statistics, various issues.

According to Food and Agricultural Organisation (FAO) statistics the EU has been the world's biggest exporter barley and major exporter of wheat since early 1980s. The international grain market has witnessed the growing volume of the EU's grain exports. It was achieved because there was no cheaper way of releasing surplus food. Moreover, since 1973 EU agricultural exports have grown faster than world agricultural exports. This growth in agricultural exports effectively implies a bigger share for the EU in world trade. Increasing the share of the EU in world grain trade is at the cost of other major traders. These are Australia, Argentina, Canada and the USA.[136]

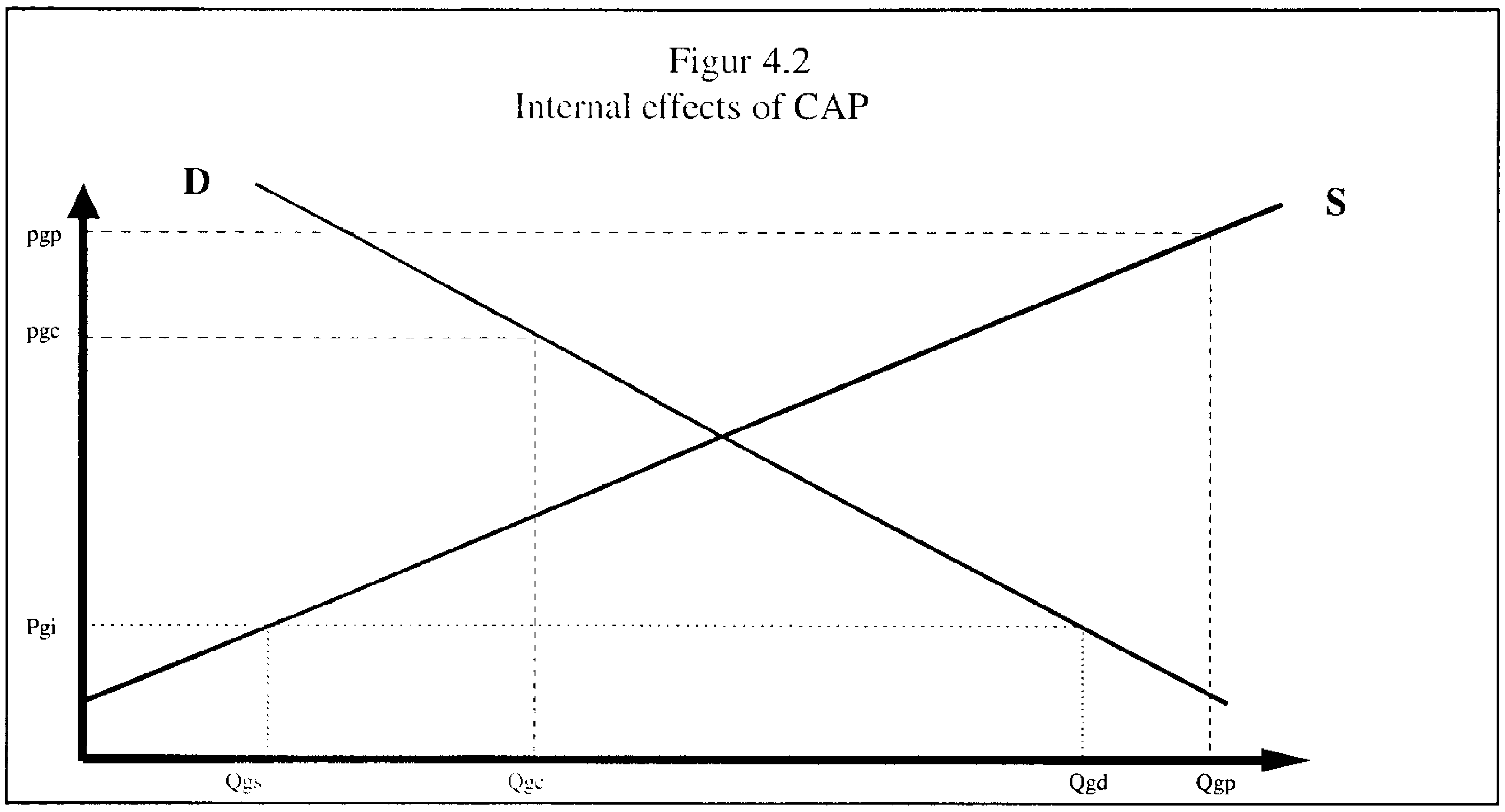
Analysis

Figure 4.2 illustrates how the CAP affected the EU's internal grain market. Before implementation of the CAP by member states, European countries had their own agricultural policies and many of them intervened in their grain markets. However grain prices in these countries were near to the world price (p_{gi}). At this price Europe was produced (Q_{gs}) and demand was (Q_{gd}). The difference between these quantities imported from non-member states, mostly from North America.

After implementation of the CAP grain prices went up to (P_{gc}) in the consumer market. This price drives demand of (Q_{gc}), but the actual received price by the EU farmers is (P_{gp}) and supply for this prices is attributed to (Q_{gp}). The difference between (P_{gp}) and (P_{gc}) is government subsidy to the EU farmers. The difference between (Q_{gc}) and (Q_{gp}) is the export by the EU and the difference between (p_{gi}) and (P_{gc}) is export subsidy.

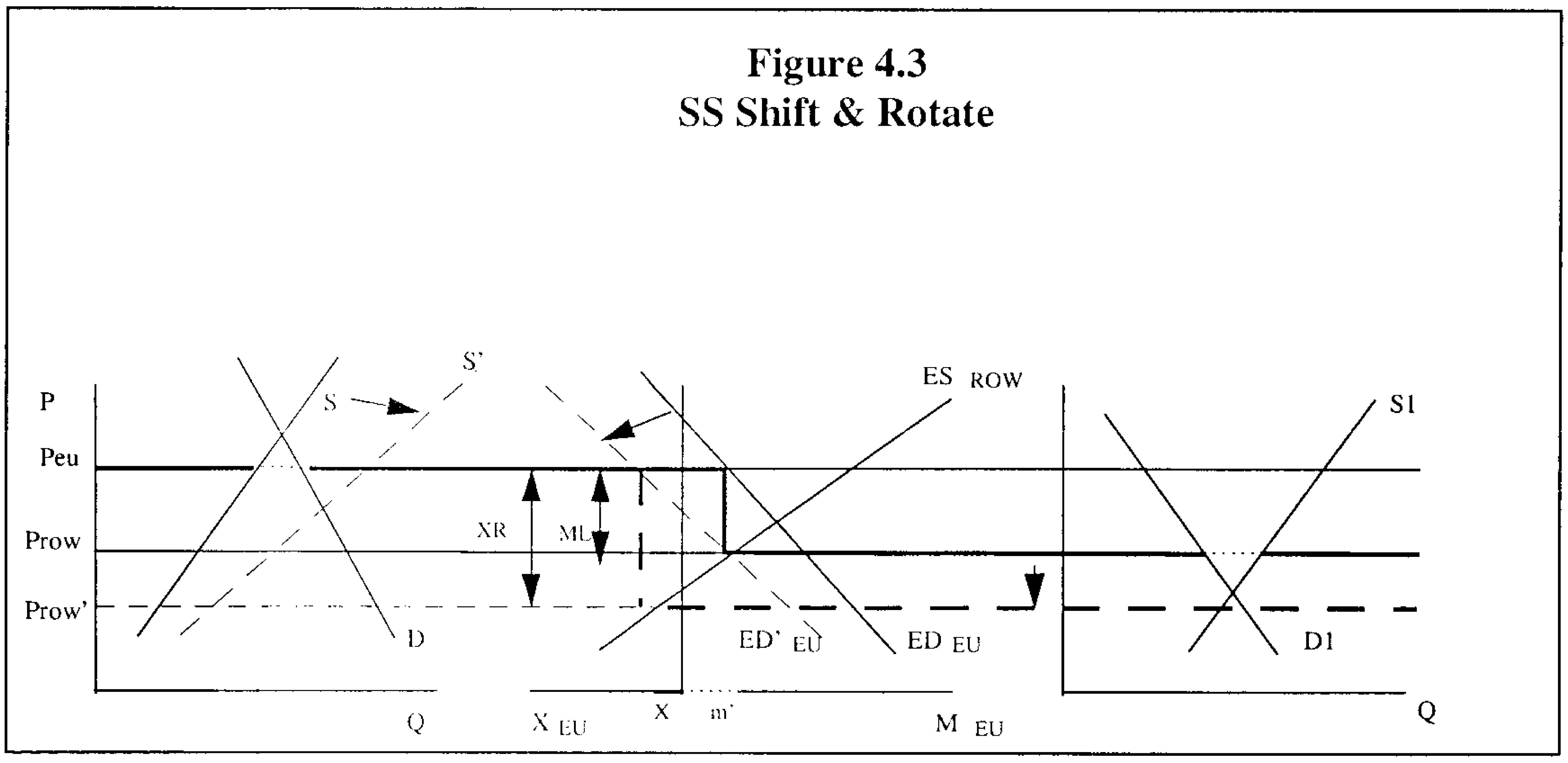
136 See Chapter Three for more detailed data.

Figure 4.2: Internal Effects of the CAP



The CAP cereal regime has encouraged quantity maximisation and large scale investments by more protectionism and guaranteed a sure and high profit for the EU producers. Consequently, the result is more grain output, which shifts the domestic supply curve to the right as is illustrated in Figure 4.3. Moreover due to the higher use of variable inputs in grain production and agriculture as whole a gradual downward rotation of the supply curve is also visible.

Figure 4.3: SS Shift and Rotate



Source: Gawei & Addy Suhut (1997:8).

The overall effect of this downward rotation together with the shift of supply curve to the right was significant leaps in EU grain output over the four decades of the CAP cereal regime. Combined with slackening demand for grain, the level of self-sufficiency has increased from 84% in 1964 to 127% in early 1990s and reduced to 123% at late 1990s. The surpluses generated have to be removed from the domestic market to prevent the price mechanism from working below the support price. Therefore "export refund" (XR) would be needed to let the EU producers match lower world prices. Thus the EU turned from being a major importer of the grain into a major exporter. These phenomena affected the pattern of the world grain trade dramatically.

The Impact of the CAP on Level of Grain Prices and Quantity of Trade

Changes in international price and volume of any commodity trade are very much related. Therefore the impact of the CAP on the level of international grain prices and volume of the trade are analysed together in this section.

Many empirical studies conclude that removal of the CAP would significantly increase world grain prices. Koester (1982), Schiff (1983), Sarris and Freebarin (1983), Anderson and Tyers (1984), Poarlbery and Sharples (1984) estimate that world prices would increase by 9.6%, 17%, 9.2%, 13% and 9% respectively, by liberalising the CAP. Sarris and Freebarin (1983) and Anderson and Tyers (1984) conclude that the CAP is responsible for 85% and 65% respectively of the decrease in world wheat prices, while Carterand Schmitz (1979) argues that the CAP depresses world price of wheat in conjunction with Japan up to 50%. However the study by Meilke and Gorter (1987) attributes a much smaller impact on world wheat prices compared to the other results. This is due to incorporation of several important features of the EU wheat market including imperfect substitutability in demand between imports and domestic supplies; the simultaneous import and export of wheat by the EU; the distinct impact of Threshold price, monetary compensatory amounts, and imperfect transmission between intervention and market prices. This study shows the wheat prices increase by 8% with the removal of the CAP.[137]

Analysis

The CAP price support caused the EU domestic price of grain to rise above the world price. Hence it expanded domestic production and reduced domestic

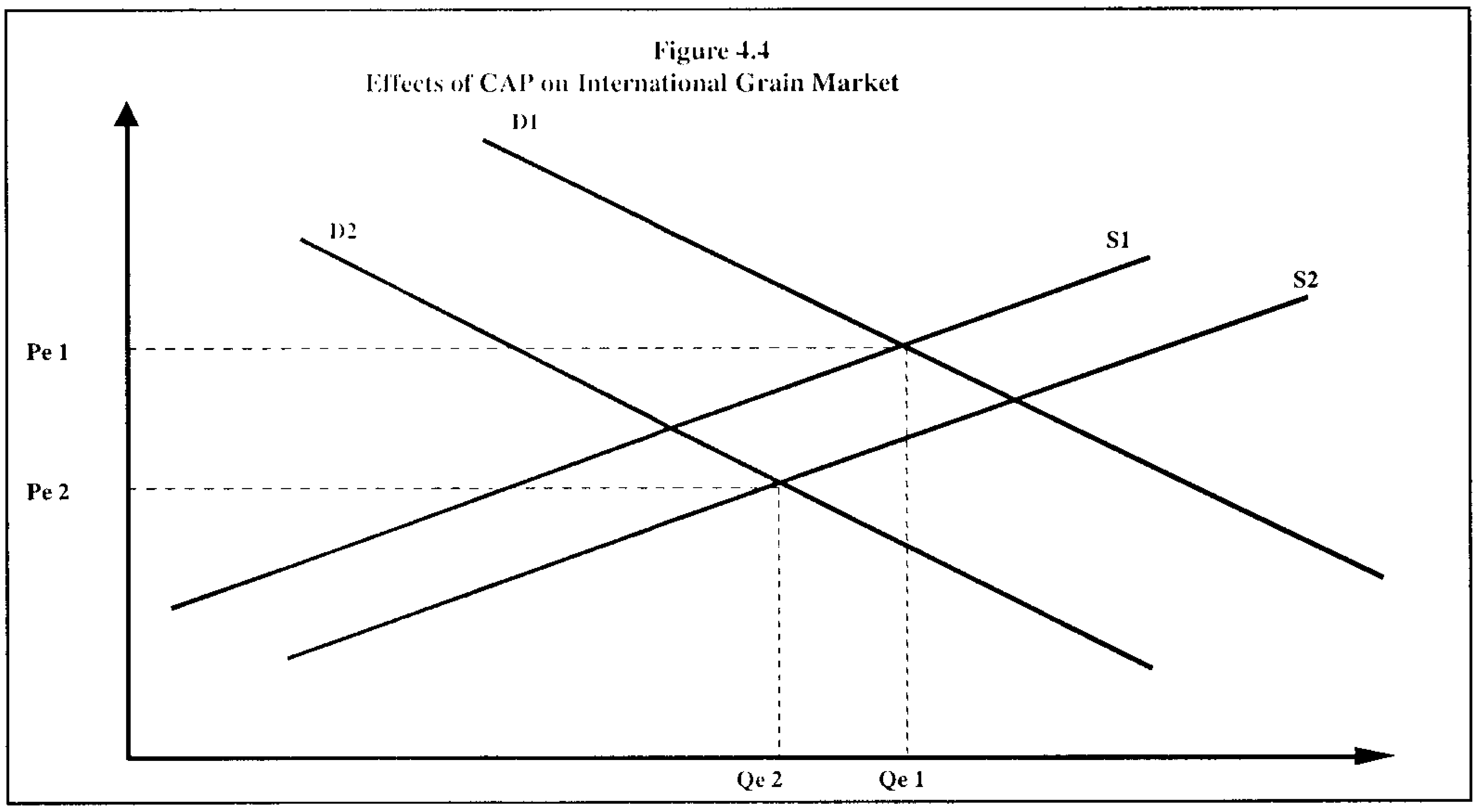
---

[137] Details of these studies are available in Chapter Two.

consumption because of movements along the domestic supply and demand curves.[138] Since the EU is a large country and her grain production accounted for 1/5th of world production, the CAP has a knock on effect on world grain prices (Gawei & Addy Suhut, 1997).

Figure 4.4 illustrates how the CAP shifts the world supply and demand curves. S_1 and D_1 represent world grain supply and demand before the CAP implemented by the EU, and S_2 and D_2 show the supply and demand after that. This shift in world supply and demand curve for grain is due to a reduction of demand for grain within the EU and expansion of world supply due to expansion of the EU exports. Thus the price of grain falls from P_{e1} to P_{e2} and demand reduces from Q_{e1} to Q_{e2}.

Figure 4.4: Effect of the CAP on the International Grain Market



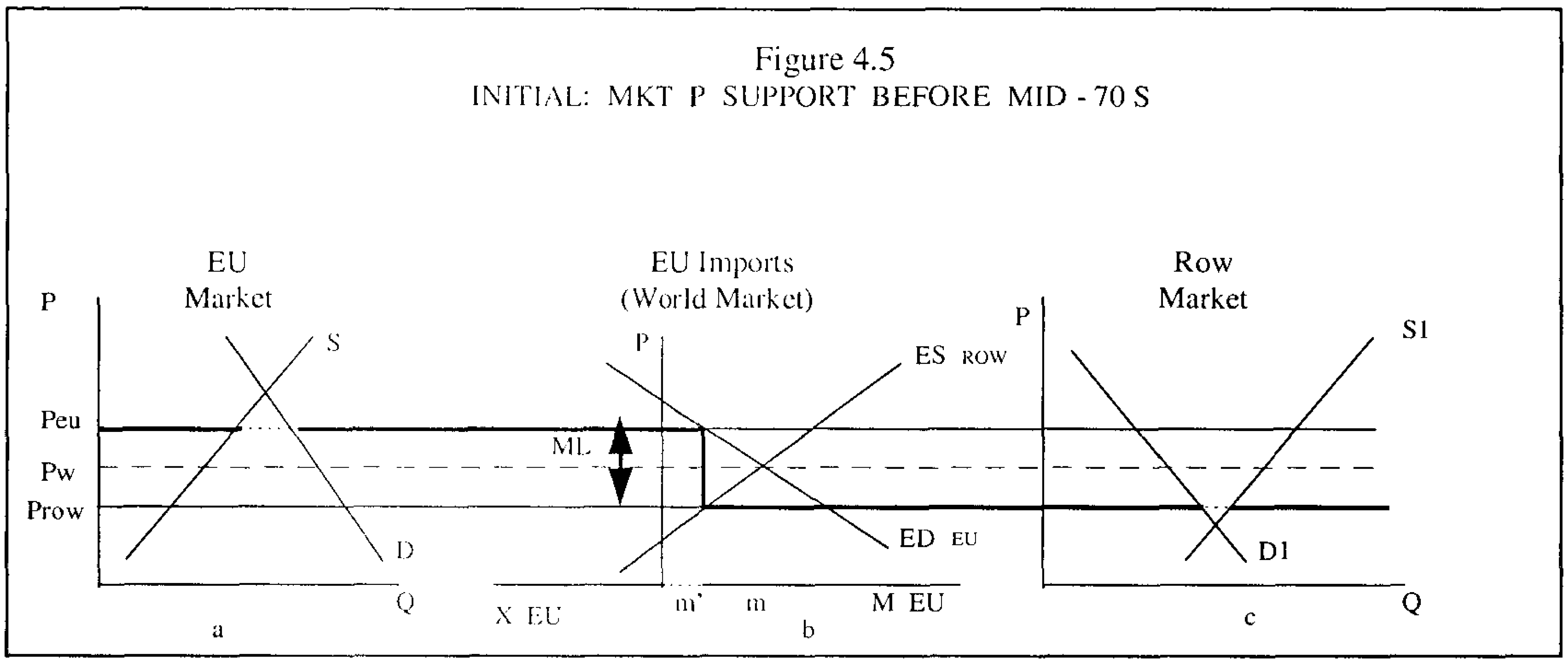
However, the increase in grain production in the early years of the CAP reduced the EU grain deficit but didn't crowd out imports altogether. Up to the middle 1970s the internal EU price (PEU) specified by cereals support regime reducesd the volume of the EU import demand to (m') from (m). Given (m') volume of EU import, the rest of the world would then be able to export only (m') amount of grain at the lower price (P_{ROW}); at (m), the free-trade equilibrium quantity of traded grain, there would be an over supply of exports compared to the reduced demand for import by the EU, resulting in the fall in grain prices for the rest of world to (P_{ROW}).

138 See Figure 4.2. In reality, demand by consumers did not fall much because of the relatively inelastic demand for such essential food.

Changes in the export and import quantity are illustrated in Figures 4.5 and 4.6 as movements along the EU excess demand and the rest of the world excess supply curves.

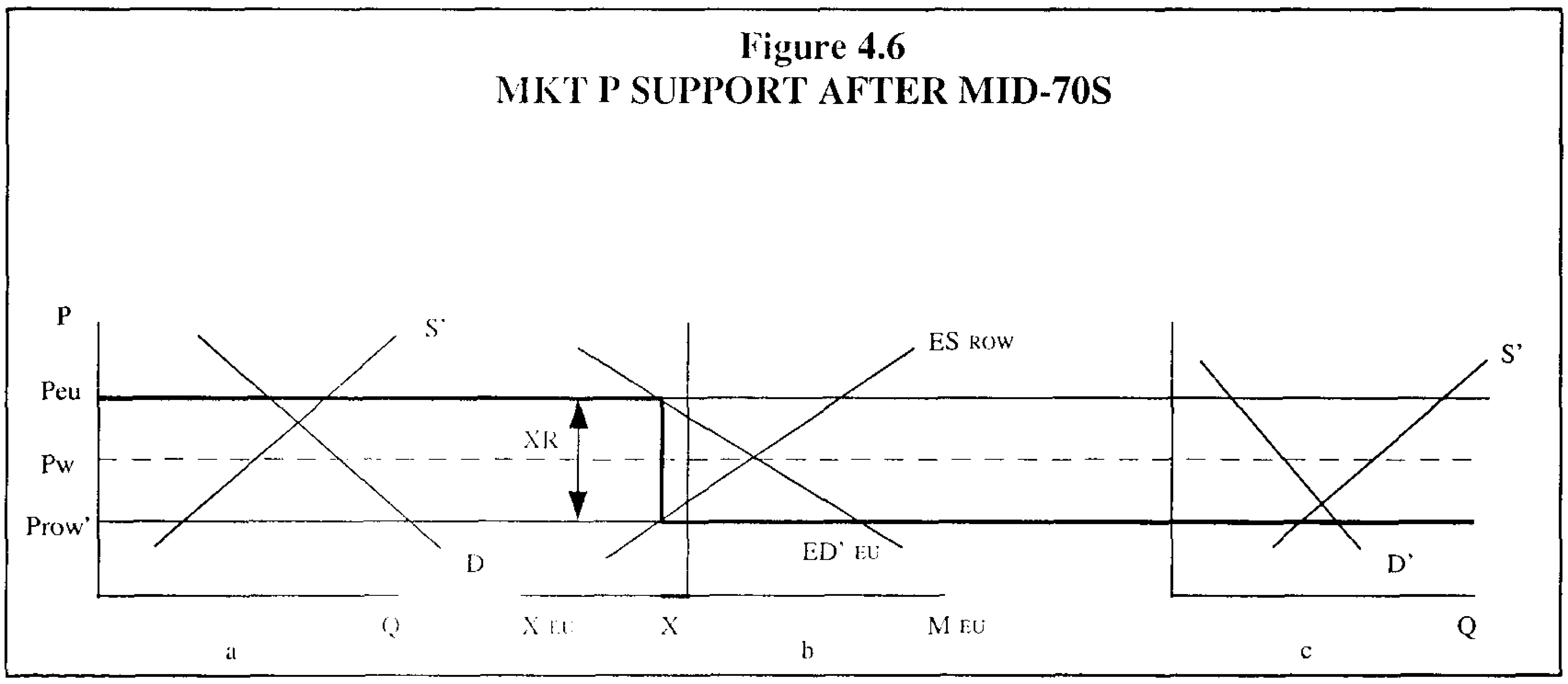
The lower price in international markets induced Non-EU grain producers to produce less, resulting in less export, and allowed the consumers to consume more (diagram c), while there are opposite effects within the EU (diagram a).

Figure 4.5: Initial: Market Price Support Before Mid-1970s



Source: Gawei & Addy Suhut (1997).

Figure 4.6: Market Price Support After Mid-1970s



Source: Gawei & Addy Suhut (1997).

The surpluses generated after mid 1970 were exported to the international market. The burden of increasing surpluses depressed the world price as a results of growing the EU exports, in turn implies a larger gap between world and the EU prices which needs to be filled by bigger export subsidies per unit of output. Referring to figure (b) the further the volume of trade moves towards the negative axis (the more EU export), the further world prices fall, hence the less export by other exporters could be expected.

The per unit export subsidy expenditure should, in theory, be greater than the per unit import tariff revenue.[139] Reversal of the EU government cash flow results in the deterioration of the EU net welfare position but improvement of that of the rest of the world.

4.4.2 Welfare Analysis (The EU and Non-EU Welfare Gains and Losses)

Any trade policy welfare analysis should be divided into two different areas. Firstly the effect of such policy on the economic welfare of the countries implementing the policy and secondly, the impact on other countries' economic welfare. Having said that this section follows suit.

The effects of agricultural price distortions on global welfare are very considerable. According to research, distortion of grain, livestock and sugar markets in all industrial countries alone cost the world economy of the order of US $25 billion per year (in 1980 dollars), and they cost producers in developing countries $28 billion per year (Tyers & Anderson, 1986).

For many agricultural exporting countries the agricultural protectionism of the CAP has led to a reduction in their share of world trade. Roarty (1983) outlined that the CAP has a "distorting effects on world agricultural trade in general, and damaging effects on the economic development of countries which are largely dependent on agricultural exports. Non-EU agricultural exporters reduced their production and consequently their exports to keep the grain price at reasonable level.

On the other hand, the costs of such distortion in industrial countries including the EU will keep rising over time, even if nominal protection rates remain unchanged. The reason for this is that the domestic markets for these products are growing, so the losses from production are applying to larger production and consumption volumes over time.

---

139 This is because the world price is lower since the EU started exporting.

The welfare impact of the CAP on non-EU countries, by transferring the price instability into the world market, is considerable. Other countries prefer more-stable to less-stable prices, and welfare in both food-importing and exporting countries would be improved by the reduction in instability in international food prices.

The impact of the CAP on other sectors of the EU's economy is also considerable. The EU has diverted considerable resources into the agricultural sector (Breckling & Thorpe, 1987). The burden of this resource transfer is borne by manufacturing and service industries in the EU economy. The study by Breckling and Thorpe (1987) outlined that the transfer amount to the agricultural sector within the EU is over 73000 m ECU a year. Thus the output and export of other sectors of economy are lower than what would be the case in absence of the CAP. According to the study the manufacturing output is 1.7% lower. Studying the major economies of the EU Breckling and Thorpe also concluded that the effects of the CAP has been to lower employment in these countries.

Gowei & Addy Suhut (1996) welfare analysis of the CAP stated that, up to mid 1970s the welfare analysis for the EU and the rest of the world under the CAP cereal regime involved import tariffs. The raising of the EU domestic grain prices increased domestic producer surplus to the cost of loss in consumer surplus which is greater. If the EU been a "small country" the import tariff revenue collected by the government would have been less than the dead-weight loss. Since the EU is a large country, thus it has affected the world prices, the tariff revenue have been larger (this is caused by the "terms of trade gain").[140] The rest of the world was unambiguously losing out due to the CAP cereal regime before mid-1970s, as a result of loss in foreign producer surplus which was greater than the gain in foreign consumer surplus.[141]

When the guarantee system shifted from one with deficit into one with surplus after the mid-70s, the EU shifted from being a collector of import levy revenues into a payer of export subsidies.

---

140 This is because the EU variable tariff lowers international export prices. Therefore, the overall loss in surplus may be offset by the EU's gain in the form of tariff collection. Thus the net gain or loss for the EU from the policy depends on the actual size of the dead-weight loss and the terms of trade gain.

141 In the broad classification of the rest of the world, grain exporters lost more than net grain importers who may even gain from the lower international price.

In theory, per unit export subsidy expenditure should be greater than per unit import tariff revenue, since world prices are lower when the EU is exporting. As the direction of the grain trade reversed, the EU government converted from a gainer into a loser, by paying export subsidies rather than collecting import tariff. However, basically the CAP welfare effect is to take from EU consumers and foreign producers and give to EU producers and foreign consumers, though the magnitudes of these transfers are different. These differences in magnitude together with the reversal of EU government cash flow results in the deterioration of the EU net welfare position but the improvement of that of the rest of the world. Before the mid-1970s the net EU welfare effect was ambiguous. After the mid-70s, the EU as a whole is definitely losing from the implementation of the CAP.

Even if the overall EU loses out under this analysis which is the usual conclusion of partial equilibrium studies on the CAP, there are still some non-economic benefits such as better income distribution across sectors and compensating socio-political benefits transfered to the agricultural sector.

4.5 The Impact of the CAP on International Grain Price Variability

World agricultural price instability also has been theoretically demonstrated by the many scholars; i.e. Blandford and Lynch (1993). Mix of trade and domestic policy together with fluctuation in production generates different degrees of price variation. Variations in international grain prices, not only depend on the agricultural policies and changes in production level themselves but also on relative size of the producing countries implementing such policies.This is similar for the level of grain prices.

Following Blandford and Lynch (1993), world price instability is defined as the absolute value of the difference between expected and actual prices adjusted for the mean. In the case of the EU agricultural policy, the use of variable levies and export subsidies together with price fixing reduced the mean and increased the variance of international grain prices, while raising the average level and reducing the instability of grain prices within the EU.

Mathematical Framework

Consider the following linear two-country model where demand in countries 1 and 2 is given by

$$d_i = a_i - b_i p + \delta_i \qquad i = 1, 2 \qquad (4.1)$$

and supply is given by

$S_i = \alpha_i + \beta_i p + \varepsilon_i \quad i = 1, 2 \qquad (4.2)$

and where: d_i = demand in country 1
s_i = supply in country 1
P = price

The terms a_i , b_i, α_i , β_i are fix parameters, and δ_i and ε_i denote random variables distributed as N (0 , $\sigma_{\delta i}$) and N (0 , $\sigma_{\varepsilon i}$), respectively.

Free trade

Under free trade, aggregate excess demand is zero, i.e.

$$\sum_i d_i - \sum_i s_i = 0 , i = 1,2 \qquad (4.3)$$

From (4.3), the equilibrium price can be found to be

$$P_w = \sum_i \frac{a_i - \alpha_i + \delta_i - \varepsilon_i}{b_i + \beta_i} , i = 1,2 \qquad (4.4)$$

and hence the variance of the free trade world market price is

$$\sigma_{pw} = \sum_i \frac{\sigma_{\delta i} + \sigma_{\varepsilon i}}{(b_i + \beta_i)} 2 \ , i = 1,2 \qquad (4.5)$$

Price Fixing

In most state trading nations, but also in some other countries, internal prices are fixed by government policy. Trade is strictly controlled by the government which allows only specific quantities to be imported which vary from year to year. For the cases where external prices rise above the internal price, a ban on exports coupled with import subsidies is needed to maintain the policy. If the price in the importing country is fixed at $\bar{p}_2$, the equilibrium price in the exporting country is

$$P1 = \frac{\sum a_i + \alpha_i + \delta_i + \varepsilon_i - \bar{p}_2(b_2 + \beta_2)}{b_1 + \beta_1} , \quad i = 1,2 \qquad (4.6)$$

and the price variance is

$$\sigma_{p1} = \frac{\sigma_{\delta 1} + \sigma_{\delta 2} + \sigma_{\varepsilon 1} + \sigma_{\varepsilon 2}}{\left(b_1 + \beta_1\right)^2} \qquad (4.7)$$

From (4.7) it can be concluded that all instability in the importing country has been exported to the exporting nation.

Comparing σ_{p1} with the variance of price under free trade, it is found that

$$\frac{\sigma_{p1}}{\sigma_{pw}} = \frac{\left(b_1 + b_2 + \beta_1 + \beta_2\right)^2}{\left(b_1 + \beta_1\right)^2} \rangle 1 \qquad (4.8)$$

It is clear that this notion increases when supply and demand in the importing country become more inelastic.

Variable Levy

As long as the export price is below the price in the importing country, the imposition of a variable levy has the same affect on instability as in a pure case of price fixing. In a case where the export price rises above the price determined by the importing country, the latter would import the commodity as in the free trade case up to the self-sufficiency price. Since the export price can most of the time assumed to be below the price in the importing country, the latter can shift almost all internally created instability onto the external market.

4.6 1992 Reform and Consequences

Indeed production beyond self-sufficiency has turned out to be a serious problem for the EU, due to the simple fact that production surpluses involve very high costs primarily via export refunds.[142] Furthermore, dumping has created an opposition from other exporters while crop destruction has been regarded as unethical.

The inevitable solution to the surplus problem has to be the reduction of output either by straight forward reduction of the level of guaranteed prices (movement along the supply curve) and/or by quotas (shift/rotation in the supply curve). In fact both these measures are being implemented following the modification to the cereal regime in 1992 MacSharry reform. The reform was relied on covering Price, Land

142 In 1991: ECU 10.1 bn

and Income. It was decided that intervention price for grain would be reduced by 29% over three years starting 1993/94, an agreed amount of land was to be set aside on a rotational basis and compensatory payments were introduced to compensate farmers who lost their earnings.

The implication of this reform for the EU and the world is to reverse the static and dynamic effects of the pre-reform policies, which had induced over-production within the EU. It directly reduced the CAP budget deficit by direct reduction of output and expenditure. Furthermore, it creates less maximisation incentives than that generated by the level of previous support. Its impact on the world market is to provide less export and high grain prices which could reverse the previous CAP effects to some extent.

4.7 Simplifying Assumptions for Theoretical Approach and Conceptual Model

The aim of this section is to remove many details, and thus develop a simple framework, to facilitate an easy understanding of the principles. However it is envisaged that the assumptions and simplification that will be made in this section will not hinder the theoretical and empirical insight and the fundamental conclusion of this chapter.

A proper theory of grain shipping markets should at least focus more on the bulk carriers market. Pirrong (1993) noted that most of the grain trades are shipped on general purpose bulk carriers that are also capable of being converted to transport other bulk commodities, such as ore and coal. In reality, there are other types besides bulk carriers which may occasionally carry grain such as oil tanks, combined carriers and general cargo ships (see Chapter Three, Section 3.8), however as Nagatsuka (1986) outlined their share in grain transport market is negligible. Additionally, each ship type can be distinguished according to age, propulsion and cargo handling technology. This study shall ignore all these differences. Thus the assumption will be that only one type of ships exists (bulk carriers). However, different sub-market for this section of shipping will be considered.[143]

Due to the similarities in finance, operations and commodity trading among the different ship sizes in one sector of shipping market, it is believed that there is

[143] Definition of each size is provided in Chapter Three.

substitutability between them in these three areas. The degree of substitutability between shipping sub-markets implies the spill over effects among these shipping sub-markets. On the other hand, the extent to which these shipping sub-markets are not substitutes may suggest that they react differently in case of external shocks. This study shall ignore these issues for the sake of simplification. Furthermore, it will be assumed that ships are fully loaded and there is no partial loading for any ship size, in any route.

In fact two types of shipping services are performed in international shipping. The first type is liner service.[144] The other type of ocean transport service is called tramp service. Tramp ships have no regular routes or schedules, and rates are set by negotiation between shippers and traders. Harris (1983) outlined that 93% of world grain shipments were transported on trampships since 1979. Given its importance to international trade in grain, the tramp service market is the central focus of this study. Therefore, it is assumed that there is perfect competition in supply and freight market, easy passage in the market and free entry into the market.

The conceptual model of the study provided here is simplified for better understanding. The CAP is considered as a major influential factor in grain international trade. It has affected the regularity, volume and pattern of the grain trade. The level of grain freight rate has affected the regularity and volume of this trade. On the other hand, port developments and investments are influenced by the regularity and volume of the trade as well as shipment sizes. Shipment size could also be influenced by the pattern and volume of the trade. Furthermore, the pattern of the trade could change average distance and consequently total ton mile demand. Freight markets could be characterise in long run and spot market which interact and could be influence by the volume of the trade. Finally, ship size contribution in grain trade, infancies by port development, shipment size and average distance.

4.8 General Hypothesis

The formation and development of the EU together with implementation of the CAP have contributed to structural changes in the international grain market. Such structural changes have affected the pattern and volume of demand for different dry

[144] In the liner shipping service, ships travel fixed routes and schedules. Shipping territories are divided through negotiation among liner shipping firms, and liner rates are collectively set by the shipping firms participating in negotiation. Thus the competition is restricted and the liner market is often considered to be non-competitive (imperfect).

bulk carriers market sub-sector (Capesize, Panamax and Handysize). This mainly occurs because of port and route restriction.

The starting point for an economic analysis of the shipping market is sea-borne trade, because demand for shipping services totally depends on international commodity trades. The structure of sea-borne trade therefore underpins the structure of demand for maritime transport. Shipping operators are in the business of providing transport for movement of cargo from origin to destination, and have limited influence over demand for their services. Naturally, the type of service required depends upon the cargo to be moved and ports and routes restrictions. This fact demands the shipping market to be highly disaggregated by sector and differentiated by size. Thus any theoretical framework utilised to hypothesise this market should recognised such disaggregation and differentiation.

Glen (1990) proposes a differentiation hypothesis for the tanker market. He argues that the theory of homogeneous, perfectly competitive market which previously was suggested by the shipping economists is no longer valid (Zannetos, 1966). This hypothesis partially discusses the commodity flows and tonne-miles demand, which is affected by the changes in structure of demand and production. This establishes the argument that structural changes in demand and production of a commodity trade will alter the pattern of demand for different shipsize. This arises because of port and routes constraints for particular shipsize. This hypothesis was utilised to explain the differentiation in tanker market and never been applied to dry bulk carriers market.

As discussed in Chapter Three the structure of demand and production in world grain market has changed since the 1980s, in the sense that the EU gradually turned from being a major importer of grain to a major exporter. This structural change in international demand and production of grain has affected the pattern and volume of demand for different bulk carriers market sub-sectors. Related to this general hypothesis there are a number of interrelated but distinct sub-hypotheses.

4.8.1 Sub-hypotheses

H1: Development and Policy Implementation by an Economic Integration has Important Consequences for Shipping Transport Service.

The traditional hypothesis in the shipping literature argues that economic (regional) integration normally leads to relatively less demand for shipping transport services, because of diversion of longer hauls to shorter due to more intra-regional trade (Wijnolst & Wergeland, 1997). *Alternatively it is more* *valuable to evaluate the size of demand that the external trade of the combined economies of the member states of the regional economic integration could generate for shipping services. In this respect this work focuses on the expansion and/or reduction of the EU external trade rather than internal EU trade.*

Since the CAP was one of the first obligations placed upon the EU by the Treaty of Rome, it carries all the characteristics of the EU. Analysis of the CAP in Chapter Four and also other studies which were reviewed in Chapter Two revealed that the CAP measures have strongly affected the pattern of production and trade in international grain market. This could be related to more than the CAP measures alone.

The removal of frontiers, mobility of labour and citizenship of the European Union, have extended the dimension of the CAP's effects on international grain trade beyond the effects that could be produced by a simple custom Union policy measure. Barrass and Madhavan (1996:47) states that " the European Union was from its inception designed for economic integration well beyond the degree of co-operation required for membership of customs union". Furthermore as their economies integrated within a single entity, member states can no longer maintain economic relations on a purely individual basis with third countries or within international organisations. Consequently, the community has taken the lead in trade policy and international economic co-operation such as the GATT (W.T.O). More generally, it was mentioned in Chapter Two that integration has broadened the EU member states role as an entity. The EU now has a major presence in the world, as the single market has developed against the background of interdependence in the global economy.

Therefore the analytical interest for this study in the subject of economic integration has broadened, particularly in response to proposals for further economic and monetary integration in the EU. It argues that for long term analyses of the CAP effects on international shipping transport services, instead of considering only conventional trade creation and diversion analyses. This is more useful to evaluate the size of demand that the external trade of the combined economies of the member states could generate for shipping services. However it remains the case that the most thoroughly developed framework of thought in this field still relates to the particular issues of customs union formation which will be also followed by this study.

H2: How Different Ship sizes are Affected

Changes in the pattern of international grain production and trade by the CAP, decreased the demand for "Capesize" and increased the demand for "Panamax" and "Handysize" bulk carriers.

The majority of the grain import volume to the EU, imported from North America (USA, Canada), formed the North Atlantic grain trade route.[145] This trade was an important proportion of international grain trade during 1960s and 1970s, about 20 million tons, satisfied most of the grain import demands within the EU, this trade reduced by 90% in 1990s. On the other hand, the EU become a major producer of the grain and as the self-sufficiency level increased beyond the domestic demand the surplus production was dumped to the world market. Therefore, new shipping routes with different characteristics and restrictions have been established. The new routes departures from the EU's ports mostly go to destinations in the Middle East, Africa and other developing countries. With respect to the differentiation hypothesis, such a structural change in demand and production of grain could influence the different dry bulk market sub-sector supply and demand equation.[146]

From the bulk carrier operator's point of view, the involvement of each shipsize in specific route and commodity trade is important for preparing an appropriate strategy. According to the data and discussion presented in Chapter Three, contribution of "Capesize" in the grain trade has reduced dramatically in the last two decades (1980s and 1990s). It has been also established in Chapter Three that many factors prevent the "Capesize" from contributing into the grain trade. Most importantly the volatility of this market in the sense of supply and demand makes investment in port facilities for large vessels uneconomical. However, potentially only North America and the EU grain ports are capable of handling large vessels. Furthermore, the volume of the trade in North Atlantic was high enough to provide a good source of demand for "Capesize" vessels. And finally the economies of scale attached to this size ship encouraged shippers to use this size vessel for this particular route. Given this, the contribution of "Capesize" to the grain trade, in fact, could only happen in North Atlantic route. As mentioned previously, the EU became a major exporter of grain since mid the 1980s. This created new shipping routes with destinations in developing countries. The ports in developing countries according to the analysis in Chapter Three do not have the capacity to handle large ships. Thus the EU exports generates more demand for smaller ships ("Panamax" and "Handysize").

---

145 North Atlantic grain trade is defined in Chapter Three.
146 Evidences are provided in Chapter Three.

This hypothesis is based on potential trading route and port facilities for grain. Thus further development in port facilities may invalidate the entire hypothesis. However the driving force for any investment in port facilities will depend on the pattern and volume of trade which for grain depend upon reduction of trade restrictions.

H.3 Grain Freight Rates Influence The Supply of Shipping Capacity for Ocean Grain Shipping Services

The relative grain freight rates play an important role to encourage or discourage the ship-operators, operating different shipsizes to be employed in grain sea-borne trade (load even partially).

The discussion regarding shipsize preferences and efficiency in different commodity trades (iron ore, coal and grain) based on route and port constraints at origin and destination and volume of shipment in Chapter Three revealed that, each shipsize is more favourable to specific dry bulk commodity trade(s) (e.g. "Handysize" to grain, "Panamax" to coal and "Capesize" to iron ore). However, there is an important factor "the level of freight rates" which always could undermine all the rules and theories in shipping literature. This variable could encourage different shipsizes to penetrate into the market which is considered to be unfavourable but providing higher pay.

Thus in time of low demand in other dry bulk market (iron ore and coal), which consequently will cause low freight rates in these market, the shippers of other bulk cargoes will penetrate into the grain market. In other words, as demand for other dry commodity trade changes the supply in the grain market will be affected. Relatively higher grain freight rate created by strong demand for grain shipping services may also induce bulk carriers of other commodities (e.g. iron ore and coal) to arrange to carry grain.

To support the above argument it should be noted that the highest volume of grain, carried by "Capesize" accrued in 1982 and 1983. Overall volume of demand for this size ship was 262 M.tons at that time. Grain generated 22 M.tons about 9% of overall demand for this size ship at that time. The overall demand (for Capesize) of 484 M.tons in 1995 shows the reduction of grain production in both percentage and actual volume which were 2.5% and 11 M.tons respectively. The period between

1982 and 1983 which represents the highest point for contribution of "Capesize" in grain trade also coincides with low freight rates in iron ore and coal market.[147]

H4: Freight Rate Influence Volume of Grain Trade

Grain is not a sensitive commodity but it is elastic to price changes and since it is a low-valued commodity, freight rates forms a considerable proportion of their landed prices. Therefore the volume of sea-borne trade for this product is sensitive to level of freight rates. In the other words, volume of demand for grain shipping services is determined by the level of grain freight rates.

Figure 4.7 illustrates how price and volume of sea-borne trades for these products could be influenced by freight rates. It can be deduced from Figure 4.7, for low-valued commodities the quantity of grain Q moving by sea is dependent upon the freight rate F which is equal to vertical separation between the supply (in exporting country) and demand (in importing country) curves S and D. Given that the demand function is:

$Pd = m_1Q + C_1$

and the supply function is:

$P_s = m_2Q + C_2$

then $(P_d - P_s) = F = (m_1 - m_2)Q + (C_1 - C_2)$ which is the demand function for the maritime transport.

when f = 0,

$Q = \dfrac{C1 - C2}{m1 - m2}$ which represents the value of Q at the intersection of the supply and demand curves.

When Q = 0,

$F = C_1 - C_2$ i.e. the separation between the supply and demand curves on the vertical axis. Hence the demand function can be drawn as shown in Figure 4.7

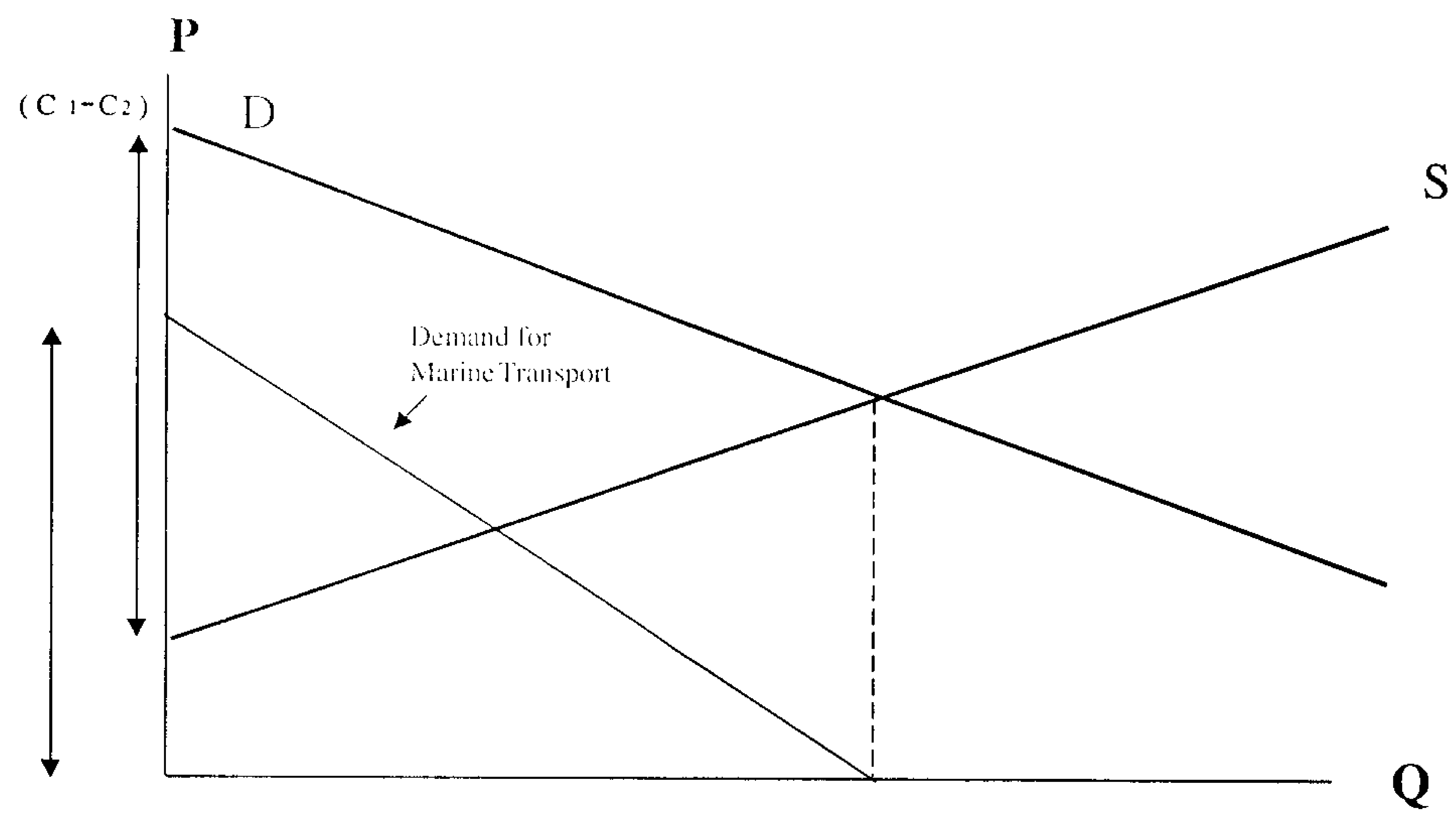
In general $D(Q) - S(Q) = Ds(Q)$ where $D(Q)$, $S(Q)$ and $Ds(Q)$ are the respective functions representing the demand for the grain, the supply of the grain and the demand for sea transport of the grain.

[147] See Chapter Three for evidence.

However for high-valued commodity trades the general assumption is that, demand for shipping services (for such commodities) are completely inelastic with respect to freight rates and therefore will be treated as exogenous.

Figure 4.7: Demand for Grain Transportation

Figure :4.7



Source: Evans & Marlow (1997).

The elasticity of demand for shipping services in low value commodity trades such as grain and soybean is important to determine the effect of freight rate changes on volume and pattern of their trades, and depend upon the elasticity of these cargoes and the proportion of the freight rate with respect to their total prices.

H.5 Protection Measures in Agricultural Policy Separated the Domestic Grain Market From World Market

Threshold price actually separates the EU market from world market and prevents the world prices from influencing the EU grain import, while export refunds encourage the EU producers to export more. Therefore it could be argued that trade protection is of considerable importance in modelling grain trades.

Classical models of international trade generally assume the existence of a frictionless environment where goods move freely between countries (see Chapter Two Section 2.2). Thus imports are a function of domestic supply (*S*), consumption(C) and world price (P). Therefore the import could be modelled as follows:

$$I = f(\overset{-}{S}, \overset{+}{C}, \overset{-}{P})$$

The EU governments exert considerable control over grain prices, so those world prices are separated by policy measures. The CAP Threshold price, which is the price set at the EU's frontiers and must be reached by imports, is the main CAP instrument used to control the EU's imports and ensure that the target price cannot be undercut by imports. On the other hand, the EU's Export Refunds are subsidies to help the EU's producers compete on world markets. It represents the approximate differences between average world price and the actual internal EU price.

H6: Soybean Trade and its Relation With Ocean Grain Shipping Services
The contribution of "Capesize" into the sea-borne grain trade since the actual grain trade (wheat and coarse grain) in North Atlantic has folded, is attributed to increase of soybean trade in this route. Therefore the level of soybean trade in North Atlantic could also influence the grain freight rates.

Much of the attention on soybean in this research has been derived from the fact that definition of grain adopted by study does not include soybean.[148] However, as mentioned in Chapter Two Section 2.1, in the shipping literature and data, soybean has been included in grain definition.[149] Furthermore, there is substitutability between soybean and grain in many markets, especially in the feed grain sector where lower price soybean have been ousting higher-priced grain especially in the EU markets.[150] This has exacerbated surplus and expenditure problems in the EU grain sector.

---

148 Subject to the CAP cereal regimes, the level and type of protection measures are different for soybean and other grains (wheat and coarse grains).

149 Specifically, data for grain transported by different shipsize produced by Fearnaly.

150 It may be useful to comment here on the idea of demand elasticity. The most commonly used elasticities are own price elasticity, cross-price elasticity and income elasticity. The measure will be defined as the ratio of the proportionate change in quantity demand for particular good to the proportionate change in the specified determination of demand. Primarily food products such as grain and soybean are generally inelastic to change of income and for grain specifically there is substitution (soybean), Thus, grain is elastic to cross-price. Therefore, cross elasticity for grain and soybean could be expressed as follows:

$$Ec = \frac{\Delta Q / Q}{\Delta P_a / P_a}$$

Since the demand for shipping transport is a derived demand.[151] The substitutability in consumer markets could be extended to the shipping market which provides the same type of port facilities and shipping services for both soybean and grain. In other words the shipping tonnage and port facilities which were used for grain transport could be used (without any changes or further investment) to carry soybean. Thus as import demand for grain decreased (due to higher import price created by import levy) the import demand for cheaper soybean has increased. Consequently the same port facilities and tonnage can be employed in sea-borne soybean trade.

As mentioned in Chapter Three, the US dominates world production and exports of soybean, exporting about 74% of soybean in 1999.[152] On the other hand the EU is the world's major importer of soybean, importing about 42% of total world import in 1995 with around 32% of US export being directed to the EU market.[153] According to the hypothesis that the "Capesize" can only contribute to grain Commodity (wheat, coarse grain and soybean) in the North Atlantic. This trade provides a good source of demand for this ship size.

4.9 <u>Possible Effects of the Liberalisation of CAP on Structure of Demand For Shipping Transport of Grain (a Simulation Model)</u>

There are many counterfactual analyses in the agricultural literature regarding the liberalisation of the CAP and its consequences for different sectors of the EU and international economy.[154] Most of these studies are motivated by the negotiation in the GATT (WTO). This work also undertakes such a counterfactual analysis to investigate the impact of possible liberalisation of CAP on structure of demand for shipping transport of grain by means of a simulation model under different scenarios.

Positive elasticity exists if *S* and *G* are perfect substitutes for each other, because changes in the price of *G* will provide more demand for *S* and zero elasticity means no relationship between these products and negative valuation denotes the products are complementary.

151 Evans and Marlow (1997), define derived demand as "derived demand exists when goods or service are demanded not for themselves but for their usefulness in producing other goods or services. The demand for any factor of production is a derived demand as is the demand for sea transport. The elasticity of demand for a factor of production, or any goods or service the demand for which is derived, will depend on the elasticity of demand for the goods being produced or transported, on the ease with which a substitute can be used".

152 US Department of Agriculture (1999).

153 US Department of Agriculture (1999).

154 See Chapter Two (literature review) for details of these studies.

Despite the growing trend in world grain production and consumption, the sea-borne trade in this commodity is almost at the same level since 1982.[155] One observation could be made. As regional consumption increased the production in the same region has increased. This implies major consumers became major producers, which resulted in a reduction of imports. Schultz (1964) stated that "the level of agricultural production depends not so much on technical consideration, but in large measure on what government do to agriculture" (Barrass & Madhavan, 1997). Concluding that the reason for expansion of regional productions, is not only technological improvement but government intervention into agricultural activities is the main reason behind that.

The CAP and its cereal regimes as an important agricultural protectionism policy, has been a major influence on world grain trade as outlined by many researchers.[156] The CAP affects world trade volume for grain products. Without the CAP, demand for imports would be more and regional supply would be less which may lead to more international trade. This problem led to agricultural trade becoming the main issue of (GATT) Uruguay Round of negotiation. The reason that led to suspension of the (GATT) in December 1990 was the failure to find agreement on agricultural trade issues. In this Round of negotiation, the EU and the USA had two different proposals for partial liberalisation of agricultural support on the world grain market.

The EU proposed a 30% cut in agricultural support in OECD countries to be accompanied by rebalancing of the CAP. The base year from which these changes were to be initiated was 1986. The USA proposed a 90% cut in export subsidies and a 75% reduction in all other trade distortions in OECD countries with 1988 taken as the base year.

According to the McCorrist (1992) both these proposals would lead to more international grain trade. However, the US proposal increases the international trade more than the EU one. The EU's proposal at GATT in December 1990 proved to be unacceptable to the US and the Cairns group. The magnitude of the proposed level of cuts was deemed to be too low and the principle of rebalancing the CAP was not acceptable to agricultural exporters. There was also rejection of the EU's choice of base period. Consequently, the gap between the proposals of the two major parties in the GATT Round proved to be too wide to form the basis of a compromise. However, these two proposals will provide grounds to for evaluating the effects of

---

155 See Chapter One Figure 1.2.
156 See Chapter Two Section 2.2.

possible changes of the CAP policy measures on the structure of demand for ocean grain shipping services.

Figure 4.8 presents a simplified illustration of supply and demand conditions for ocean grain shipping transport to illustrate the effects of the proposed changes. The supply function depends upon prices of the variable inputs such as fuel prices. D_1 represents the demand for ocean grain shipping service, with the CAP in operation. Considering the EU and the US proposals in the GATT, D_2 represents the demand if the EU proposal is implemented and D_3 illustrates the demand if the US proposal implemented. Mathematically, these effects could be computed by using the following formula:

Demand curve *D1* was shifted to new position *D2, D3* and new equilibrium situation occur. The line connecting *D1* to *D2* illustrates the effect of the EU proposal and the line connecting *D1* to D_3 illustrates the effect of the US proposal. It is possible to measure the slope of the lines by the following formula.

$$\frac{vertical\,changes}{horizontal\,changes} = \Delta Q / \Delta F$$

If:

$SS = f(D)$

slope of the line will be:

$$\frac{f(D1) - f(D2)}{D2 - D1} \text{ or } = \frac{S2 - S1}{D2 - D1}$$

If we defined demand and supply model in linear parameters form as follows:

$DD = a + bd$

$SS = c + ed$

If the demand is reduced by any exogenous variables (e.g. CAP), this parameter should be added to the equation.

$DD = a + bd - p$

'p' is protection level under CAP

If we consider,

$DD = SS$

the reduced form of supply and demand equations will be:
$a + bd - p = c + ed$

The only endogenous variable is d therefore,
$a - p = c + ed - bd$
$a - p - c = ed - bd$
$a - p - c = d\,(e - b)$

If we divide both side of the equation by (e - b) then,
$$d = \frac{a-c}{e-b} - \frac{p}{e-b}$$

Now we have the reduced form of our supply and demand equations. To understand the effect of 'p' on demand curve, we focus on the part of the equation where 'p' is engaged.

$$\frac{p}{e-b} \; or \; \frac{1}{e-b} \cdot p$$

if $b > 0$, $e < 0$ therefore $(e - b)$ is $(- ve)$
Therefore p will be multiplied by a $(+ve)$ number.

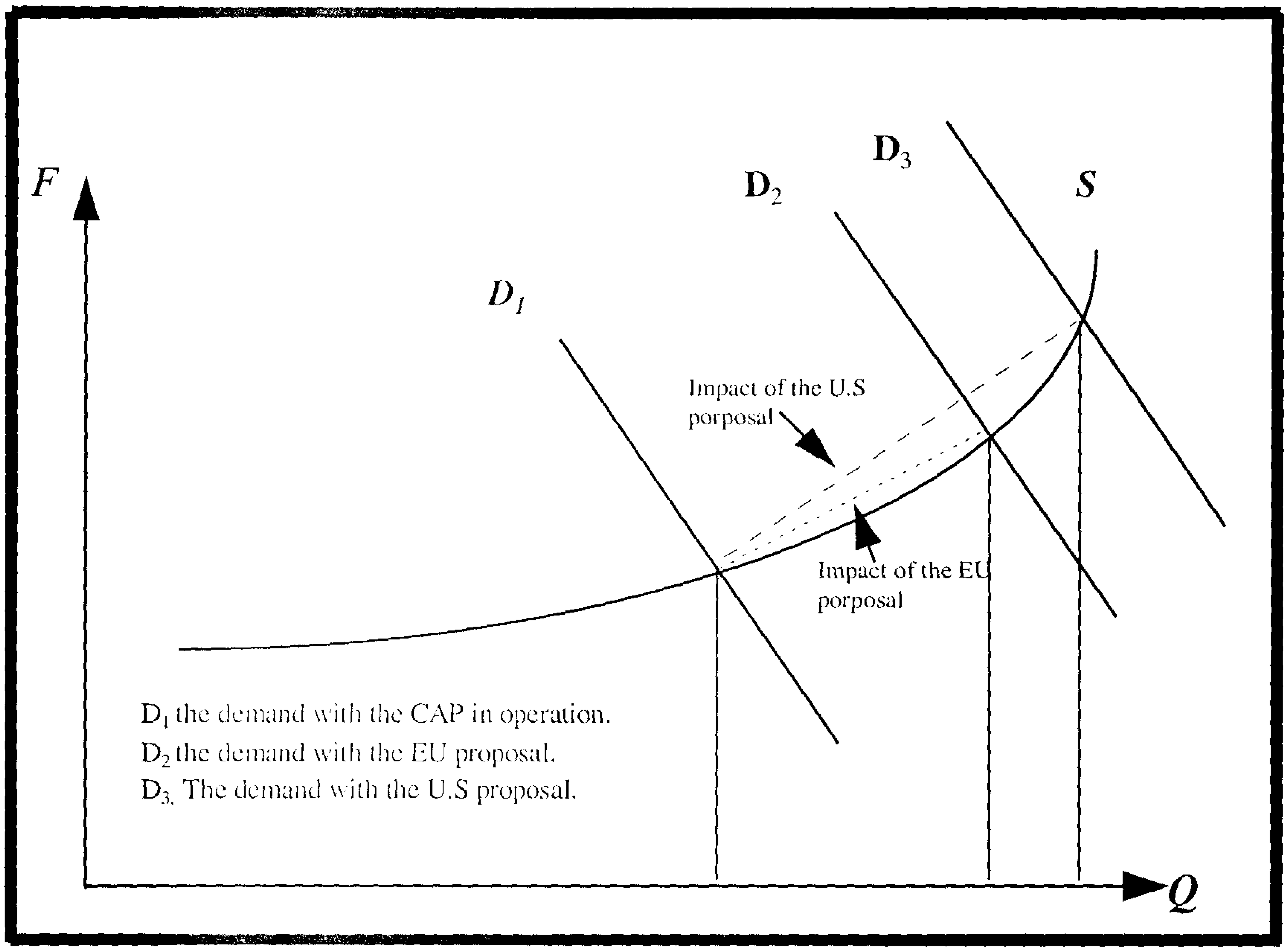
If we consider $p = 0$ then:
$$d = \frac{a-c}{e-b}$$

If 'p' obtained any (+ve) amount then demand is reduced by $\frac{1}{e-b}$ and d will be changed in same direction and same proportion as $\frac{1}{e-b} \cdot p$

The above mathematical explanation could not result in counterfactual analysis of the effect of removal or reduction of the CAP measures, because the equilibrium positions are unknown. Alternatively, this study suggests a simulation approach by using the models which will be outlined in Chaptrs Six and Seven to evaluate the effects of these two proposals on demand for ocean grain shipping services under two different scenarios.

Scenario 1: A 30% cut in PSE_S in the EU with 1986 taken as the base period.
Scenario 2: A 90% cut in PSE_S in the EU with 1988 taken as the base period.

Figure 4.8:CAP Liberalisation



4.10 Conclusion

Conceptual analysis of the CAP measures in this chapter revealed that these measures influence the EU grain market as well as the international market. During the life of the CAP, due high producer and consumer price not the supply curve has shifted to the right and demand has slackened. Furthermore, also constant expansion of grain products within the EU gradually rotated the supply curve downwards.

This increased the level of the EU's self-sufficiency much more than 100%, therefore, with the help of the export subsidy the EU turned from a major grain importer to a main exporter. Due to these changes the international pattern of the trade changed dramatically. Furthermore, the EU is a large country (effectively involved in international trade). Any changes in her supply and demand level will affect the world prices.

To keep the world price at a reasonable level, non-EU exporters reduced their production which limited the level of the international grain trade. This was a damaging phenomenon for the major grain exporting countries. On the other hand, importing countries economies gained from lower world price created by the implementation of the CAP by the EU.

The analysis provided in this chapter was simplified in many ways which produced some limitation to the analysis. First of all, the general framework was a partial equilibrium one. Thus the disadvantages regarding this type of analysis as outlined in Chapter Two apply to these analyses. In addition trade, flow is one way, which implies that the EU cannot be importing while exporting grain. Hence import levies and export refunds cannot occur simultaneously. The analysis also assumed that 100% of grain surplus are exported and that foreign and domestic grain demand curves are constant. Finally, the assumption is made that foreign supply curves are fixed and do not respond to CAP or any technological developments.

The CAP exerts a destabilising effect on world grain prices. When the EU prices do not have to adjust to world changes/shocks in demand and supply, that means the world prices should fluctuate more. The 1992 CAP reform was an attempt to reduce the EU's budgetary problems which could help the world price to be increased to some extent, and consequently the production and trade. However, whether these theoretical effects match up to the actual outcome of the reform is yet to be studied as the reform gets fully implemented.

CHAPTER FIVE: ECONOMETRIC METHODOLOGY

5.1 Introduction

This chapter illustrates and discusses the methodologies and econometric techniques relevant to empirical analysis undertaken in this thesis to model the hypothesis framework. The traditional methodology for investigating the relationship between variables within a model was based on the economic theory that provided guidelines for underlying structure of the econometric relationship. The inferences were made on the estimated regression relationship with variables in levels. It was later that Granger and Newbold (1974) recognised that when time series data are used in estimating a regression, the results may falsely indicate the existence of a causal relationship between the variables of the model when, in fact, there is not such a relationship at all. This problem called "spurious regression" and arises because the regression variables are non-stationary.[157] Therefore it is very important to discover the univariate behaviour of time series data in model building and hypotheses testing.

The first part of this chapter is dedicated to the Unit roots (stationary) element. This section discusses the underlying properties of stationary and non-stationary (unit roots) processes. Then discussions regarding the tests that are employed to investigate the presence of the unit roots in the time series model will be presented. This is includes Dickey and Fuller (1979 and 1981) in detail and Phillips-Perron (1988) in brief.

The second part is focused on different type of dynamic modelling; this is because the hypothesis specifies the existence of a dynamic relationship. The simultaneous-equation as a multivariate dynamic modelling is discussed. This method will estimate the model with due consideration to all the variables and equations in the system. Then the tests related to the simultaneous-equation method will be presented such as Hausman test, F test for specification and Identification of the variables (Rank and Order Identification). Alternative multivariate dynamic modelling approach known as Vector-Autoregression (VAR) discusses together with different methodological issues of such a model in analysing time series and its advantages and drawbacks.

---

[157] If at least one of the explanatory variables in a regression equation is non-stationary in the sense that it displays a distinct trend, it is very likely the case that the dependent variable in the equation will display a similar trend (Thomas, 1997:377).

Moreover the use of impulse response analysis for investigating the dynamic relationship among the variables in a VAR model is also discussed. In this respect firstly Sims (1980) approach for "orthogonalising" the innovations in VAR model and constructing "orthogonalised" impulse responses will also be discussed. Since these impulses are not unique and depend on the ordering of the variables in the VAR model the proposed model of Pesaran and Shin (1997) which uses "generalised" impulse responses together with the application of orthogonalised and generalised impulse responses in a cointegrating VAR model is also discussed.

The cointegration methodology, which enables investigation of equilibrium relationship among non-stationary series, is discussed next. The two alternative tests for cointegration will be presented, namely the two-step estimator of Engle and Granger (1987) and the Johansen (1988) cointegration model. The latter technique involves modelling the non-stationary series as a Vector Autoregressive VAR model.

In Appendix 9, the underling assumption regarding the specification of the model, such as linearity, parameter stability, serial correlation, homoskedasticity and normality and R^2's representative will be discussed.

Therefore this chapter structured as follows: Section 5.2 discusses different testing procedures for examining the stationarity of the series. Section 5.3 introduces structural modelling including simultaneous equations and Two-Stage Least Squares. Section 5.4 contains discussions on multivariate dynamic modelling approach, Vector Autoregression (VAR). Different methodological issues of using this modelling technique in analysing time series as well as its advantages and disadvantages will be discussed in this section. These include recent developments in estimating VAR models in presents of nonstationarity time series; i.e. cointegration techniques, impulse response analysis on VAR and error correction model. While Section 5.6 is the conclusion.

5.2 Stationarity and Unit Root Process

Time series analysis is an important factor in analysing the economic data, such a series in most cases are not stationary. Maintaining the stationary condition is very important, since non-stationary variables lead to spurious regression (Thomas, 1997:377 & 578). In order to avoid the spurious regression problem there is a need to difference the series for stationarity.

A stochastic series, S_t is said to be stationary (Covariance stationary) if the mean remains constant over time. Furthermore, its autocovariance between two observations, S_t and S_{t-k}, is independent of time and depends only on the distance between the observations. This could be expressed as follows:

$$E(S_t) = \mu, \forall t$$
$$E[(S_t - \mu)^2] = Var(S_t) = \sigma^2, \forall t$$
$$E[(S_t - \mu)(S_{t-k} - \mu)] = Cov(S_t, S_{t-k}) = \gamma_k, \forall t$$

whether a series is stationary or non-stationary depends on the presence or otherwise of unit root in the *(AR)* representation. Considering that S_t is produced by *AR (1)* process as follows:

$$S_t = \rho S_{t-1} + \mu_t \quad ; \quad \mu_t \sim IN(0, \sigma^2) \qquad (5.1)$$

where u_t is error terms (normally distributed) with zero mean and variance σ^2. The series S_t will be stationary if $|p|<1$, if $|p|=1$, S_t will not be stationary. Thus the behaviour of the series S_t is governed by its initial value S_0 (see e.g. Enders, 1985).

Where $$S_t = S_0 + \sum_{i=1}^{t} \mu_i$$

It can be seen that S_t is influenced by all disturbance terms occurring between periods *1* and *t*. This means that a changes in u_t produces a permanent effect on the conditional mean of the S_t. In other words if at some point $S_t = C$ then the expected time until S_t return to *C* is infinite (∞). Finally the variance of S_t is $t\sigma^2$ which is not constant, and become infinitely large as *t* approaches infinity $(t \to \infty)$.

Furthermore, as *t* increases $Cov\ (S_t, S_{t-k}) = (t-k)\sigma^2$ will also increase. Hence correlation coefficient between S_t and S_{t-k} will be as follows:

$$p_k = \frac{Cov(S_t, S_{t-k})}{\sqrt{Var(S_t)Var(S_{t-k})}} = \frac{(t-k)\sigma^2}{\sqrt{t\sigma^2(t-k)\sigma^2}} = \sqrt{\frac{t-k}{t}} \qquad (5.2)$$

Therefore as t become large compare to k than all p_k approaches to one (unity). It means that the autocorrelation function of the series will decay very slowly.

In a non-stationary series that follows a stochastic trend, the series illustrates an upward or downward trend because of cumulative effects of the disturbances, but the series does not converge to its long run mean, zero. Taking the first difference of the series could eliminate such a trend (stochastic trend). If for example taking the first difference of the S_t as follows:

$$\Delta S_t = \mu_t$$

the process is stationary because:

$$E(\Delta S_t) = 0$$
$$Var(\Delta S_t) = \sigma^2$$
$$Cov(\Delta S_t, \Delta S_{t-k}) = 0$$

If the first difference of the series become stationary, it is referred to as first difference – stationary or integrated of order 1 series expressed as *I(1)* (Engle & Granger, 1987). However, if the series should difference for *d* times to become stationary, it denoted as *I(d)*.

5.2.1 Unit Root Tests

Inspection of the autocorrelation function (ACF) is a useful means to detect the existence of a unit root. However, as Enders (1995) outlined, the problems may arise when the ACF takes values close to 1.[158] This will illustrates a non-stationary process (the slowly decaying pattern), therefore, it may conclude that a series is non-stationary when in fact it is a stationary process.

The popular procedure to test for unit roots is to use the Dicky-Fuller (DF) (1979). In order to test for stationarity *AR(1)* further to equation 5.1 the linear trend and intercept term and time trend are considered in the following forms:

$$\Delta S_t = \gamma S_{t-1} + \mu_t \qquad (5.3)$$
$$\Delta S_t = \alpha + \gamma S_{t-1} + \mu_t \qquad (5.4)$$
$$\Delta S_t = \alpha + \delta t + \gamma S_{t-1} + \mu_t \qquad (5.5)$$

Where $\gamma = p - 1$, μ is an intercept term and δt is a linear trend term. The above models using OLS estimation by constructing a *t*-statistics and using the critical values Fuller (1976) test the following hypothesis:

$$H_0 : \gamma = 0 \text{ (or } p = 1)$$
$$H_1 : \gamma < 0 \text{ (or } p < 1)$$

158 Equation 5.3.

Each of the above models implies a different alternative hypothesis for the data generating process (DGP) of the services. The equation (5.3) tests the hypothesis of unit root against the alternative that the series S_t is stationary around a zero mean; equation (5.4) test if the series is stationary around a non-zero mean; and third model tests if the series is stationary around a linear deterministic trend.

Considering the test statistic for model (5.3) Z, Z_α, for model (5.4) and Z_t for model (5.5) where $Z_t < Z_\alpha < Z$, it is difficult to select one model to use for unit roots testing.

Perron (1988) to tackle the difficulties for using (DF) unit roots suggest a sequential testing procedure. This sequential procedure is provided in Appendix 9. He suggests that the procedure should start from the most general specification to a more restrictive model. The procedure stops if the null hypothesis of unit root could be rejected at any stage, and if the null hypothesis could not be rejected the series has unit root.

The Augmented Dicky Fuller tests (ADF) introduced by Dicky and Fuller (1981), by using DF distribution, extended the DF test to accommodate higher order Autoregressive processes, and lagged values of the dependent variable.[159] These are included to compensate for the presence of autocorrelation in the residual series. Hence, the appropriate regressions are as follows:

$$\Delta S_t = \gamma S_{t-1} + \sum_{i=1}^{p} \Psi_i \Delta S_{t-i} + \mu_t \quad (5.6)$$

[160]

$$\Delta S_t = \mu + \gamma S_{t-1} + \sum_{i=1}^{p} \Psi_i \Delta S_{t-i} + \mu_t \quad (5.7)$$

$$\Delta S_t = \mu + \delta t + \gamma S_{t-1} + \sum_{i=1}^{p} \Psi_i \Delta S_{t-i} + \mu_t \quad (5.8)$$

Harris (1995) suggests that the appropriate lag-length (P) is the most important issue to perform the ADF test. Less lags could results in over rejecting the null hypothesis of unit root when is true, however, more lags may ignore the probability of rejecting a false hypothesis. To overcome the problem of the appropriate time lag

---

159 DF distribution is based on the assumption that μ_t is white noise.

160 To test the null hypothesis of a unit root, $H_0 : \gamma = 0$, the same critical value as DF test is used (i.e. $Z_t < Z_\alpha < Z$ for models (5.6), (5.7), (5.8) respectively.

one of the Akaike information criterion (AIC) (Akaike 1973) or the Schwars Bayssian information criterion (SBIC) (Schwarz 1978) should be consulted.

The AIC criteria trades off the increase in the value of the log-likelihood function against the loss of degrees of freedom when the lag-length of the model increases; the selected model is the one which scores the lowest value of the AIC or SBIC.[161]

Mills (1993) suggests that the SBIC is strongly consistent and always determines the true model asymptotically, while for the AIC an over-parameterised model could emerge therefore, the SBIC usually preferred by the researcher over the AIC.

Phillips (1987) and Phillips and Perron (PP) (1988) introduced an alternative approach to ADF. In this approach instead of using a parametric correction for auto-correlation (through the additional lagged terms), a non-parametric correction to the t-statistic is undertaken to account for the residual auto-correlation that may be present when the underlying process is not AR(1). Thus, DF type equations such as 5.3 to 5.5 are estimated and then the *t-statistic* is amended to take account of any bias due to auto-correlation in the error term. However, the PP test is based on a weaker set of assumptions regarding the error process than ADF test, although it could be a efficiently used to test for unit roots when the underlying DGP of the series is quite general.

This study uses the ADF test for unit root because of its popularity and the stronger set of assumptions regarding the error process. Furthermore, as Schwet (1989) highlighted the PP test has poor size properties, (i.e. the tendency to over-reject the null when it is true) when the underlying DGP has large negative moving average components.

5.3 Simultaneous Equations

In the normal econometric approach where there is a two-way flow of influence among economic variables, the simultaneous equations framework is utilised to model the variables which are related to each other in different ways and affect each other simultaneously.[162] The simultaneous equation model specifies the interaction of the economic variables over the time t. The necessary condition for analysing

161 AIC=-2(LL-K), SBIC=-2(LL-0.5K LogT), where LL is maximum value of the log-likelihood function of ADF regression, K is the number of regressors and T is the number of observations.

162 Structural econometric model means that the specific relationships between variables are based (either formally or informally) on economic theory.

these interaction within a finite time period is the convergence of the interaction towards an equilibrium. If such stability (moving about equilibrium position) occurs the model is stable. This implies that exogenous impacts on endogenous variables of lagged t became smaller as t increased. It indicates that variables may not be related contemporaneously but with time lag. This implies that the relationship is dynamic. This approach requires a division of variables into those that are endogenous to the model and those which could be treated as exogenous. A specific characteristic of the simultaneous-equation model is that, the endogenous variable in one equation may be an independent variable in another equation in the system as follows:

$$AZ_t = \alpha_0 + DZ_{t-1} + \beta V_t + \mu_t \qquad u_t \sim \text{IN}(0, \Sigma) \qquad (5.9)$$

Where Z_t is the vector of the endogenous variables, V_t is the vector of the exogenous variables, α, β are the matrices of unknown parameters and μ is the vector white noise process with covariance matrix Σ. Considering two variable cases for the endogenous Z_t and two components for the exogenous variables V_t the above equation could be illustrated in following matrix form:

$$\begin{pmatrix} 1 & -\alpha_{12} \\ \alpha_{21} & 1 \end{pmatrix} \begin{pmatrix} z_{1,t} \\ z_{2,t} \end{pmatrix} = \begin{pmatrix} \gamma_{1,1} & 0 \\ 0 & \gamma_{22} \end{pmatrix} \begin{pmatrix} z_{1,t-1} \\ z_{2,t-1} \end{pmatrix} + \begin{pmatrix} \beta_1 \\ \beta_2 \end{pmatrix} \begin{pmatrix} v_{1,t} \\ v_{2,t} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{pmatrix} \qquad (5.9)$$

In the above model which is indicate the *structural* model the α_{12} and α_{21} illustrate the simultaneous interaction of the endogenous variables. The structural model is directly derived from economic theory; to estimate the unknown parameters there is a need to determine the reduced form model as follows:

$$\begin{pmatrix} z_{1,t} \\ z_{2,t} \end{pmatrix} = \frac{1}{1-\alpha_{12}\alpha_{21}} \begin{pmatrix} \gamma_{1,1} & \alpha_{12}\gamma_{22} \\ \alpha_{21}\gamma_{11} & \gamma_{22} \end{pmatrix} \begin{pmatrix} z_{1,t-1} \\ z_{2,t-1} \end{pmatrix} + \begin{pmatrix} \beta_1 & -\alpha_{12}\beta_2 \\ \beta_2 & -\alpha_{21}\beta_1 \end{pmatrix} \begin{pmatrix} v_{1,t} \\ v_{2,t} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} & -\alpha_{12}\varepsilon_{2,t} \\ \varepsilon_{2,t} & -\alpha_{21}\varepsilon_{1,t} \end{pmatrix}$$
(5.10)

The above can be rewritten as follows by renaming the parameters matrices.

$$\begin{pmatrix} z_{1,t} \\ z_{2,t} \end{pmatrix} = \begin{pmatrix} \varphi_{1,1} & \varphi_{12} \\ \varphi_{21} & \varphi_{22} \end{pmatrix} \begin{pmatrix} z_{1,t-1} \\ z_{2,t-1} \end{pmatrix} + \begin{pmatrix} \delta_1 \\ \delta_2 \end{pmatrix} \begin{pmatrix} v_{1,t} \\ v_{2,t} \end{pmatrix} + \begin{pmatrix} \mu_{1,t} \\ \mu_{2,t} \end{pmatrix} \qquad (5.11)$$

The unknown parameters of the structural model can be estimated as follows:

$$\varphi_{11} = \frac{\gamma_{11}}{1-\alpha_{12}\alpha_{21}} \qquad \varphi_{12} = \frac{\alpha_{12}\gamma_{22}}{1-\alpha_{12}\alpha_{21}}$$

$$\varphi_{21} = \frac{\alpha_{21}\gamma_{11}}{1-\alpha_{12}\alpha_{21}} \qquad \varphi_{22} = \frac{\gamma_{22}}{1-\alpha_{12}\alpha_{21}}$$

$$\delta_1 = \frac{\beta_1 - \alpha_{21}\beta_2}{1-\alpha_{12}\alpha_{21}} \qquad \delta_2 = \frac{\beta_2 - \alpha_{21}\beta_1}{1-\alpha_{12}\alpha_{21}}$$

The correlation between endogenous explanatory variables and disturbance terms results to the problem of simultaneous equation bias. Therefore in this situation the OLS method can not result in consistent estimators.[163] Furthermore, consistent estimation of any equation in a model was then possible only if the equation was identified. This is regarded as the placing of a zero restriction on parameters.

By using simultaneous-equation methods the equation of the models will be estimated jointly. There are some other reasons for using this method for modelling the impact of the reduction of the EU grain imports on the structure of demand for "Capesize" bulk carriers. Firstly, it is the only method that can calculate jointly and severally a large number of equations and variables. Secondly, correlation between endogenous variables and disturbance results in the problem of simultaneous equation bias. It eliminates the bias of OLS method and looked at the single-equation within the system. Finally, it eliminates bias in the simulation, since the equations are determined jointly. The predetermined variables will be considered, based on the assumption that the past will reflect on the present.

Two alternative methods may be adopted to estimate the structural equations. Firstly, single equation methods or limited information methods, and secondly, system methods or full information methods.

In the first method each equation within the system is estimated individually, taking into account any restrictions placed on the equation. In this case the restrictions on the other equations in the system are ignored. In the second methods all the equations in the model estimated simultaneously, taking due account of all restrictions on such equations by the omission or absence of some variables.

This study uses the first method (single equation methods), because as Gujarati (1995) highlighted that there are many disadvantages using second method. Firstly computation burden in full information method is enormous. Secondly, this method

163 Estimators do not converge to their true population values no matter how large the sample size.

"lead to solutions that are highly non linear in the parameters and are therefore often difficult to determine. Thirdly, if there is specification error (such as, wrong functional form or exclusion of relevant variables) in one or more equations of the system, that error is transmitted to the rest of the system. As result, the systems methods become very sensitive to specification errors" (Gujarati, 1995:679).

5.3.1 Identification

Through identification process it will be possible to establish that "whether numerical estimates of the parameters of structural equation can be determined from the estimated reduced form coefficients" (Gujarati, 1995:657-58).

Any reduced form equation is either exactly identified, over identified, or under identified. If by estimating the reduced form coefficients, the parameters of the structural equation cannot be estimated, then the equation is under identified. It is exactly identified if unique numerical values of structural parameters can be estimated. Finally, it is over identified if more than one numerical structural parameter can be obtained from reduced-form equation.

A systematic routine can be utilised to restore the reduced -form equations to obtain the identification of an equation in a system of simultaneous equations. This systematic routine is performed in two folds, first order and then rank conditions of identification. Considering the following notation the rank and order condition could be defined.

N = number of endogenous variables in the model
n = number of endogenous variables in a given equation
P = number of predetermined variables in the model
p = number of predetermined variables in a given equation
Definition of rank condition (Gujarati, 1995:665):

In a model of N simultaneous equations, in order for an equation to be identified, the number of predetermined variables excluded from the equation must not be less than the number of endogenous variables included in that equation less 1, that is:

$$P - p \geq n - 1$$

if $P-p=n-1$, the equation is just identified, but if $P-p>n-1$ it is over-identified.[164] The order condition discussed is a necessary condition for identification, however it is not a sufficient condition, even if it is satisfied. This is because as Gujarati (1995) suggests " the predetermined variables excluded from the equation but presented in the model may not all be independent, so that there may not be one-to-one correspondence between the structural coefficients and the reduced form coefficients" (Gujarati, 1995:665).

Thus it would not be possible to estimate the structural parameters from the reduced form coefficients. Hence to have the sufficient as well as necessary condition there is a need to utilise the rank condition of identification. The rank condition is both a necessary and sufficient condition for identification. The rank condition specifies whether the equation under consideration is identified or not, whereas the order condition indicates that if it is exactly identified or overidentified. It means that:

> "In a model containing N equations and N endogenous variables. An equation is identified if and only if at least one non-zero determinant of order (N-1) × (N-1) can be constructed from the coefficients of the variables (both endogenous and predetermined) excluded from that particular equation but included in the other equations of the model" (Gujarati, 1995:665).

The above discussion could be summarised as bellow:

- If $P\text{-}p > n\text{-}1$ and the rank of A matrix is $N\text{-}1$, the equation is over identified.
- If $P\text{-}p = n\text{-}1$ and the rank of A matrix is $N\text{-}1$, the equation is exactly identified.
- If $P-p \geq n-1$ and the rank of A matrix is less than $N\text{-}1$, the equation is under identified.
- If $P\text{-}p< n\text{-}1$, the structural equation is unidentified. The rank of the matrix in this case is bound to be less than $N\text{-}1$.

5.3.2 Test of Simultaneity (Hausman Specification Test)

If there is no simultaneity problem the OLS estimators should be employed to estimate the model, alternatively if simultaneity between the variables of the model exists and the model is over-identified, only 2SLS could reveal consistent and efficient estimators.

---

164 There is a different counting rule to determine the order condition that reveals a similar result.

Technically the problem arises because some of the variables are assumed to be exogenous in the system are not, hence could be uncorrelated with the disturbance. This is a very important issue, since all the asymptotic properties rest on this assumption.

To perform the Hausman test there is a need to obtain reduced form equations from structural equations.[165] The reduced form equations contain the reduced form error terms μ_t. Estimating reduced form equations by OLS utilised estimated endogenous variables $\hat{p}_t$ and estimated residuals $\hat{\mu}_t$. Since the coefficients of p_t and reduced form error term μ_t are the same, under the null hypothesis that there is no simultaneity the correlation between $\hat{\mu}_t$ and the structural error term μ_t should be zero, asymptotically. Therefore, if the coefficient of μ_t is statistically zero it concludes that there is no simultaneity problem and if the coefficient is statistically significant the simultaneity problem exists.[166]

5.3.3 Test For Exogeneity

Normally the endogeneity or exogeneity of the variables within a system of equations are predetermined, based on *a priori* information available before hand. However, it is possible, statistically to test for exogeneity of the variables within the system.[167]

In a four equations model with four endogenous variables Y_1, Y_2, Y_3 and Y_4, and four exogenous variables X_1, X_2, X_3 and X_4, if the first equation of the model considered as:

$$Y_{1i} = \alpha_0 + \alpha_2 Y_{2i} + ... + \beta X_{1i} + \mu_{1i} \qquad (5.12)$$

If Y_2, Y_3 and Y_4, are endogenous the above equation cannot be estimated by OLS because OLS estimation in this case produces inefficient estimators. In order to find out the exogenous variables there is a need to obtain reduced form equation by

165 The reduced form equations will have only predetermined variables on the right hand side.

166 If more than one endogenous regressor is involved, the F test will implemented instead of T test.

167 The relation between causality and exogenity explain in manner of Granger's causality test. However, Maddala (1992:389-395) suggests it is better to keep the concepts of causality and exogeneity separate.

obtaining the predicted value of Y_2, Y_3 and Y_4, which are $\hat{Y}_2, \hat{Y}_3$ and $\hat{Y}_4$ respectively.

Based on the Hausman test discussed earlier the following reduced form equation could be estimated.

$$Y_{1i} = \alpha_0 + \alpha_2 Y_{2i} + ... + \lambda_2 \hat{Y}_{2i} + \lambda_3 \hat{Y}_{3i} + \lambda_4 \hat{Y}_{4i} + \mu_{1i} \qquad (5.13)$$

Then the hypothesis that $\lambda_2 = \lambda_3 = \lambda_4 = 0$ can be tested by using *F* test. If the hypotheses is rejected Y_2, Y_3 and Y_4 can be considered endogenous but if it is not rejected they should be seen as exogenous.

5.4 Vector Autoregression (VAR)

Sims (1980) proposed the Vector Autoregression (VAR) method as an alternative to simultaneous equation modelling when there is not a structural model based on an economic theory available. The VAR methodology is based on a reaction against the simultaneous equation approach that was dividing the variables into those which are endogenous and those exogenous to the model.

In a VAR framework the problems associated with identification and exogeneity and endogeneity of the variables is solved by assuming that all the variables in the economic system are in continuous interaction. Therefore, there is a need to specify only two things. Firstly, the set of variables (endogenous and exogenous) that is believed to interact and hence should be included as part of the economic system that one is trying to model. Secondly, the number of lags that are needed to capture most of the effects that the variables have on each other (Thomas, 1997:354). Furthermore, the equations of a VAR model are constrained to be linear, thus there is not a need to specify the functional forms of the model.

Such equation has exactly the same set of regressors. Therefore for the vector of variables Z_t, Sims suggests the following model to estimate the dynamic relationships.

$$Z_t = A_t + ...A_k Z_{t-k} + u_t \qquad u_t \sim IN(0, \Sigma) \qquad (5.14)$$

Where

t = (t =1,...,k)

$Z_t =$ *(n×1) vector of economic variables*

A_i = *an (n×n) matrix of parameters*
u_t = *an (n×n) vector of random errors*

$$x_t = \alpha_{21} y_{t-1} + \alpha_{22} x_{t-1} + b_{21} y_{t-2} + b_{22} x_{t-2} = \varepsilon_{2,t}$$
$$y_t = \alpha_{11} y_{t-1} + \alpha_{12} x_{t-1} + b_{11} y_{t-2} + b_{12} x_{t-2} = \varepsilon_{1,t}$$

The vector of Z_t and μ_t are determined as follows:

$$Z_t = \begin{pmatrix} x_t \\ y_t \end{pmatrix}, \quad \mu_t = \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{pmatrix}$$

And for $k=2$ (Maximum lag) there are two 2x2 Matrices A_i available as follows:

$$A_1 = \begin{pmatrix} \alpha_1 & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix}, \quad A_2 = \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix}, \ldots.$$

The above VAR model implies that each variable in the vector Z_t is regressed on its own lag values of other variables present in the system. Therefore, the parameters in A_i are explaining the dynamic relations among the different variables. The VAR model also illustrate that all the variables depends on all other variables in the model, with exactly the same lag structure applied to each variable in the all equations. It means no-zero restrictions are imposed and all the α, and b parameters are non-zero. Since initially no restrictions are placed on any of the parameters in any of the equation in this methodology, therefore everything causes everything and there is no need for underling economic theory.

VAR modelling has a number of advantages; for example, because all regressors are lagged variables, they can be assumed to be contemporaneously uncorrelated with the disturbance. Thus each equation can be consistently estimated by OLS. VAR are very often used for policy analysis, to examine the effect of changes or shocks on the various variables in the model.

The particular problem for implementation of a VAR system involves selection of an appropriate specification including number of variables to be included and the maximum lag length to be employed. The appropriate specification of the VAR system in order to obtain unbiased estimates of the matrices of parameter and draw correct inferences around them, a strong condition exist and it require all the variables included in Z_t to be stationary.

The stability condition for VAR model is same as the simultaneous equation model. Lutkepohl (1993, in Veenstra, 1999:143) states that if the VAR (1) in equation (VAR equation) is solved repeatedly the stochastic process Z_t will be achieved.

$$Z_t = (I_n - A_1)^{-1}\mu + \sum_{i=0}^{\infty} A_i^i \varepsilon_{t-i}, \qquad t = 1,2,... \qquad (5.15)$$

where *n is the* number of variable in the VAR model and *I* is the *identity* matrix.

Furthermore, a complementary condition should also hold, this is, that the matrix A_1 have modulus less than one, as follows:

$$\det(I_m - A_1 v) = 0 \qquad for \ |v| > 1 \qquad (5.16)$$

Where $\det(I_m - A_1 v)$ is the characteristic equation of the VAR model.

If the condition in equation (5.16) hold, the roots to this equation are greater than one or unity on absolute value that means the roots lies outside the unit circle. Therefore, the stability condition for VAR model holds.

5.4.1 VAR Estimation

The VAR model is a natural analogue of the multivariate regression model. Furthermore, the equations of the model contain the same explanatory variables. Therefore, same as the estimation procedures for the multivariate regression model, the ordinary least squares (OLS) could be used to estimate equation by equation (see Lutkepohl, 1993:64ff) (Veenstra (1999:136). This particular structure of the VAR (all equations of the model have the same number of explanatory variables) cause the VAR models to be over-parameterised. On the other hand it could improve estimation efficiency by removing insignificant coefficients. This will occur if the time series Z_t is stationary, which led to the t-statistics of the individual coefficients have the conventional t-distribution. In contrast, in the SUR model the maximum likelihood estimator resembles a general least squares (GLS) estimator except in special cases.

5.4.2 Inferences and Order Selection

The discussion of inferences on parameters, goodness of fit and diagnostic tests in Appendix 9 carries over directly to the VAR model. Furthermore, one hypothesis of considerable interest is testing the order of a VAR process. A natural procedure for

VAR *(P)* is to choose a maximum possible value for *(P)* and then fit a VAR *(P)*. Within the VAR *(P)* model test that Π_p, where Π is the matrix of parameters. If the hypothesis is rejected, decide that *(P)* is order of process. If the hypothesis is accepted, conclude that the order of the VAR is less than or equal to *P-1*, and proceed to fit a $VAR_{(p-1)}$, in which the hypothesis $\Pi_{p-1} = 0$ is to be tested. Continuing in this manner. This testing down procedure selects the order of the VAR as *p-j*, using the first *j* for which the hypothesis $\Pi_{p-j} = 0$ is rejected. Since this procedure is inherently system wide, and need system inference some way of the approximation and the degrees of freedom in the estimation has to be found, to avoid estimation of too many undesirable parameters.

However formal tests could be used to specify the significance alternatively by setting order criterion. These tests are Schwarz (1978) criterion and Akaike's information criterion which will be discussed in detail in Section 5.7.9.

The expressions in VAR context are

$$AIC_{(p)} = \ln\left|\hat{\Sigma}_p\right| + \frac{2M^2 p}{T} \qquad (5.16)$$

$$SC_{(p)} = \ln\left|\hat{\Sigma}_p\right| + \frac{2M^2 p \ln T}{T} \qquad (5.17)$$

where M is the number of variables in the system, T is the sample size, and $\hat{\Sigma}_p$ is the estimated covariance matrix of residual obtain with a $\text{VAR}_{(p)}$ model. The order of *j* will be chosen because AIC or SC criterion is minimised. The main advantage of this order selection criterion is works equally for stationary and non-stationary VARs. This led to the order selection comes first and establishing stationarity come second (Veenstra, 1999:137).

The models in this thesis are based on yearly data of not more than 30 observations which could be considered as a small sample. For small samples the criterion has a tendency to select small order or no order at all, therefore; further criterion is necessary to specify the VAR model. Therefore in this thesis both AIC and SC criterion have been implemented (Veenstra, 1999:137).

5.5 Cointegration and Error Correction Model (ECM)

Maintaining the stationarity condition is quite important, since the use of non-stationary variables may lead to spurious regression.[168] It is quite clear that it is not possible to maintain the stationarity condition for all the variables specially shipping variables such as freight rates and commodity prices. There are two ways to overcome this problem. Firstly, use some form of transformation such as differencing and construct stationary variables and use these variables to estimate the VAR model. Differences of variables in first approach eliminate the long run relationships of the variable. Furthermore, such differencing may distort relationships among the original variables. Secondly, transform the equation (5.23a) to a co-integration and Error correction model representation in the equation (5.23).

There is a close relation between models of cointegration and models of error correction. If the two variables in Error Correction Model (ECM) are cointegrated, it means it is only internally consistent. If they are not cointegrated the right-hand side cannot be *I(0)*, even thought the left-hand side must be. Therefore the same assumption for producing the cointegration implies (and is implied by) the existent of ECM.[169]

The major function of ECM is that, it suggests a way to build an elaborate model of the long run relation in Z_t as well as a test for cointegration. It means that the residuals from an estimated cointegration model which estimated equilibrium errors can be included in an elaborate model of the long-run covariation of Z_t. This is based on the Granger representation theorem (see Hamilton 1994, p 582).

If a multivariate or a univariate framework contains a unit root, it should be differenced in order to become stationary. Therefore the regression model should be estimated using the differenced series. However, this procedure is incorrect in many cases, because it ignores the information which is contained in the long-run relationship between the variables. Engle and Granger (1987) suggest that there may be a linear combination of integrated variables that is stationary.

Generally any linear combination among the series with order one *I(1)* will also be *I(1)*; and also the residuals ε_t obtain from such a econometric model will also be

---

168 If at least one of the explanatory variables in a regression equation is non-stationary in the sense that it displays a distinct trend, it is very likely the case that the dependent variable in the equation will display a similar trend (Thomas, 1997:377).

169 The result in its general form is known as the Granger Representation Theorem (Hamilton, 1994:582).

$I(1)$. Considering two series of X_t and Y_t of $I(1)$ there could be a number of β such that $X_t - \beta Y_t = \varepsilon_t$ is stationary. Engle and Granger (1987) defined such a series (X_t, Y_t) as cointegrated of order (1,1) denoted $I(1,1)$.

5.5.1 The Engle-Granger (1987) and Johanson (1988) Procedure

Engle-Granger (1987) introduced a two-step co-integration test for two non-stationary series. The first step estimates the residuals, ε_t, through the following regression:

$$X_t = \beta_1 + \beta_2 Y_t + \varepsilon_t \qquad (5.18)$$

This model called cointegrating or equilibrium regression. If X_t and Y_t are cointegrated, the estimated residual series $\hat{\varepsilon}_t$ is stationary. The $\hat{\varepsilon}_t$ illustrates of X_t and Y_t from their long-run relationship; for investigating this, the following ADF test of $\hat{\varepsilon}_t$ has been proposed by Engle and Granger (1987).

$$\Delta \hat{\varepsilon}_t = \Psi \hat{\varepsilon}_{-1} + \sum_{i=1}^{p-1} \Psi_i \Delta \hat{\varepsilon}_{t-i} + \omega_t; \qquad \omega_t \sim IN(0,\sigma_\omega^2) \qquad (5.19)$$

where lagged values of $\Delta \hat{\varepsilon}_{t-i}$ are entered into the equation to "whiten" the errors. The inclusion of a trend term, δ, and/or a constant, μ in (5.19) depends on whether a constant or a trend appears in the cointegrating regression since deterministic components can appear in equation (5.18) or in (5.19).

When $\Delta \hat{\varepsilon}_t \sim I(0)$ in next step an error correction model (ECM) of the joint process should be identified in such a way that:

$$\hat{\varepsilon}_{t-1} = X_{t-1}\beta_t - \beta_2 Y_{t-1} \qquad (5.20)$$

where $\hat{\varepsilon}_{t-1}$ last period estimate and provides the information on the speed of adjustment to equilibrium, as follows:

$$\Delta X_t = -\alpha_1 \hat{\varepsilon}_{t-1} + \gamma_1 \Delta Y_t + \sum_{j=1}^{m} \theta_j \Delta Y_{t-j} + \sum_{j=1}^{k} \varphi_j \Delta X_{t-j} + v_t \qquad ; v_t \sim IN(0,\sigma_v^2) \qquad (5.21)$$

However, there are some disadvantages regarding this procedure, Harris (1995) highlighted that the finite sample estimates of the long term relationship are potentially biased and using a different normalisation, that is reversing the order of the variables in the cointegrating regression, could produce different results. He added that ECM of 5.21 imposes the restriction that Y_t is weakly exogenous to X_t due to this the Y_t series appear on regressor only in 5.21.[170] This results in inefficient estimates, because the model does not take into account all the information that the variables have to offer. Furthermore, this procedure does not allow performing hypothesis test on the estimated coefficient, β_1 and $\beta 2$, in the (5.18). Phillips and Durlauf (1986) derive the distributions of OLS estimators, (β_1, β_2) and their associated standard errors in (5.18) and highlighted these to be highly non-normal thus invalidating standard inference.

The Johanson (1988) technique has the ability to perform hypothesis tests for restricted version of the cointegrating relationship by providing a test statistic with exact limiting distribution. The Johanson method uses the two-step estimator by directly testing for cointegrated relationships in a multivariable vector Autoregressive (VAR) framework. The result by this test in more reliable than the result produced by EG test because VAR framework considered all the variables within the model as they are endogenous and uses the information provided by both series to generate the cointegration tests.

5.5.2 The Johanson (1988) Tests for Cointegration

The multivariate extenuation of DF test utilised by Johanson (1988) for cointegration analysis. It could be illustrated by considering n variables of I (1), $(X_t, Y_t, ...C_t)$ generating by the following multivariate system.

$$X_t = \sum_{i=1}^{p} A_{11}(i) X_{t-i} + \sum_{i=1}^{p} A_{12}(i) Y_{t-i} + ...\sum_{i-1}^{p} A_{1n}(i) C_{t-i} + \varepsilon_{X,t} \qquad (5.22)$$

$$Y_t = \sum_{i=1}^{p} A_{21}(i) X_{t-i} + \sum_{i=1}^{p} A_{22}(i) Y_{t-i} + ...\sum_{i-1}^{p} A_{2n}(i) C_{t-i} + \varepsilon_{X,t}$$

Since such equation has exactly the same set of regressors, and therefore the vector of variables Z_t, which could be represented as follows:

$$Z_t = A_t + ...A_k Z_{t-k} + \mu_t \qquad \mu_t \sim IN(0, \Sigma) \qquad (5.23a)$$

where Z_t is $(n \times 1)$ vector of variables and each A_i is an $(n \times n)$ matrix of parameters, and μ_t is $(n \times n)$ vector of residuals (normally distributed with zero mean), and variance/covariance Σ.

---

170 i.e. the current value of Y is not affected by the current value of X.

If Z_{t-1} is subtracted from both sides of the above vector Autoregression (VAR) model (reparmetrising the model) the following equation will be resulted

$$\Delta Z_t = (A_t - I_n)Z_{t-1} + ...A_k Z_{t-k} + \mu_t \qquad (5.23)$$

Where I_n is a $(n \times n)$ identity matrix and if the process is continued in this fashion up to Z_k it will generate the following set of equations

$$\Delta Z_t = \Gamma_1 Z_t + ... + \Gamma_k \Delta Z_{t-k} + \Pi Z_{t-k} + \mu_t \qquad \mu_t \sim IN(0, \Sigma)\,(**) \qquad (5.24)$$

where

$$\Gamma_i = -(I - A_1 - .... - A_{k-i}) \ , \qquad i = 1,....,k-1$$

$$\Pi = -(I - A_1 - .... - A_k)$$

The equation (5.24) called Vector Error Correction model (VECM) which will led to estimate both long and short run relationships simultaneously by estimates of Γ_i and Π, respectively.

The most important parameter for cointegration among the series is the rank of matrix Π.[171] If rank ($\Pi = 0$), then Π is the $(n \times n)$ zero matrix specifying that the cointegration relationships does not exist between the series. Then expression 5.24 would be reduced to VAR model in first differences. If Π has a full rank $\Pi = n$ then all the variables in Z_{t-1} are *I(0)* therefore, the appropriate modelling strategy is to estimate a VAR model in levels. Finally if (Π) has reduced rank ($\Pi = 1$) Hence there is a single cointegration relationship. Since the rank of Π is equal to the number of its characteristic roots (eigenvalue) which are different from zero, the number of distinct cointegrating vectors can be obtained by estimating how many of these eigenvalue are significantly different from zero.

Johanson (1988) developed a procedure to estimate the maximum likelihood of the parameters in equation (5.24) In this method the matrix of long run relationship parameters (Π) is decomposed into two matrices of α $(n \times r)$ and β $(n \times r)$ ($\Pi = \alpha\beta'$), where r is equal to the rank of Π. Matrix β contains a series of elements

---

171 The rank of a square $n x n$ matrix is the number of its linearly independent rows, or columns.

that can produce stationary series when combined linearly[172] with the variables in Z_t. Next, the number of rows in matrix β which is equivalent to the number of co-integrating vectors (stationary linear combinations or r) and called the co-integration rank will be estimated. This is done by regressing ΔZ_t and Z_{t-k} on ΔZ_{t-1} to ΔZ_{t-k+1} : forming the residual product moment matrix S_{ij} as follows

$$\Delta Z_t = p_1 \Delta Z_{t-1} + ... + p_{k-1} \Delta Z_{t-k+1} + R_{0t} \quad (3) \qquad (5.25)$$
$$Z_{t-k} = T_1 \Delta Z_{t-1} + ... + T_{k-1} \Delta Z_{t-k+1} + R_{kt} \quad (4) \qquad (5.25a)$$

and forming the residuals product moment matrix S_{ij} as follows

$$S_{ij} = T^1 \sum_{i=1}^{T} R_{it} R'_{jt} \qquad i, j = 0, k$$

and

$$|\lambda S_{kk} - S_{k0} S_{00} S_{0k}| = 0 \quad (6) \qquad (5.26)$$

The roots of equation (5.26) that can be sorted in descending order are known as the eigenvalues ($\hat{\lambda}_1 > \hat{\lambda}_2 .... > \hat{\lambda}_n$) of matrix Π. Consequently the r eigenvectors can be obtained from r largest eigenvalues which appear to have the largest canonical correlation between the two sets of residuals (levels and first difference regressions 5.25 and 5.25). The eigenvectors corresponding to the r largest eigenvalues are quite important because they are the only vectors that can make the linear combinations of Z_t stationary, i.e. $\hat{V}_i' Z_t \sim I(0), (i = 1....r)$. Therefore, the r eigenvectors ($\hat{V}_t, \hat{V}_2, ..., \hat{V}_r$) comprise the maximum likelihood estimates of $\hat{\beta}$ = ($\hat{V}_t, \hat{V}_2, ..., \hat{V}_r$).

There are two types of test for identifying of co-integration rank, r, which is equivalent to the number of the largest eigenvalues and call trace statistics:

$$\lambda_{trace} = -T \sum_{i=1}^{T} \log(1 - \lambda_i) \qquad r = 0,1,2,....,n-1 \qquad (5.27)$$

where λ_i are the estimated eigenvalues. This test is based on the likelihood ratio tests between restricted and unrestricted models where restriction imposed for

---

172 It has been argued in the statistical behaviour of the non-stationary time series (see Engle and Granger, 1986) that if two or more series are non-stationary, a linear combination of those variables with the order of integration of $I(2)$ may exist.

different values of r. Trace statistics test the null hypothesis that there are maximum r co-integrating vectors against the alternative of r+1. The asymptotic criteria values for this tests can be obtained from Osterwald-Lenum (1992). Other test statistics which is quite similar to the trace test is called maximal-eigenvalue ($\lambda_{\max}$) can be written as

$$\lambda_{\max} = -T \log(1 - \lambda_{r+1}) \qquad r = 0,1,2,....,n-1 \qquad (5.28)$$

With identical critical values as λ_{trace}. Maximal eigenvalue test statistics test the null hypothesis of the existence of r co-integrating vectors against the alternative of r+1 co-integrating vectors. The problems associated with the power and size of these tests are quite important and the critical values tabulated in Osterwald-Lenum (1992) should only be used as indications when deterministic and other stationary variables are included in the system.

5.5.3 Appropriate Time Lag and Asymptotic Distribution

There is a need for several decisions to be made before estimating the long-run relationships in the VECM. Firstly, the lag length of the VECM should be specified. Using the longest length in combination with the AIC (1978) or the SBIC (1978) to achieve the most parsimonious model.[173]

Secondly, asymptotic distributions of the cointegration test statistic depend upon the presence of trends and/or constants in the model, deterministic components that should be considered in the model must be specified.

Five different model specifications utilised by Johanson and Juselius (1990) and Osterwald-Lenum (1992) to expand the VECM to accommodate the different types of deterministic terms (such as an intercept, a linear trend or both).

The most unrestricted model is the following one, it indicates the linear trend and intercept in short-run model, to eliminate linear trends in the differenced series ΔZ_t and the quadratic trend in the level series ΔZ_t.

$$\Delta Z_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \alpha\beta' Z_{t-1} + \mu + \delta t + \varepsilon_t \qquad (5.29)$$

173 For instance, 4 and 12 lags can be chosen for quarterly or monthly data, respectively.

The second model which presented in following form deals with trend term in the long-run model and intercept term in the short-run model. Therefore the presence of a trend term in the cointegrating vector so as to capture any exogenous growth in the long-run relationship.

$$\Delta Z_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \alpha \begin{pmatrix} \beta \\ \delta \end{pmatrix}' (Z_{t-1}^{'} t)' + \mu + \varepsilon_t \qquad (5.30)$$

The third model introduces an intercept term in short-run which allows for the existence of a linear trend in the level series.

$$\Delta Z_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \alpha \beta' Z_{t-1} + \mu + \varepsilon_t \qquad (5.31)$$

In fourth model intercept term in long-run model specifies that, there is no linear trends in the levels of the data; the intercept is restricted in the cointegration space to allow for the units of measurement of the variables.

$$\Delta Z_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \alpha \begin{pmatrix} \beta \\ \mu \end{pmatrix}' (Z_{t-1}^{'} t)' + \varepsilon_t \qquad (5.32)$$

The fifth model indicates no deterministic components in the short-run or in the cointegrating relations. Therefore, created the most restricted model specified that the mean of the data series, in ΔZ_t, is zero.

$$\Delta Z_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \alpha \beta' Z_{t-1} + \varepsilon_t \qquad (5.33)$$

There is also some economic argument in order to specify the most appropriate model as well as the model selection criterion.

5.5.4 The Vector Error Correction Model: Estimation

A two variable system such as a model in this study, can contain at most one co-integrating relation, since the number of co-integrating relationships is determined by rank $\Pi(1)$, and rank $\Pi(1) = 2$ corresponds to stationarity, whiles rank $\Pi(1) = 0$ corresponds to saying that the system is stationary in first differences. A VAR model when is stationary in first difference or integrated of order one such as the model here is normally represented as (2) in error correction framework. The steps that should be taken in estimation and testing hypothesis in the presence of non-stationary variables in a VAR model is as follows: firstly, the co-integration relations are estimated, in this thesis the Johansen test has been used and substituted in the model. Secondly, the other model parameters are estimated.

5.6 Impulse Response Analysis

Interpreting the estimated coefficient of a VAR model is a difficult task. There is a need to look at the impulse response functions and variance decompositions of the system to be able to interpret the VAR results. The impulse response function tracks the evaluation of economic shocks through the system. To measure the time path of the difference shocks on the variables contained in the VAR system there is a need to construct the Vector Moving Average (VMA) representation of the VAR model. This is because the covariance matrix of the residuals is a VAR model is not diagonal, implying contemporaneous correlation among the errors. Therefore, the evaluation of the VAR model caused just by an innovation in one variable may not be appropriate, as this innovation may occur at the same time as another innovation in the system.

Since an Autoregression has an MA representation, a VAR also can be represented in infinite sum of the current and past values of shocks in ε_t.

Returning to the VAR equation.

$$Z_t = A_t + \ldots A_k z_{t-k} + u_t \qquad u_t \sim IN\,(0, \Sigma)$$

Sims (1980) construct the VMA representation of the VAR model by replacing the z_t by z_{t-1} in the VAR model and continued in this fashion (i.e. substitute z_{t-2} into the model) and so on. This could be denoted as follows:

$$Z_t = \sum_{i=1}^{\infty} \Phi_i \varepsilon_{t-i} \qquad (5.34)$$

where Φ_i is a 2×2 matrices, computed using the recursive relations

$$\Phi_I = A_1\Phi_{i-1} + A_2\Phi_{i-2} + \ldots + A_k\Phi_{i-k}, \qquad i = 1,2\ldots$$

with $\Phi_0 = I_2$, and $\Phi_i = 0$ for $i<0$ equation (5.34) can be written in matrix form as follows

$$\begin{pmatrix} S_t \\ F_t \end{pmatrix} = \sum_{i=0}^{\infty} \begin{pmatrix} \varphi_{11}(i) & \varphi_{12}(i) \\ \varphi_{21}(i) & \varphi_{22}(i) \end{pmatrix} \begin{pmatrix} \varepsilon_{S,t-i} \\ \varepsilon_{F,t-i} \end{pmatrix} \qquad (5.35)$$

The impulse response functions trace the effect of an innovation in one variable while held others constant. Then the $\varphi_{kj}(i)$ coefficient syndicates the effect of a shock in the error terms on the endogenous variables of the model. Therefore, the coefficient $\varphi_{12}(0)$ is the instantaneous effect of a one-unit change in $\varepsilon_{Y,t}$ on X_t with all other variables held constant. i.e. $\partial X_t / \partial \varepsilon_{Y,t} = \varphi_{12}(0)$, where ∂ is the partial differentiation operator. There is one impulse response function for each innovation and each endogenous variable. Thus the Four sets of coefficients $\varphi_{11}(i)$, $\varphi_{12}(i)$, $\varphi_{21}(i)$ and $\varphi_{22}(i)$ are the impulse response functions. Plotting the impulse response functions is a practical way to visually represent the behaviour of the z_t series in response to various shocks.

It means that the components in $\varepsilon_t = (\varepsilon_{X,t}, \varepsilon_{Y,t})'$ may be contemporaneously correlated in which case $\mathrm{E}E(\varepsilon_t, \varepsilon_t') = \Sigma$ is non-diagonal. If $\varepsilon_{X,t}$ and $\varepsilon_{Y,t}$ are correlated, then simulation of a shock to say $\varepsilon_{Y,t}$ while assuming that $\varepsilon_{X,t}$ is held constant will lead to misleading results. Sims (1980) introduced a solution by implementing the following Cholesky decomposition of Σ where:

$$\sum = TT'$$

where T is a 2x2 lower triangular matrix. By rewriting the equation (5.34) (VAM) Sims introduces the following model:

$$Z_t = \sum_{i=1}^{\infty} (\Phi_i T)(T^{-1}\varepsilon_{t-i}) = \sum_{i=1}^{\infty} \Phi_i' \mu_{t-i} \qquad (5.36a)$$

where $\Phi_i' = \Phi_i T$ and $\mu_t = T^{-1}\varepsilon_t$

$$\therefore E(\mu_t, \mu_t') = T^{-1}E(\varepsilon_t, \varepsilon_t')T'^{-1} = T^{-1}\sum T'^{-1} = I_2$$

and the new errors, μ_t, obtained using the transformation matrix, T, which are contemporaneously uncorrelated and have unit standard errors. It means, the shocks in μ_t are orthogonal to each other. Therefore, by using orthogonalised shocks the impulse responses can be constructed. That could be denoted as follows:

$$OI_{X,Y,t+n} = e_2'\Phi_n T e_1 \qquad (5.36)$$

where OI is orthogonalised impulse response function of "unit shock" (which is equal to one standard error) at time t to the orthogonalised error of the equation at time t on the futures equation at time $t+n$ e_1 and e_2 are selection vectors such as $e_1 = (1,0), e_2 = (0,1)$. The *OI* of the equation at time t then a unit shock to the futures equation at time $t+n$ is as follows:

$$OI_{Y,X,t+n} = e_1'\Phi_n T e_2$$

The problem with this orthogonalization method is that if (e.g. $Z_t = (X_t, Y_t)'$ changed instead of $Z_t = (Y_t, X_t)'$ then a new transformation matrix will emerge and *OI* will be different. This is because the ordering of the variables is important in the evaluation of VAR result. The ordering depends upon the magnitude of the correlation coefficient between $\varepsilon_{X,t}$ and $\varepsilon_{Y,t}$. The larger the correlation coefficient, the larger the impact of the of changes in order of the variables.

5.6.1 Impulse Response Analysis in a VECM

Pesaran and Shin (1997) introduced the General Impulse Response (GIR) function to track the problems associated with dependence of *OIR* on the ordering of variables in the VAR. Pesaran and Shin (1997) discusses the multivariate distribution assumed for the vector of disturbance, ε_t. They concludes that if ε_t follows a bivariate normal distribution, and assuming that the shock is equal to one standard deviation of the error term in the spot equation i.e. $\delta_1 = \sqrt{\sigma_{XX}}$ then :

$$GI_Y(n, \delta_1 = \sqrt{\sigma_{XX}}, \Omega_{t-1}) = GI_{X,Y,t+n} = \frac{e_2'\Phi_n \sum e_1}{\sigma_{XX}} \quad (5.37)$$

where Ω_{t-1} is the information set available to market agents at time *t-1*, e_1 and e_2 are selection vectors defined in (5.36) and Φ_n is computed from the VMA in equation (5.34). Similarly, the general impulse response function of the spot equation at time $t+n$, following a unit shock to the future equation at time t is given by:

$$GI_{Y,X,t+n} = \frac{e_1'\Phi_n \sum e_2}{\sigma_{YY}}$$

Unlike the *OIR*, The *GIR* are invariant to the ordering the variables in the VAR and take account for historical patterns of correlation observed amongst the different shocks. For the first variable in a VAR, the *OIR* and the *GIR* are identical; for remaining variables they are identical only if Σ is diagonal.

Impulse response analysis for the VECM of equation (5.24) can be carried out along the lines set out above. However, Pesaran and Shin (1997) illustrate that, for VECM of (5.24), the *OIR* and the *GIR* of the futures at time *t+n*, following a unit shock at *t* are as follows:

$$OI_{X,Y,t+n} = e_2'\Phi_n Te_1$$

$$GI_{X,Y,t+n} = \frac{e_2'\Phi_n \Sigma e_1}{\sigma_{XX}}$$

Which are the same as ORI and GIR for the VAR model in (5.36) and (5.37), respectively. Hence the impulse responses for a VECM will be calculated in a same way in a normal VAR model. The only difference which highlighted by Pesaran and Shin (1997) is that, in the VAR model $\lim_{i\to\infty}\Phi_i = 0$, while in the VECM $\lim_{i\to\infty}\Phi_i = C(1)$ where *C(1)* is an non-zero matrix with rank 1, derive from the VMA representation of the underlying VECM as Pesaran and Shin (1997) outlined. Therefore the variables in the VAR are I(0) in levels, the effect of a shock in variables ultimately vanishes, however in a VECM where the variables are not stationary the effect of the shock will be persistent and the variables will adjust to the new long-run level once shocked.

5.7 Conclusion

This chapter presented a brief summary of recently developed econometric methods and time series models, which are used extensively in later chapters of this thesis. Particularly, univariate properties of time series including stationarity and related statistical problems, which may arise in the presence of non-stationarity series in regression models, In this respect Dickey and Fuller (1979 and 1981) and Philips and Perron (1988) unit root tests discussed.

The structural modelling, simultaneous equations introduced and Two-Stage Least Square was discussed. Problem of identification was highlighted and the method of rank and order identification introduced to deal with the problem. Moreover, the Hausman specification test was presented to specify the simultaneity of the model together with the test for exogenity to confirm the endogenous and exogenous variables.

In context of multivariate time series analysis, the VAR methodology and its estimation problems are presented. The multivariate analysis of time series is then extended to models, which take into account stochastic properties of the series. In this respect the Engle-Granger (1987) cointegration method briefly introduced, and the Johansen's (1988) univariate cointegration technique was discussed in details because this technique is used in this thesis. In connection to Johansen's technique VECM models, which captures both the short run dynamics as well as the long run relationships between the variables through cointegration relationships, are also discussed.

Finally various specification and diagnostic tests that normally performed to specify the statistical reliability of the models were presented and their functions were discussed.

CHAPTER SIX: ECONOMETRIC MODEL, ESTIMATION, EVALUATION AND SIMULATION "CAPESIZE"

6.1 Introduction

This chapter presents and estimates a model of the distorting effect of European Union's Agricultural Policy (CAP) on the structure of demand for grain transportation by "Capesize" bulk carriers.

It was established in Chapter Three Section 3.8 that the only route by which "Capesize" vessels can contribute to the grain trade is North Atlantic.[174] An increase in demand for grain import in Western Europe would increase the volume of North Atlantic grain trade and this would in turn increase the employment opportunities for "Capesize" vessels in grain trade.

Considering the above statement, it is possible to utilise a structural economic model for the contribution of this ship size to the grain trade. A simultaneous equation framework is utilised in this chapter to estimate the "Capesize" sub-market model. This is because the specific relationships between variables could be based on a proper economic theory for appropriate structural modelling. An econometric approach is normally utilised when variables are related to each other in different ways and affect each other simultaneously.[175] After the identification process has been implemented the 2SLS technique is used for estimation.[176]

The model consists of four equations. The variables that influence the supply of "Capesize" vessels in general terms are incorporated alongside other variables that influence the contribution of this size vessel in grain trade. Moreover, on the demand side the variables that influence grain trade in North Atlantic are also included. The CAP impact is proxied by the one variable, Producer Subsidy Equivalent (PSET).[177]

The model is used to simulate the possible effect of the liberalisation of the CAP on the structure of demand for shipping transport of grain by "Capesize" vessels. A number of alternative policies have been simulated. In the Uruguay Round of

---

174 North Atlantic grain trade as defined in Chapter Three Section 3.7.

175 Structural Econometric Model means that the specific relationships between variables are based (either formally or informally) on economic theory.

176 Identification process specified that the model is over-identified, therefore 2SLS is an appropriate method to estimate an over-identified model.

177 Producers Subsidy Equivalent has been explained in Chapter Two Section 2.2.2.

negotiation the EU and the USA had different proposals for liberalisation of agricultural support on the world grain market. These two proposals have been considered as the most probable future changes in the international grain market, and are used as a basis of simulation model.

The structure of the chapter is as follows: Sections 6.2, 6.3 and 6.4 present a summary of the model and definitions of the estimation period and data. The "Capesize" model is discussed in Section 6. 5 while Section 6.6 provides the model's identification (Order and Rank Identification). Results of the Simultaneity and Exogenity tests are analysed in Sections 6.7 and 6.8 and further results for stationarity and cointegration are shown in Section 6.9 and 6.10. The econometric estimation of the model is discussed in Section 6.11 while 6.12 provides an analysis of the possible effects of the liberalisation of the CAP based on the simulations carried out.

6.2 Summary of Structural Model

The employment of "Capesize" vessels in the grain trade is assumed to rely on the North Atlantic route. This route is defined as the EU grain Import from the USA and Canada. This assumption is based on two factors. Firstly, the ports restrictions means that ports on both side of the Atlantic are capable of handling the large ships in grain trade. Secondly, the volume of the EU grain import from North America which was 20 M.T. in late Seventies and early eighties (see Chapter three) represents 25% of the total international grain trade at the time. Therefore the quantity of the trade was also very high to provide sufficient demand for "Capesize" vessels in this route. Moreover, economics of scale and a competitive marketing edge has resulted in many exporters preference to use large ships in this trading route.

Moreover the grain trade in North Atlantic would be affected by changes in EU grain imports. All other things being equal, when EU grain imports increase "Capesize" employment in grain trade improves. The level of grain imports into the EU depends on the scale of grain production and consumption within the EU itself. The EU agricultural market is a protected market in which government intervention strongly influences supply and demand in the market. Therefore, government intervention is the main factor to influencing the EU grain trade.

The hypotheses present the ideas of this study in two stages. Firstly, they address the CAP effects on the structure of demand for "Capesize" bulk carriers due to a reduction of the EU's grain imports from North America. Secondly, they address the impact of the CAP, through its expansionary impact on the level of EU's exports, on the structure of demand for smaller bulk carriers. This chapter is devoted to the model which quantifies the impact of the reduction of the EU grain imports from North America on Capesize bulk carriers only. A dynamic relationship is postulated as the variables involved interact simultaneously and depend on each others' movements, other variables outside the system as well as on past values.

A simultaneous equation framework is utilized to model the variables that are related to each other in different ways and affect each other.[178] In the simultaneous-equation model the endogenous variable in one equation may become an independent variable in another equation of the system.

The correlation between such endogenous explanatory variables and disturbance results the problem of simultaneous equation bias. Therefore in this situation the OLS method would not yield consistent estimators.[179] The 2SLS method has been implemented to estimate the model.

6.3 Estimation Period

Since this study involves estimating the impact of the CAP on the structure of demand for different bulk carriers market subsections, the estimation period should be allocated in such a way to produce the most reliable results.

To produce reliable and useful results, two criteria should be considered. Firstly, the time for implementation of the CAP has to be considered. Secondly, the recognizable time for differentiation in dry bulk carriers market also should be taken into the consideration.

Although the CAP was approved in 1962, it took five years to implement a common market organization for cereals with unified grain policy prices in 1967. On the other hand the recognizable time for differentiation in bulk carriers market dates back to early 1970s, when Capesize bulkers appeared in the market.[180]

---

178 Structural econometric model means that the specific relationships between variables are based (either formally or informally) on economic theory.

179 Estimators do not converge to their true population values, no matter how large the sample size.

180 The time when Capesize bulk carriers appeared in the market for first time.

Considering the above criteria, 1970 is selected as the base year for estimating the three different models. 1998 is allocated as the ending year, because reliable data at the time of estimation (1999) was available only up to this year.

6.4 Data for Capesize Model

Data for the volume of grain transported by "Capesize" in Mt. (GTC) was collected from different issues of world bulk trade published by Fearnleys. This data includes grain and soybean.[181] The data provided figures for the grain transported by bulk and combined carriers in percentage terms, were transformed by the author to actual nominal figures.

The US Department of Agriculture and the International Grain Council (IGC) publishes data for the North Atlantic grain trade (NGT). Those data include the EU coarse grain and wheat import from the USA, and the EU wheat import from Canada. Data for North Atlantic soybean trade (NST) is provided by the US Department of Agriculture.[182] Data regarding the EU grain consumption (EGC) was obtained from the US Department of Agriculture. This data includes figures for wheat and coarse grain measures in metric tons. Monthly data for Bunker price collected form Clarksons shipping company and the yearly average of those data calculated by the author.

The most difficult data collected for this analysis were for the "Capesize" Grain Freight Rate (CGF). Since the base year for this estimation is 1970, there was no readily available yearly data regarding this variable that dated back to 1970. Hence there was a need for that author to construct this data set. This data set was constructed in two stages.

Firstly, time charter rates for "Capesize" were collected from Drewry Shipping Consultants. By using a model based on some assumptions, this data set was transformed to the spot equivalent (freight rate $/ton).[183] However since this data set (time charter rates) only dates back to 1980, the second stage involved calculation of the "Capesize" freight rate, for another ten years, back to 1970, using a regression model.

---

181 The reason for including soybean in this data is explained in Section 1.2, where grain definition is provided.

182 Defined as the EU soybean import from USA.

183 See Appendix 9 for assumption details.

The full "Capesize" spot rate equivalent series which was created using time charter rates for "Capesize" (produced as outlined above) was used in the regression model together with actual "Panamax" freight rates. Correlation existed between the "Capesize" spot rate equivalent series and actual "Panamax" freight rates from 1980 to 1998. Assuming that this trend has been constant through the years, the correlation coefficient was used in a regression analysis to calculate the "Capesize" spot rate back to 1970. The details are available in Appendix 8.

6.5 Modelling the Impact of the CAP on "Capesize" Contribution in Grain Seaborne Trade

Sub-hypothesis two argues that the majority of the grain import volume to the EU was imported from North America and also that most of "Capesize" contribution to grain trade could only occur in the North Atlantic. In this section, a set of equations comprising a model are presented to measure the impact of the CAP on the contribution of "Capesize" bulk carriers to the seaborne grain trade through a reduction of the EU grain import from North America.

The model consists of four equations which define the volumes of various grain trades and the "Capesize" grain freight rate in the North Atlantic (CGF). The grain trades are as follows: grain trade transported by "Capesize" (GTC), the North Atlantic grain trade (NGT)[184] and the North Atlantic soybean trade (NST).

Many shipping models attempt to formulate the behaviour of freight rates by reference to the expectation hypothesis. These include a lagged dependent variables, to reflect the assumption that the past will affect the present. In this instance, lagged dependent variables have also been included.

Equation 1

In the first equation, the dependent variable is the volume of sea-borne grain trade transported by "Capesize" bulk carriers (GTC).[185]

$$GTC_t = f_1(\overset{+}{NGT_t}, \overset{+}{CGF_t}, \overset{+}{NST_t}, \overset{+}{GTC_{t-1}}, \varepsilon_t) \qquad (6.1)$$

184 The EU grain import from Canada and USA.

185 GTC is the total demand generated by grain for "Capesize" vessels. Fearnley's shipping, on a yearly basis, produce the data for transport of grain by any "Shipsize". This data includes grain and soybean (this is due to Fearnley's definition of grain that includes soybean in the definition of grain).

In this equation, the most important independent variable is North Atlantic Grain Trade (NGT). Sub-hypothesis two argues that this is the main trading route for "Capesize" bulk carriers involved in the grain trade. Thus it is expected that there should be a very close and positive relationship between the EU's grain imports from North America and the volume of grain transported by "Capesize" vessels.

Sub-hypothesis three states that the level of grain freight rates induces "Capesize" operators to enter into the grain market, suggesting a strong and positive relationship between the level of grain freight rates in the North Atlantic trade and the contribution of "Capesize to the grain trade.

The other independent variable is soybean trade in the North Atlantic, that is EU soybean imports from USA. As mentioned previously, data regarding grain transport by any shipsize includes soybean as well as grain, therefore separation of soybean figure from actual grain figure is not possible. Hence, the EU's soybean imports from the USA is considered as an independent variable in this equation.

Equation 2

To specify the impact of the CAP on the EU grain import from North Atlantic, the second equation formulates the North Atlantic Grain Trade (NGT) (The EU grain import from USA and Canada) as follows:

$$NGT_t = f(, \overset{+}{EGC_t}, \overset{-}{PSET_t}, \overset{-}{PSET_{t-1}}\, \overset{-}{CGF_t}, \overset{+}{NGT_{t-1}}, \varepsilon_t) \qquad (6.2)$$

It was outlined in sub-hypothesis 5 that the EU exerts considerable control over grain prices (normally, the EU's prices are higher than world prices). Therefore, the relationship between domestic and international prices is extremely important in determining how the EU responds to shifting world market condition and in modelling the EU's imports. The EU chooses to ignore the world markets and controls its domestic prices. This means domestic prices (P_d) would not be a function of world prices (P_w), but of world prices plus policy instruments, used to maintain domestic prices, where (A_{ms}) is the aggregate measure of support in the EU. This is expressed as follows:

$$P_d = A_{ms} + P_w$$

A_{ms} can take the form of any of the measures of government intervention like Producer Subsidy Equivalent (PSE).[186]

Furthermore, import levels are generally a function of domestic production and consumption. Therefore, the EU Grain production (EGP) and consumption (EGC) could be considered as two additional variables that influence the EU grain imports from North America.

The EU grain production (EGP) is a function of both the import (threshold) price (P_t) and the domestic (intervention) price (P), therefore it is a function of the Produce Subsidy Equivalent (PSE) as well. This is defined as follows:

$$EGP = EGP(P, P_t), \text{ with } EGP_p<0 \text{ and } EGP_{pt} > 0 \quad (6.3)$$[187]

Since the *EGP* is influenced by *PSET*, EGP has been removed from the equation to avoid serial correlation. As sub-hypothesis four argues, the cost associated with the shipment of goods may be substantial. This is especially true for grain products, which generally are low-value and bulky. Dunn (1987) notes that the transport cost is a substantial proportion of grain delivery prices. Thus the freight rates play an important role in final grain prices and in the volume of trade. Additionally, it was assumed that "Capesize" transports the majority of North Atlantic grain trade. Therefore, the "Capesize" grain freight rate in North Atlantic "*CGF*" could be an important variable to influence the North Atlantic grain trade.

Equation 3

Freight rates represent an important proportion of grain prices and are often considered to be a function of the distance between traders, or alternatively, to be a simple proportion of commodity prices (Hsu & Goodwin, 1996). Neither method of formulating a simple proxy for transport costs has proved to be very effective in analysing trade flows or volume (Binkley & Harrer, 1982:140-114). However, many factors may influence freight rates for grain in general and there are also

186 This measure includes all government policies, even those that would not directly distort internal market prices, while the other would only specify those policies that directly distorted prices to producers and consumers. Thus this study uses PSE as an indicator of government intervention in grain market. PSE could be defined as follows:

$$PSE= Q_p(P_d-P_w)+D-L+B$$

where Q_p is domestic production, D is direct payments to farmers, L measures levies/taxes paid by farmers to the governments, B measures other budgetary transfers (such as input subsidies). P_d and P_w represent the domestic and world prices respectively.

187 EGP_p and EGP_{pt} are first derivatives of the dependent variable with respect to the subscripted variable.

specific factors regarding each route. The grain freight market is subject to supply and demand shifting factors that are specific to shipping services.

The general theory for freight market indicates that the major determinants of freight rates are total demand, variable inputs (e.g. fuel prices) and existing capacity of the fleet. However to model freight rates for a specific route, ship size and commodity trade, there is a need for more detail. Firstly, freight rates for a specific ship size in a specific route and for a specific commodity trade are influenced by the general condition of the freight market. The general condition of the freight market could be represented by a freight rate index. This index is very important for the bulk carriers sector and grain freight market.[188] It is essential for calculating the actual rates in this sector. The Grain Freight Rate Index could be defined as follows:

$$GFI = f(\overset{-}{CBF}, \overset{+}{TGT}, \overset{+}{BP}) \qquad (6.4)$$

where:
(CBF) is Existing bulk carriers fleet,
(TGT) is Total world Grain Trade and
(BP) is bunker price.

Another variable, which may influence the freight rate for a specific shipsize in a specific route and commodity trade, is the demand in this route generated by the commodity trade (considering the port and route restrictions for specific shipsize). Therefore, the "Capesize" grain freight rate in North Atlantic also depends on the demand for this size ship generated by grain and soybean "NGT" and "NST".

Furthermore, as the major commodity trade for "Capesize" is "Iron Ore", the Seaborne Iron Ore trade "IST" will be considered within the equation. Many shipping models that attempt to capture the behaviour of freight rates refer to the expectation hypothesis.[189] To account for this the lagged value of CGF is considered in this equation to specify the effect of past major freight rate for "Capesize" on the present. The "Capesize" grain freight rate in North Atlantic "CGF" is defined as follows:

$$CGF_t = f(\overset{+}{NGT_t}, \overset{+}{NST_t}, \overset{+}{CIR_{t-1}}, \overset{+}{GFI_t}) \qquad (6.5)$$

---

188 Freight rate index will be referred to as just freight rate in order to make it easier to understand.

189 See Chapter Two.

By substituting equation (6.4) into equation (6.5), the resulting equation (6.6) will represent the structural equation for supply of shipping fleet in this particular route, as follows:

$$CGF_t = f(\overset{+}{NGT_t}, \overset{+}{NST_t}, \overset{+}{CGF_{t-1}}, \overset{-}{BP_t}, \overset{+}{TGT_t}, \overset{-}{CBF_t}) \qquad (6.6)$$

Since estimation of the above structural equation is statistically problematic its reduced form equation presented as follows.[190] Therefore the final equation is as follows:

$$CGF_t = f(\overset{+}{NGT_t}, \overset{+}{CGF_{t-1}}, \overset{+}{IST_t}) \qquad (6.7)$$

Equation 4

Sub-hypothesis six argues that the North Atlantic soybean trade could influence the contribution of "Capesize" bulk carriers into the grain trade. Since there is a cross elasticity between soybean and actual grain, the soybean trade could be influenced by the level of the grain price in the EU. Furthermore, since soybean is a low value commodity trade, the level of the freight rate could influence the volume of its seaborne trade. The relationship is given as follows:

$$NST_t = f(\overset{+}{ESC_t}, \overset{+}{ESP_t}, \overset{+}{CGF_t}, \overset{+}{PSET_t}, \overset{+}{NST_{t-1}}) \qquad (6.8)$$

Where:
(NST) is North Atlantic Soybean trade
(ESP) is the EU Soybean production
(ESC) is the EU Soybean Consumption
(CGF) "Capesize" freight rate
(PSET) is the producer subsidy equivalent for grain.

From, the above argument, the North Atlantic soybean trade could be expressed as a function of the EU's soybean production (ESP), the EU's soybean consumption (ESC), the level of support price for grain within the EU (PSE) and "Capesize" grain freight rates in North Atlantic (CGF) as in equation (6.8) (Geraci & Prewo, 1977:67-74).

190 Preliminary results reveal that the three deleted variables are not significant. The main reason for these important shipping variables not to be significant could be due to partial modelling of the shipping market.

6.6 Identification

Chapter Five Section 5.3.1 noted that through the identification process it will be possible to establish "whether numerical estimate of the parameters of structural equation can be determined from the estimated reduced form coefficients" (Gujarati, 1995:657-58). A systematic routine, as presented in Chapter Five, Section 5.3.1 is performed here so that the reduced-form equations will obtain the identification of an equation in a system of simultaneous equations. This procedure is presented in two stages, first order and then rank conditions of identification.

Endogenous variables:

- GTC Volume of grain transported by "Capesize"(Mt.).
- NGT North Atlantic grain trade (Mt.).
- CGF "Capesize" grain freight rates in North Atlantic ($/ton).
- NST North Atlantic soybean trade. Defined as the EU soybean import from USA (Mt.).

Exogenous Variables use lagged one period

- EGC The EU grain consumption (Mt.).
- PSET Producers Subsidy Equivalent ($/ton),
- PSET(-1) Producers Subsidy Equivalent ($/ton), lagged one period
- ESC The EU soybean consumption.
- ESP The EU soybean production.
- IST Iron Ore seaborne trade
- CGF(-1) "Capesize Iron Ore freight rate, lagged one period
- GTC(-1) Volume of grain transported by "Capesize", lagged one period
- NGT(-1) North Atlantic grain trade, lagged one period
- NST(-1) North Atlantic soybean trade, lagged one period.

6.6.1 Order Condition

The similar rule that was outlined in Chapter Five, Section 5.3.1 is applied to the "Capesize" model to exercise the order condition. This procedure shows that all the equations are over identified and that the order condition is satisfied. However, the order condition may yield satisfactory results in any particular equation and yet the relation may not be identified. Therefore, it is also important to satisfy the order condition. This is done in the next section.

6.6.2 Rank Condition

The rank identification is achieved by assuming that some variables of the model have zero coefficients in the equation. It is an indication that some variables do not directly affect dependent variables in the equation.

The following tables demonstrate the rank condition of identification. Since it was possible to construct at least one non-zero determinant of order *3 (= N-1)* where *N=10* all equations are over-identified. Hence, the rank condition of the identification is also satisfied.

Since the model is over-identified, it could not be estimated by indirect least squares (ILS) (see Section 5.3), as there is more than one estimate of the coefficients of the structural model. Furthermore, the OLS estimators are also inconsistent due to the correlation between the stochastic explanatory variables and the stochastic disturbance term. Therefore, there is a need to find a "proxy" for the stochastic explanatory variable which will be uncorrelated with the stochastic disturbance term. This "proxy" is known as an instrumental variable. The two stage least squares technique (2SLS), introduced by Basmann (1957) allows for the use of instrumental variables. In the first stage of 2SLS, the stochastic explanatory variable is regressed on the predetermined variables in the whole system to eliminate the likely correlation between the explanatory variable and the disturbance term. In the second stage, the explanatory variable is replaced by its estimated value in the structural equation. Two stage least squares (2SLS) is utilised to specify the equations and the models. This method provides an appropriate means to estimate over-identified models and to obtain a unique estimate for each structural parameter.

6.7 Test of Simultaneity (Hausman Specification Test)

This study utilised simultaneous equations to model the impact of the CAP on the structure of demand for Capesize, therefore a test of simultaneity should be employed to ascertain whether there is a simultaneity problem.

Chapter Five Section 5.3.2 outlined that (it will be repeated here for convenience) if the coefficients of p_t and the reduced form error term μ_t are the same then under the null hypothesis there is no simultaneity and the correlation between $\hat{\mu}_t$ and the structural error term μ_t should be zero, asymptotically.[191] Therefore, if the

[191] See Chapter Five section 5.3.2 and 5.3.3.

coefficient of μ_t is statistically zero, it implies that there is no simultaneity problem and if the coefficient is statistically significant, a simultaneity problem exists.

Dependent variable GTC

F Statistics	40.549
Significant Level	0.000
Null Hypothesis rejected simultaneity problem exists	

Dependent variable NGT

F Statistics	3.184
Significant Level	0.044
Null Hypothesis rejected simultaneity problem exists	

Dependent variable CGF

F Statistics	4.224
Significant Level	0.017
Null Hypothesis rejected simultaneity problem exists	

Dependent variable NST

F Statistics	5.809
Significant Level	0.005
Null Hypothesis rejected simultaneity problem exists	

The test's results indicate that simultaneity exists within the model.

6.8 Test for Exogeneity

The model discussed in Chapter Five Section 5.3.3 could be applied to specify the exogeneity of variables in the "Capesize" model. The model under investigation is a four-equation model in four endogenous variables, GTC, CGF, NGT, NST and eight other exogenous variables. The first equation is:

$$GTC_t = -\gamma_1 + \alpha_1 NGT + \beta_1 CGF + \delta_1 NST + \lambda_1 GTC_{t-1} + \mu_{1i}$$

When NGT, CGF and NST are truly endogenous, the equation could not be estimated by OLS. The procedure starts by obtaining the reduced-form equations for CGF, NST, NGT. From these reduced-form equations, the predicted values of the variables $\hat{CGF}$, $\hat{NST}$, $\hat{NGT}$ are determined. Following the Hausman test discussed in the previous section, the following equation could be estimated by OLS:

$$GTC_t = -\gamma_1 + \alpha_1 NGT + \beta_1 CGF + \delta_1 NST + \lambda_1 GTC_{t-1} + \varphi_1 \hat{NGT}_t + \varphi_2 \hat{CGF}_t + \varphi_3 \hat{NST}_t + \mu_{1i}$$

Using the F test the hypothesis, that $\varphi_1 = \varphi_2 = \varphi_3 = 0$, will be tested. If this null hypothesis is rejected, NST, NGT and CGF can be deemed endogenous, but if it cannot be rejected they can be treated as exogenous.

NGT

F Statistics	34.241
Significant Level	0.045
Null Hypothesis rejected NGT is endogenous	

CGF

F Statistics	2.571
Significant Level	0.081
Null Hypothesis rejected CGF is endogenous	

NST

F Statistics	4.080
Significant Level	0.080
Null Hypothesis rejected NST is endogenous	

The test confirmed the endogenity of the predetermined variables.

6.9 Stationarity of the Series

Time series analysis is an important aspect in the analysis of economic data. In most cases, such data series are not stationary. Maintaining the stationarity condition is quite important, since non-stationary variables lead to spurious regression.[192]

Tests for stationarity were carried out using the Augmented Dickey-Fuller test (1981). The results are based on the null hypothesis of a unit root. If the Dickey-Fuller t statistics of the level exceed the critical value, the null of a unit root is rejected. The results for each data series are presented in Table 6.1. The results of ADF test indicate that all the data series are first difference stationary or I(1).

Table 6.1: Unit Root Tests for all the Series in the Model

$$\Delta lnX_t = \alpha_0 + \alpha_1 lnX_{t-1} + \sum_{i=1}^{n} \delta j \Delta lnX_{t-j}$$

	LGTC	LNGT	LCGF	LNST	LEGC	LPSET	LESC	LESP	LIST
ADF Levels	-2.62	-.045	-1.43	-2.63	-1.64	-2.34	-2.46	-1.25	-0.19
1st diffs.	-4.85	-5.65	-4.62	-4.12	-4.79	-9.77	-4.06	-3.71	-5.21

1%, 5% and 10% critical values for ADF test are -3.70, -2.97 and -2.62, respectively.
The lag length for ADF test is chosen in order to minimise the SIBC.
All tests include a constant as indicated by SIBC and the t test.

6.10 Cointegration

If a multivariate or a univariate data series contains a unit root, they should be differenced in order to create a stationary series. The regression models should be estimated using the difference series. However, this procedure is incorrect in many cases, because it ignores the information about the long-run relationship of the variables. Engle and Granger (1987) suggested that there may be a linear combination of integrated variables that is stationary and they introduced the cointegration technique to establish whether any long-run relationship exists between the series in econometric model.

[192] If two variables are trending then, even if there is no casual link between them, they are likely to be highly correlated. But the correlation is an entirely unmeaningful or spurious one.

This study focuses on the multivariate cointegration method to understand the long-run relationships in the study's economic models. It is emphasised that even if the non-stationary series are used in levels to estimate an econometric model, they move together over time and the difference between them will be stationary. Therefore, the important feature of the cointegration for this study is to highlight the existence of a long run equilibrium relationship to which the economic system converges over time. In such a way ε_t can be recognised as a dis-equilibrium error, that is, the distance that the system is away from equilibrium at time t.[193]

The results of the multivariate cointegration method showed that there is at most one cointegrating vector with in each Equation of the model. The linear combination of order one series I(1) is normally I(1) themselves. A cointegrating vector has the property that it is I(0), that is, stationary in levels even though each individual component item is non-stationary in levels. What is implied is that one can use the cointegration term to establish the existence of a long-term permanent link between the series contained within it.

Table 6.2: Johansen Multivariate Cointegration Test for Each Equation of the Model

Equation of the model	Eigenvalue	Likelihood ratio	5% Critical value	Hypothesized No. of CE(s)
GTC	0.6963	65.80	47.21	At most 2*
	0.5090	33.62	29.68	
NGT	0.9811	132.5	47.21	At most 2*
	0.7071	37.22	29.68	
CGF	0.8297	78.17	68.52	At most 1*
	0.4671	32.14	47.21	
NST	0.9767	192.10	68.52	At most 5*
	0.8851	98.01	47.21	
	0.6616	43.91	29.68	
	0.3219	16.82	15.41	
	0.2475	7.11	3.76	

Johansen's reduced rank cointegrating tests for each equation are estimated using a model with a constant in the cointegrating vector and no trend as selected by SBIC, calculated through $CSBIC = T\log(\Sigma) + v\log(T)$, where T, Σ and v are the number of observations, the determinant of the variance-covariance matrix of the residuals and the number of the parameters respectively.
* Indicates rejection of the null hypothesis at the 95% significance level.

193 The Johansen (1988) technique has been used in this study for the integration test.

6.11 Econometric Estimates[194]

The four equations of the model have been jointly estimated in level form, because simultaneity existed and also because the results of the multivariate cointegration method suggest that there is at most one cointegrating vector within each equation of the model. The estimated results in equations one to four reveal that the volume of grain transported by "Capesize" bulk carriers at time t (GTC_t), is significantly influenced by the variables which are involved in the model.

In equation one, growth in North Atlantic grain and soybean trade would influence the volume of grain transported by Capesize (GTC). The estimated coefficient indicates a strong positive relationship. Therefore, these results support the argument that the only route by which "Capesize" vessels can contribute into grain trade is North Atlantic.[195]

Equation one also demonstrates the importance of the "Capesize" grain freight rates for grain transported by such ships. Since equation one represents the demand side, the "Capesize" grain freight rate (CGF) demonstrates a positive and significant relationship with (GTC_t). This supports the sub-hypothesis three, which argues that "Capesize" operators would contribute more to grain trade if the relative grain freight rates are high.[196] It also supports the sub-hypothesis four that freight rate in low value commodity trades can influence the volume of the trade to some extent. Furthermore, equation one also expressed a dynamic relationship within the model by relating the lagged (GTC) to the present (GTC). The estimated coefficient for lagged (GTC) is very significant.

194 Skew and Kurt are the estimated centralised third and fourth moment of the data, denoted $\hat{\alpha}_3$ and $(\hat{\alpha}_4 - 3)$ respectively; their asymptotic distribution under the null are $\sqrt{T}\hat{\alpha}_3 \sim N(0,6)$ and $\sqrt{T}(\hat{\alpha}_4 - 3) \sim N(0,24)$.
The figure in (.) and [.] are t-statistics and probability values, respectively.
BL (Q_1) and (Q_6) is the Box-Ljung statistic for 1st and 6th order serial correlation in the residuals, the 5% critical values for these tests are 3.51 and 6.43, respectively.
ARCH is the F test for 6th order autoregressive conditional heteroscedasticity. The 5% critical values for this test is 1.43.
J-B is the Jarque-Bera (1980) test for normality. The 5% critical values for this test is $\chi^2(2) = 5.44$.
The standard errors are corrected for serial correlation and /or heteroscedasticity using the Newey-West method.

195 See Section 3.9.8 for more details.

196 Relative grain freight rates to iron ore and coal.

Table 6.3: Estimations of the Models

$$InGTC_t = \gamma_1 + \alpha_1 In\ NGT + \beta_1 In\ CGF + \delta_1 In\ NST + \lambda_1 In\ GTC_{t-1} + \varepsilon_t$$
$$InNGT_t = \gamma_2 + \alpha_2 InPSET + \beta_2 InEGC + \delta_2 InCGF + \lambda_2 InNGT_{t-1} + \varphi \ln PSET_{t-1} + \varepsilon_t$$
$$InCGF_t = +\gamma_3 + \alpha_3 InNGT + \delta_3 InCGF_{t-1} + \lambda_3 InIST_t + \varepsilon_t$$
$$InNST_t = +\gamma_4 + \alpha_4 InESC + \beta_4 InESP + \delta_4 InPSET + \lambda_4 InCGF + \theta InNST_{t-1} + \varepsilon_t$$

Equation of the Model	(1)	(2)	(3)	(4)
γ_1	-3.81 (-1.32)			
α_1	0.10 (2.25)			
β_1	0.29 (1.67)			
δ_1	0.61 (2.44)			
λ_1	0.49 (3.59)			
γ_2		-75.31 (-1.31)		
α_2		-0.08 (-2.85)		
β_2		4.42 (1.40)		
δ_2		-0.82 (-2.02)		
λ_2		0.65 (4.22)		
φ		-0.08 (-2.15)		
γ_3			-27.46 (-4.02)	
α_3			0.09 (2.01)	
δ_3			0.17 (1.89)	
λ_3			1.59(4.30)	
γ_4				-17.97 (-2.69)
α_4				1.59 (3.09)
β_4				-0.06 (2.13)
δ_4				0.04 (1.91)
λ_4				-0.25 (-1.89)
θ				0.54 (4.37)
R squared	089	0.80	0.74	0.89
R-bar squared	0.86	0.76	0.70	0.87
D.W	1.89	1.98	2.12	2.57
S.E	0.35	0.44	0.14	0.21
Skew	0.45 [0.36]	-0.51 [0.30]	-0.02 [0.97]	1.78 [0.00]
Kurt	-0.50 [0.64]	-0.13 [0.90]	-0.90 [0.40]	5.99 [0.00]
J.B	1.21 [0.54]	1.22 [0.54]	0.92 [063]	54.73 [0.00]
ARCH	1.17 [0.38]	3.15 [0.04]	0.92 [0.47]	0.57 [0.74]
B.L (Q_1)	2.66 [.010]	0.43 [0.51]	0.98 [0.47]	3.92 [0.04]
B.L (Q_6)	13.50[0.03]	3.4 [0.75]	4.90 [0.55]	9.30 [0.15]

Equation two indicates the importance of producer subsidy equivalent (PSET) for North Atlantic grain trade (NGT). (PSET) has a negative effect on (NGT) (EU grain import). Meanwhile, EU grain consumption has positive impact on (NGT). Equation two showed the effect of "Capesize" grain freight rate (CGF) on (NGT). There is a strong negative relationship between (CGF) and (NGT). This result supports sub-hypothesis five which argues that, since grain is a low value commodity the freight rate highly influences the volume of its international trade. Additionally equation two specifies a very strong dynamic relationship. The lagged (NGT) highly influences the present situation. Therefore present situation could affect the future.

Equation three indicates that changes in the grain freight rate are affected by changes in (NGT) and that (NST) influences (CGF) but not as much as (NGT). Changes in the iron ore freight rate also influence the (CGF). This could be supported by the argument that the main commodity trade for "Capesize" is iron ore and that its freight rate is important in determining the other commodity freight rates for this ship size. Since the bulk carrier market is recognized as a perfect market, market prices should contain all the available information in the market. "This means freight rates are likely to have a sufficient information content to allow modelling with freight rate series only" (Veenstra, 1999).

Equation four indicates that changes in North Atlantic soybean are affected by changes of EU soybean production (ESP) and consumption. Increases in EU production reduced the North Atlantic soybean trade while increase in EU soybean consumption increases this trade. Furthermore, the equation specifies that producer subsidy equivalent in grain positively influences the North Atlantic soybean trade. This supports sub-hypothesis seven which argues that grain and soybean are substitutes for each other. The equation also illustrates that "Capesize" grain freight rates influence the North Atlantic soybean trade significantly. This could be attributed to sub-hypothesis four which argues that the low value commodity trade is significantly influenced by freight rates. Finally, the North Atlantic soybean trade is also affected by its lagged value.

6.12 Capesize Simulation

This section presents the results of simulations carried out to ascertain the possible effect of the liberalisation of the CAP on the contribution of "Capesize" vessels to the grain trade. This is a counterfactual analysis as discussed in Chapter Four Section 4.9. Using the model developed in Section 6.5, this section investigates the possible impact of the EU's and the USA's proposals for the partial liberalisation of agricultural support on the world grain market and on "Capesize" contribution to the grain trade. These proposals were forwarded in the WTO's Uruguay Round (WTO) of negotiation.

The structure of the theoretical model is the same as that of the econometric model estimated in previous section, thus similar quantitative results are expected. However, there is a need for certain assumptions to create an understanding about how the system responds to different policy measures. This provides a basis for comparison of the simulation results with the original econometric results.

The assumption is that the variables of the model would follow extrapolative growth (unanticipated). It means that the historical trend is considered to be unchanged. This implies that the underlying economic pattern in the historical data has remained the same. Hence, the same structure of institutional relationships that exists in the historical data should also remain considered unchanged. The results of these simulations are compared with the original estimates and the percentage change of the unanticipated results are reported and analysed.

Two different scenarios are constructed and analysed. The first scenario assumes a 30% cut in PSET in the EU with 1986 taken as the base period (the EU proposal). The second scenario is a 90% cut in PSET with 1988 as the base period (the USA proposal). Figures 6.1 to 6.4 show the response of the endogenous variables of the system to changes in agricultural policy measures according to the EU and USA proposals. It is assumed that the changes are implemented from 1992 and that they permanently reduce the agricultural protection level within the EU by 30%. These tables show percentage changes of the simulations results as compared to the original estimate (CAP existed).

A 30% unanticipated decrease in the CAP protection measures (PSET) leads to a 10.63% increase in North Atlantic grain trade (NGT) for a seven year average. It shows an increasing change of 4.02% in grain transported by "Capesize" (GTC) in seven years average. This inevitably implies a change in North Atlantic soybean trade (NST) by 8.59%. Then the "Capesize" grain freight rate in North Atlantic shows a growth trend of 5.6%.

If the USA proposal were implemented from 1992 (90% cut in PSET) the North Atlantic Grain Trade (NGT) would increase by an average of 93.69% over a seven year period. This implies an average growth in grain transported by

"Capesize"(GTC) of 21.17% over the seven year period. Growth in the "Capesize" Freight (CGF) is more significant under the USA's proposal than the EU's. The USA proposal increased the fright by an average of 50.69% in seven years. This proposal however changed the Soybean trade in North Atlantic (NST) by 56.54%.

Table 6.4: Simulated Effects of EU Proposal in WTO on Endogenous Variables of the System

Year	ORI GTC/ ton	EU GTC%	ORI NGT/ton	EU NGT%	ORI CGF$/ton	EU CGF%	ORI NST ton	EU NST%
1992	7.68	3.74	2.07	18.22	7.76	-7.64	8.22	-8.95
1993	11.33	-33.80	2.54	14.43	7.70	-2.08	7.85	-19.87
1994	8.16	-1.54	2.74	12.83	8.68	-0.62	7.06	2.87
1995	11.10	-27.84	2.76	-3.50	11.13	-15.23	9.43	-28.08
1996	10.20	-25.49	4.25	-33.79	8.71	6.80	9.38	-23.26
1997	6.30	20.63	2.53	11.31	9.27	15.10	8.96	-8.48
1998	3.74	92.45	2.16	54.88	7.50	42.87	6.42	25.64
Ave		4.02		**10.63**		**5.60**		**-8.59**

Table 6.5: Simulated Effects of USA Proposal in WTO on Endogenous Variable of the System

Year	ORI GTC/ ton	US GTC%	ORI NGT/ton	US NGT%	ORI CGF $/ton	US CGF%	ORI NST ton	US NST%
1992	7.68	5.44	2.07	15.29	7.76	19.38	8.22	-44.97
1993	11.33	-22.33	2.54	43.94	7.70	34.36	7.85	-57.45
1994	8.16	12.8	2.74	70.39	8.68	44.33	7.06	-49.61
1995	11.10	-20.77	2.76	93.11	11.13	51.91	9.43	-66.91
1996	10.20	-16.78	4.25	59.39	8.71	59.64	9.38	-66.26
1997	6.30	17.16	2.53	143.26	9.27	70.06	8.96	-61.48
1998	3.74	172.64	2.16	230.47	7.50	75.16	6.42	-49.13
Ave		21.17		93.69		**50.69**		**-56.54**

Figure 6.1: Simulated Effects of EU and USA Proposals in WTO on Grain Transported by Capesize

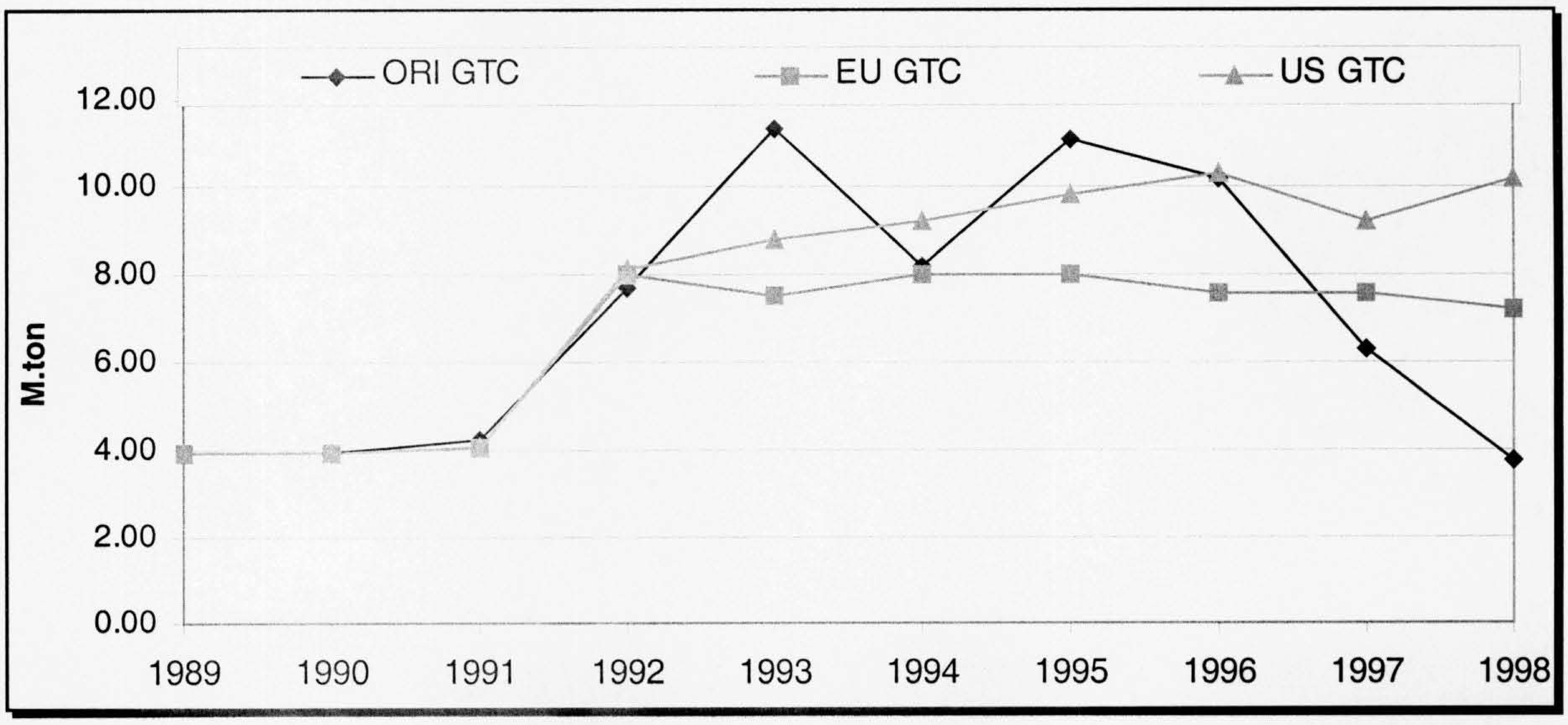


Figure 6.2: Simulated Effects of EU and USA Proposals in WTO on North Atlantic Grain Trade

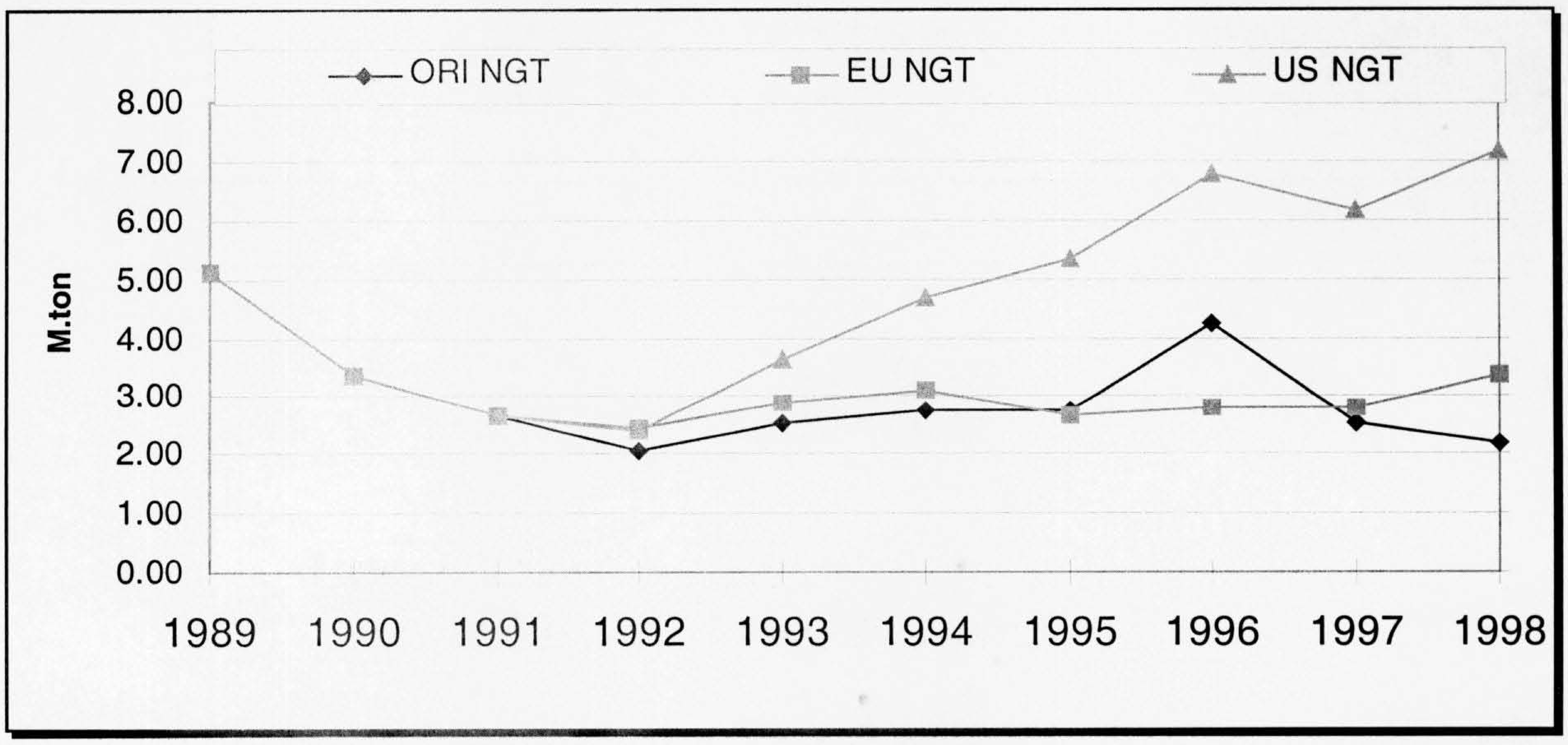


Figure 6.3: Simulated Effects of EU and USA Proposals in WTO on Capesize Grain Freight Rates

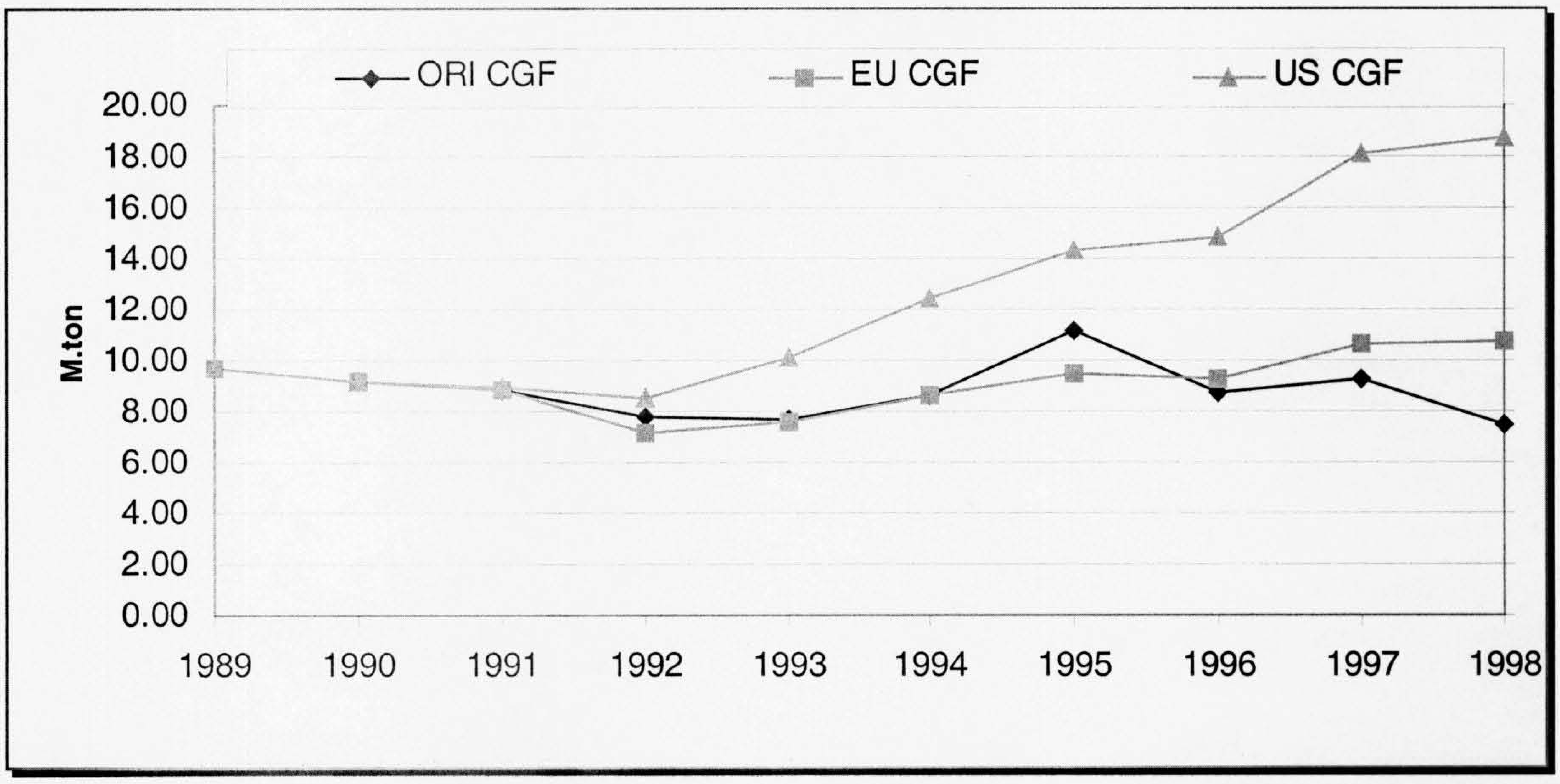
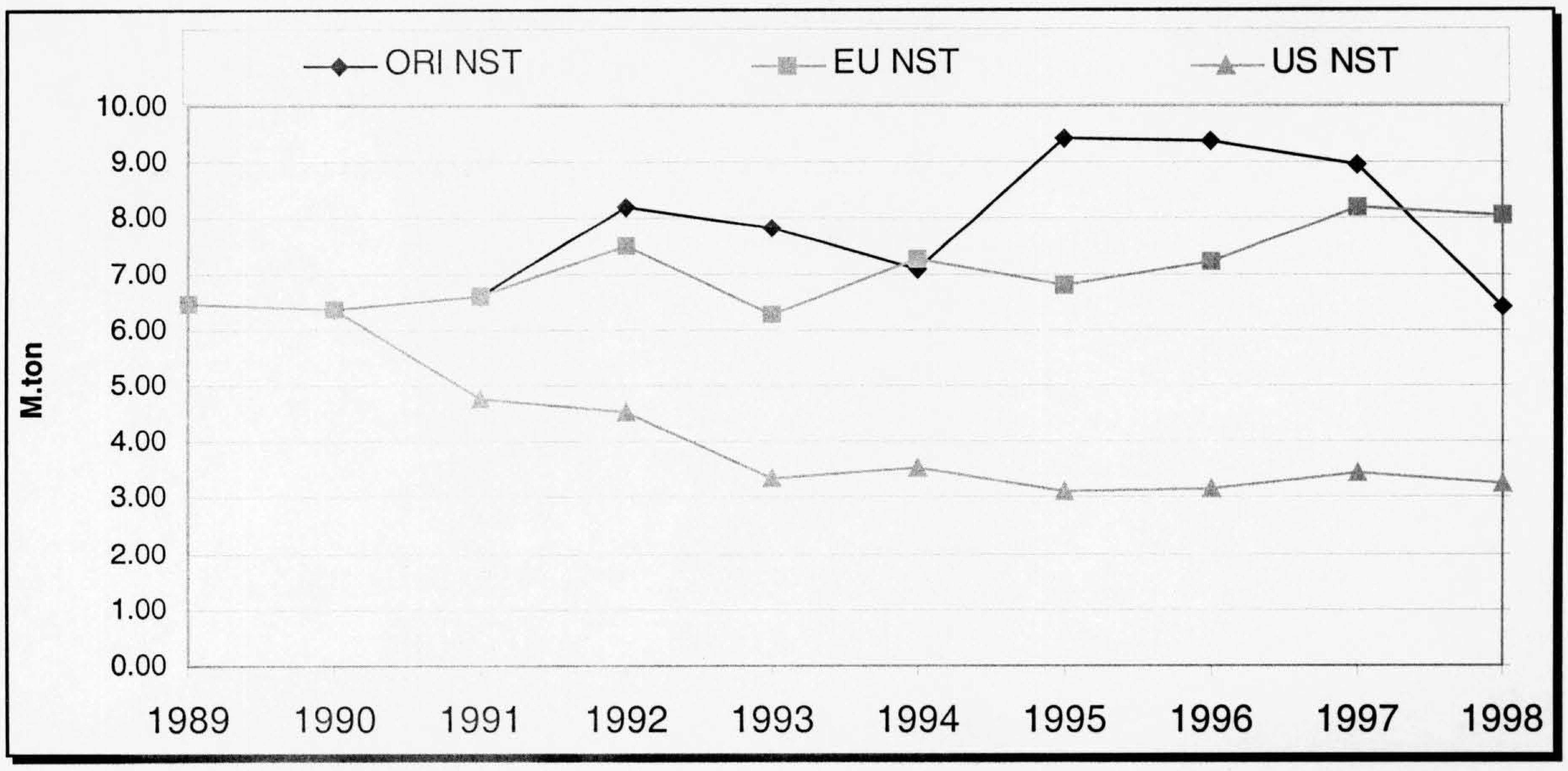


Figure 6.4: Simulated Effects of EU and USA Proposals in WTO on North Atlantic Soybean Trade



6.13 Discussion of the Simulation Results

1. The EU and USA proposals will effect the main CAP policy instrument which is the threshold price. This is the price set at the EU's frontiers and must be reached by importers to make sure that the target price can not be undercut by importers.[197] These two proposals decrease the threshold price and would bring the world price and the EU domestic price closer and thereby increasing the EU's grain imports. On the other hand, less CAP price support decreases the domestic production and may increase domestic consumption. Therefore a 10.63% (EU proposal) and 93.69%(USA proposal) increase of the EU grain import from North Atlantic are sensible.

2. The EU and USA scenarios will reduce the soybean trade in North Atlantic (EU soybean imports from the USA) by 8.59% and 56.54% respectively. The explanation is that, since there is substitutability between soybean and grain, especially in the feed grain sector. More EU grain imports will lead to less EU soybean import.[198]

3. Implementing the EU and USA proposals implies a change in "Capesize" grain freight rates of 5.6% and 50.69% respectively. This increases the revenue and thus improves the level of profitability. Improvements in profitability in the grain trade would encourage the ship-operators of this vessel size to be employed more in seaborne grain trade.[199] This may alter the changes in freight rates in longer run due to an increase in supply.

4. Comparing the original results (CAP on place) with the simulated results specifies that the implementation of any of these two proposals bring more stability to the system. It means that variation in the four endogenous variables of the system is less if the CAP is liberalised according to any of these proposals.

Variation in international grain price and trade depends upon agricultural policies. The CAP exerts a destabilising effect on world grain market.[200] When the EU, which effectively is a very large country involved in international trade, does not

[197] For more details see Chapter Four Section 4.3.
[198] For more details see Chapter 4 Section 4.8.1.
[199] For more details see Chapter 4 Section 4.8.1.
[200] For more details see Chapter 2 Section2.2.

have to adjust to world changes/shocks in demand and supply, this imbalance means the world market should fluctuate more.

Variation in grain freight market could partially be explained by a time varying volatility model used by Kavussanos (1996a).[201] However the variation in international grain market would extend to the grain freight market, because there is a close relationship between grain prices and freight rates, as considerable grain landed price is formed by freight rate.[202] Moreover as Evans and Marlow (1996) states the demand for shipping transport is a derived demand, variation in grain market could be extended to the shipping market.

Therefore it is clear that liberalisation of the CAP may reduce the international grain market and grain freight market volatility.

6.14 Conclusions

The objective of this chapter was to establish a model to measure the impact of the CAP on "Capesize" contribution to the grain trade. The four equations of the "Capesize" model have been jointly estimated in level form,[203] because simultaneity existed.[204] The results of the multivariate cointegration tests suggest that there is at most one cointegrating vector within each equation of the model. The estimated results of equations one to four indicate that the volume of grain transported by "Capesize" bulk carriers is significantly influenced by the Producer Subsidy Equivalent which is a proxy for the CAP and its distorting effects through protectionism.

Broadly, the results reveal that the "Capesize" involvement in grain is mainly in the North Atlantic route and that it depends on the EU grain imports from the USA. Therefore, the involvement of Capesize vessels in the grain trade very much depends on the level of agricultural protection in the EU.

Simulation with the model gives a clear view of the effects of changes of protection level within the EU according to the USA and the EU proposals in Uruguay Round (WTO) of negotiation on "Capesize" contribution in grain trade. The responses in these scenarios are different from each other, allowing interesting inferences to be

---

201 For more details see Chapter 2 Section 2.1.

202 For more details see Appendix 1.

203 Using Rats computer programme.

204 Hausman Specification Test has been run, and suggests the simultaneity exists. Furthermore, test for exegeneity were also implemented.

drawn from the simulation series. The results imply the model can be implemented in different situations. Both the USA and EU proposals lead to an increase in the North Atlantic grain trade and consequently more "Capesize" involvement in the grain trade. At the same time, the proposals increase the "Capesize grain freight rates in the North Atlantic and decrease the North Atlantic soybean trade in this route. However, the impact of the USA proposal is much larger than that of the EU proposal.

CHAPTER SEVEN: ECONOMETRIC MODEL, ESTIMATION, EVALUATION AND SIMULATION "HANDYSIZE" AND "PANAMAX"

7.1 Introduction

This chapter presents the models designed to evaluate the impact of the CAP on structure of demand for grain transport by "Panamax" and "Handysize" bulk carriers. The results of the models' estimation and of the simulation exercise are also discussed in the chapter. These models seek to quantify the effect of the impact of the CAP on the structure of demand for these ship sizes, through an expansion of the EU's grain exports.

The theoretical specification of the model and the econometric methodologies that were discussed in Chapter Five are used here to estimate the models. The involvement of these ship sizes in grain trade is complicated and covers many route and characteristics. This is unlike the case of the involvement of the "Capesize" in this trade and for this reason, structural modelling is not possible here.

Alternatively, the Vector Autoregression (VAR) method has been adopted. This is because all the variables in the econometric system are in continuous interaction. In order to achieve an unbiased estimate of the parameters of the VAR model and draw correct inferences from them, there is a need for all the variables of the model to be stationary, I(0). When the variables are not stationary, the Vector Error Correction Method (VECM) has been utilised by means of the cointegration relationships between variables of the model.

Both the "Handysize" and "Panamax" model are two variable (VAR) models. However as in the case of the "Capesize" model, the variables that influence the supply of these vessels in general terms are incorporated together with the other variables that influence the contribution of these size vessels in grain trade.

The hypothesis developed in Chapter Four is used in the estimation and simulation of the model of the impact of the CAP on the structure of demand for "Panamax" and "Handysize" in the grain trade.

The structure of this chapter is as follows: Section 7.2 discusses the data for the model. Section 7.3 provides and analysis of the impact of the CAP on "Handysize" and "Panamax" ship sizes. Section 7.4 outlines the models of the study while

Section 7.5 provides the results for unit root tests together with Johansen Cointegration tests. The results for the estimation of the "handysize" and "Panamax" models are discussed in Section 7.6. This is followed by impulse response analysis in Section 7.7 and simulation analysis in Section 7.8 with conclusions in the last section.

7.2 Estimation Period and Data for "Handysize" and "Panamax" Models

The estimation period for the "Handysize" and "Panamax" models is the same as "Capesize" model 1970-1998. The reasons for the choice of this estimation period were provided in Section 6.3. The data for these models are collected from the same sources as for the "Capesize" model. The data for the volume of grain transported by "Handysize" (GTH) and "Panamax" (GTP) were collected from different issues of World Bulk Trade published by Fearnleys. As in the case of the "Capesize" data, these data also include grain and soybean and are published as a percentage of total grain trade transported by these size vessels. These percentage figures are transformed to actual figures by the author.

The data for world grain price (WGP) is provided by International Grain Council (IGC). The data for rest of the world grain and soybean trades (RGS) was generated by deducting the EU grain exports from total world grain and soybean trades. The original data was obtained from the US Department of Agriculture. This data was then compared with the data from IGC.

The data for "Handysize" and "Panamax" fleet capacity (HFC) (PFC), together with data for bunker fleet capacity (BP) are provided by Clarksons Shipping Company. The data for coal freight rates (CFR) and coal seaborne trade (CST) were also obtained from Clarksons Shipping Company.

The data for Producer Subsidy Equivalent (PSET) are computed by Organisation for Economic Co-operation and Development (OECD). The mathematical model for computing this data set is presented in Chapter Two.

7.3 The Impact of the Expansion of the EU Grain Exports on "Handysize" and "Panamax" Bulk Carriers

The bulk of EU grain are exported to developing countries and there is no port and handling facilities for large ships in these countries. It was stated in sub-hypothesis two that expansion of the EU grain exports provides more demand for "Handysize" and "Panamax" ships rather than "Capesize" bulk carriers. Furthermore, the rest of the world grain and soybean trade is also mainly transported by "Handy" and "Panamax" shipsize. Therefore, the involvement of these size vessels in grain trade concerns different routes and patterns (unlike the involvement of "Capesize" in this trade which concentrates only on the North Atlantic route). Furthermore, since the shipping industry is a global industry, Veenstra (1999:134) suggests that it neutralises many local influences and limits its susceptibility to international developments only. These factors determine the nature of economic processes in shipping markets. The above consideration suggests that many variables in shipping economics processes could be considered endogenous as well as exogenous.[205]

Considering the above arguments, the formulation of a theoretical framework for the contribution of "Handysize" and "Panamax" ship sizes in grain and other dry bulk commodity trades are problematic and need a well prepared detailed trade matrices which is not available. Therefore, the use of a structural econometric model for modelling the impact of the expansion of the EU grain exports on "Handysize" and "Panamax" Bulk carriers is not possible. The specific relationships between variables could not be based (either formally or informally) on a proper economic theory which is a prerequisite for structural modelling. However, the model at least should be consistent with the general hypothesis and sub-hypothesis two.[206] Furthermore, since a dynamic relationship existed within the model, the lag structure and dynamic adjustment elements can be an important aspect of the models' specification and testing.[207]

One well known alternative methodology to structural modelling is based on the work of Smis (1980), and involves to the estimation of what are known as vector autoregressions (VARs). In Sims (1980) approach, the division between endogenous and exogenous variables is abandoned. Effectively, all variables are treated as endogenous. Additionally, no zero-restrictions are placed on the parameters of the equations in the model. Veenstra (1999) argues that as a consequence of interrelated activities in international shipping, "the economic variables in shipping are closely related, and contain, to a certain degree, similar information on the state of shipping markets, developments on international trade environment and so on". Thus it is very difficult to specify the causal relationships

---

205 For instance, developments in international crude oil market are present in a variable like the price of bunkers as well as in non-shipping variables like oil prices or crude oil consumption or production.

206 See Chapter Four for more details.

207 With multi-equation models, the leg structure of the individual equations can critically affect the behaviour of the model.

among the shipping variables. Such a phenomenon could lead to mis-specification of the model (Veenstra, 1999:134). Thus, the Vector Autoregression (VARs) method provides an appropriate means to model the impact of expansion of the EU grain exports on "Handysize" and "Panamax" Bulk carriers.[208]

The focus of this aspect of the study is to analyse the impact of the expansion of EU grain exports on the structure of demand for "Handysize" and "Panamax" bulk carriers. Hence, the models should be defined in such a manner that the role of the EU grain exports as a source of demand for these bulk carriers is highlighted among the other sources of demand (rest of the world grain and soybean trade).

7.4 Modelling The Impact of Expansion of the EU Grain Exports on "Handysize" Bulk Carriers.

Since there is almost no restriction for "Handysize" involvement in the grain trade, this size ship could contribute to all grain routes. To model the volume of grain transported by "Handysize", given the focus of this study on the impact of EU grain expansion the model is defined as follows:

$$GTH = f(\overset{+}{EGE}, \overset{-}{GFR_H}, \overset{+}{RGS}) \qquad (7.1)$$

where
(GTH) is volume of grain transported by "Handysize
(EGE) is the EU Grain Export
(GFR_H) is grain freight rate for "Handysize"
(RGS) is rest of the world Grain and Soybean Trade.

To evaluate the impact of the *(EGE)* on the structure of demand for "Handysize", there is a need to specify the variables which could influence this variable. This study considered these variables as grain freight rates for "Handysize" *(GFR_H)*, the EU excess supply *(EES)*, Rest of the world Excess demand for EU Grain Export *(RED)*. Therefore, the equation is defined as follows:

$$EGE = f(\overset{-}{GFR_H}, \overset{+}{EES}, \overset{+}{RED}) \qquad (7.3)$$

where D is domestic supplies, D_p and D_{p^t} are first derivatives of the dependent variable with respect to the subscripted variable.

$$D = D(P, P^t), \text{ with } D_p < 0,\ D_{p^t} > 0 \qquad (7.4)$$

208 See Chapter Five for more details.

The excess demand *(RED)* in the rest of the world for EU grain is given by:

$RED = RED(P_w)$, *with* $(RED)\ P_w < 0$ (7.5)

where P_w is the world grain price. The EU excess supply of grain (to domestic market and world demands) is represented by:

$EES = EES(P)$, *with* $EES_p > 0$ (7.6)

where EES is the excess supply function for the EU grain and is domestic production net demand which includes food and feed, inventory (public and private) and residual uses. The relationship between domestic and the world prices is given by:

$P = P^w + S$ (7.7)

where S is normally greater than zero and represents the variable per unit export restitution payment. The important threshold price is related to the world price by a variable per unit imports levy t:

$P^t = P^w + t$ (7.8)

where $t > s$ is the normal situation, thus implying that

$P^t \geq P$ (7.9)

By definition, exports *(E)* from the EU are

$E = EES - D$ (7.10)

clearing prices on the world market are determined by equating the EU's grain exports to world demand:

$EES - D = RED$ (7.11)

It is envisaged that a single price (world price) can adequately represent the same information that could be provided by different variables. Therefore, the international grain price has been entered into the models to replace equation (7.1).

The grain freight rate for "Handysize" is an important variable which could be influenced by other variables such as the volume of grain transported by this size ship *(GTH)*, Grain Freight Index *(GFI)*[209] and grain freight rates in the previous period *(GFR_H)*. Therefore, the third equation in the system could be defined as follows:

$$GFR_H = f(GTH, GFI, GFR_H^{t-1}) \qquad (7.12)$$

(GFI) has been defined in equation 6.4. For convenience it is reproduced here.

$$GFI = f(\overset{-}{CBF}, \overset{+}{TGT}, \overset{-}{BP}) \qquad (7.13)$$

where

(CBF) is Existing bulk carriers fleet

(TGT) is Total world Grain Trade and

(BP) is bunker price.

Another variable which could influence the freight rate for specific ship sizes in particular routes and commodity trades could be the demand in this route generated by the commodity trade (considering the port and route restrictions for specific ship sizes).

7.4.1 Modelling the Impact of the EU Grain Export on "Panamax" Bulk Carriers

The volume of demand generated by international grain trade for "Panamax" vessels could by influenced by the same factors which have been considered for "Handysize" bulk carriers. However, on the supply side there are additional factors involved.

As mentioned in Chapter Three, there are port and route restrictions which affect "Panamax" vessels' contribution to the seaborne grain trade. Moreover, as discussed in Chapter Three. "Panamax" bulk carriers are more favourable for carrying coal than grain.

A similar model could be devised for the "Panamax" sub-market. However, since the main commodity trade for "Panamax" is coal, its freight rate and volume of trade may influence the contribution of this ship size to the grain trade. Therefore, these variables have been added to the "Panamax" model which also takes into account the freight rates and fleet capacity of this ship size.

---

209 The determinants of GFI have been explain in Chapter Six Section 6.5.

7.5 Stationarity of the Series

The Augmented Dickey-Fuller unit root test (ADF) explained in Chapter Five, is performed on logarithmic levels and logarithmic first differences of the variables of the models in order to determine the order of integration of the series. The results of the ADF tests on the variable of the "Handysize" and "Panamax" models are presented in Table 7.1 The most general form of the ADF test which is indicated by the formula above the table is estimated and the number of lagged dependent variables in each test is then adjusted to remove any residual autocorrelation detected by LM test. Moreover, the sequential method that outlined in Chapter Five is followed until the best model for the ADF test is determined. The ADF unit root test results support the hypothesis that the log level of the series are integrated of first order I(1). Therefore, it can be concluded that the log levels of the variables of the models are not stationary, while first differences are stationary.

Table 7.1: ADF Unit Root Tests For All the Series of the Models in Logarithmic Form

$$\Delta lnX_t = \alpha_0 + \alpha_1 lnX_{t-1} + \sum_{i=1}^{n} \delta j \Delta lnX_{t-j}$$

Panel (A) Handysize Model						
Variables	LGTH	LPSET	LWGP	LBP	LRGS	LHFC
Levels	-2.72	-2.73	-2.68	-2.43	-2.88	-4.34
1^{st} diffs.	-4.14	-5.67	-4.41	-5.49	-6.48	------
Panel (B) Panamax Model						
Variables	LGTP	LPGF	LCST	LPFC	LCFR	
Levels	-1.38	-1.75	-1.89	-1.36	-2.92	
1^{st} diffs.	-6.16	-3.64	-4.63	-3.09	-5.18	

1%, 5% and 10% critical values for ADF test are -3.70, -2.97 and -2.62, respectively.
The lag length for ADF test is chosen in order to minimise the SIBC.
All tests include a constant as indicated by SIBC and the t test.
LPSET, LWGP and LBP are also Used in Panamax model.

7.5.1 Johansen Cointegration Tests

Johansen's (1988) cointegration method is implemented here to eliminate the existence of a long-run cointegrating relationship between the variables of the models, because the unit root tests show that the series are not stationary. The cointegration tests reject the null hypothesis that there is no cointegrating vector, against the alternative of there being one cointegrating vector. Results are presented in Table 7.2. Once the existence of the long-run relationship is estimated, the restrictions (VECM) are imposed on the cointegration vector to test the models of the study.

<u>**Table 7.2: Johansen Cointegration Test**</u>

Panel (A) Handysize Model

$$\Delta LGTH_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1,i} \Delta LGTH_{t-i} + \sum_{i=1}^{n} \alpha_{2,i} \Delta LHGF_{t-i} + \gamma_1 (LGTH_{t-1} + \beta_0 + \beta LPHGF_{t-1})$$
$$+ \delta_{1,1} LPSET_t + \delta_{1,2} LWGP_t + \delta_{1,3} LBP_t + \delta_{1,4} LRGS_t + \delta_{1,5} LHFC_t + \varepsilon_{1,t}$$

$$\Delta LPGF_t = \varphi_0 + \sum_{i=1}^{n} \varphi_{1,i} \Delta LGTH_{t-i} + \sum_{i=1}^{n} \varphi_{2,i} \Delta LHGF_{t-i} + \gamma_2 (LGTH_{t-1} + \beta_0 + \beta LHGF_{t-1})$$
$$+ \delta_{2,1} LPSET_t + \delta_{2,2} LWGP_t + \delta_{2,3} LBP_t + \delta_{2,4} LRGS_t + \delta_{2,5} LHFC_t + \varepsilon_{2,t}$$

Eigenvalue	Likelihood Ratio	5% Critical value	Hypothesized No. of CE(s)	Normalized Cointegrating Coefficients		
0.66	27.89	15.41	None*	LGTH	LHGF	C
0.02	0.50	3.76	At most 1*	1.00	33.68	-98.33

Panel (B) Panamax Model

$$\Delta LGTP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1,i} \Delta LGTP_{t-i} + \sum_{i=1}^{n} \alpha_{2,i} \Delta LPGF_{t-i} + \gamma_1 (LGTP_{t-1} + \beta_0 + \beta LPGF_{t-1})$$
$$+ \delta_{1,1} LPSET_t + \delta_{1,2} LWGP_t + \delta_{1,3} LBP_t + \delta_{1,4} LRGS_t + \delta_{1,5} LPFC_t + \delta LCST_t + \varepsilon_{1,t}$$

$$\Delta LPGF_t = \varphi_0 + \sum_{i=1}^{n} \varphi_{1,i} \Delta LGTP_{t-i} + \sum_{i=1}^{k} \varphi_{2,i} \Delta LPGF_{t-i} + \gamma_2 (LGTP_{t-1} + \beta_0 + \beta LPGF_{t-1})$$
$$+ \delta_{2,1} LPSET_t + \delta_{2,2} LWGP_t + \delta_{2,3} LBP_t + \delta_{2,4} LRGS_t + \delta_{2,5} LPFC_t + \delta_{2,7} LCST_t + \varepsilon_{2,t}$$

Eigenvalue	Likelihood Ratio	5% Critical value	Hypothesized No. of CE(s)	Normalized Cointegrating		
0.85	67.41	15.41	None*	LGTH	LHGF	C
0.477	16.86	3.76	At most 1*	1.00	-.074	-15.34

Johansen's reduced rank cointegrating tests for each equation are estimated using a model with a model with a constant in the cointegrating vector and no trend as selected by SBIC, calculated through $CSBIC = T\log(\Sigma) + v\log(T)$, where T, Σ and v are the number of observations, the determinant of the variance-covariance matrix of the residuals and the number of the parameters respectively.

* Indicates rejection of the null hypothesis at the 95% significance level.

7.6 Econometric Estimations

The Vector Autoregression (VAR) method is used for estimating the impact of the expansion of the EU grain trade on the "Handysize" and "Panamax" market sub-sector. This is a two variable system in which every equation has the same right hand variables and these variables include lagged values of the endogenous variables (left hand side). The principles of the VARs model were discussed in Chapter Five Section 5.4.

VARs have proved to be successful for analysing the dynamic impact of different types of random disturbances and policy measures on system of variables. VARs models allow for specifying flexible lag structures on the endogenous variables. It may include any number of lag intervals, each intervals with pair of numbers.

To model the "Handysize and "Panamax" Market sub-sectors a restricted VAR model has been used. A Vector Error Correction Model (VECM) is a restricted VAR with the smallest number of parameters, it is a VAR strictly in first difference. The VECM specification restricts the long-run behaviour of the endogenous variables to specify their cointegrating relationships. Moreover it allows for short – run dynamics.

The VECM specification and structure are given in Chapter Five. The general VECM of equation 5.24 is estimated for "Handysize" and "Panamax" subsectors as follows:

Handysize Model

$$\Delta LGTH_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1,i} \Delta LGTH_{t-i} + \sum_{i=1}^{n} \alpha_{2,i} \Delta LHGF_{t-i} + \gamma_1 (LGTH_{t-1} + \beta_0 + \beta LHGF_{t-1})$$
$$+ \delta_{1,1} LPSET_t + \delta_{1,2} LWGP_t + \delta_{1,3} LBP_t + \delta_{1,4} LRGS_t + \delta_{1,5} LHFC_t + \varepsilon_{1,t}$$

$$\Delta LHGF_t = \varphi_0 + \sum_{i=1}^{n} \varphi_{1,i} \Delta LGTH_{t-i} + \sum_{i=1}^{n} \varphi_{2,i} \Delta LHGF_{t-i} + \gamma_2 (LGTH_{t-1} + \beta_0 + \beta LHGF_{t-1})$$
$$+ \delta_{2,1} LPSET_t + \delta_{2,2} LWGP_t + \delta_{2,3} LBP_t + \delta_{2,4} LRGS_t + \delta_{2,5} LHFC_t + \varepsilon_{2,t}$$

Panamax Model

$$\Delta LGTP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1,i} \Delta LGTP_{t-i} + \sum_{i=1}^{n} \alpha_{2,i} \Delta LPGF_{t-i} + \gamma_1 (LGTP_{t-1} + \beta_0 + \beta LPGF_{t-1})$$
$$+ \delta_{1,1} LPSET_t + \delta_{1,2} LWGP_t + \delta_{1,3} LBP_t + \delta_{1,4} LRGS_t + \delta_{1,5} LHFC_t + \delta_{1,6} LCST_t + \varepsilon_{1,t}$$

$$\Delta LPGF_t = \varphi_0 + \sum_{i=1}^{n} \varphi_{1,i} \Delta LGTP_{t-i} + \sum_{i=1}^{n} \varphi_{2,i} \Delta LPGF_{t-i} + \gamma_2 (LGTP_{t-1} + \beta_0 + \beta LPGF_{t-1})$$
$$+ \delta_{2,1} LPSET_t + \delta_{2,2} LWGP_t + \delta_{2,3} LBP_t + \delta_{2,4} LRGS_t + \delta_{2,5} LPFC_t + \delta_{2,6} LCST_t + \varepsilon_{2,t}$$

where:

EGC	EU Grain Production	HGF	Handysize Grain Freight Rate
EGP	EU Grain Consumption	NGT	North Atlantic Grain Trade
ESC	EU Soybean Consumption	NST	North Atlantic Soybean Trade
ESP	EU Soybean Production	PFC	Panamax Fleet Capacity
GFI	Grain Freight Index	PGF	Panamax Grain Freight Rate
GTH	Grain Transported by Handysize	PSET	Producers Subsidy Equivalent
GTP	Grain Transported by Panamax	RGS	Rest of the World Grain and soybean Trade
HFC	Handy Fleet Capacity		

Using GMM, while standard error of the estimated parameters are corrected for serial correlation and/or heteroscadastisity using the newly-west (1987) method. The lag length is selected using SBIC.

As outlined in Chapter Five Sections 5.5 the Johansen test procedure is implemented to compute the likelihood ratio statistic for each added equation. Diagnostic tests for residual autocorrelation, heteroscedasticity, ARCH and normality for each short-run equation were carried out. Ljung-Box test statistics for 6^{th} order residual autocorrelation do not reject the null hypothesis of no auto-correlation at the 5% significant level in both models (Panamax and Handysize). In equations with significant ARCH effects it is envisaged that these are stationary. Hence unconditional variance of residuals are constant, therefore, OLS and SURE estimation methods would revealed the BLUE estimator (Greene, 1997:570). Heteroscedasticity tests illustrate that there is no heteroscedasticity in any of the short-run models.

The estimate of the VECM model for Handysize and Panamax size dry bulk carriers are shown in Table 7. Coefficient γ_1, γ_2 in the short run model indicate the speed at which the independent variable will move in the next period to restore the long-run equilibrium relationship. For instance, in the Handysize model the negative and significant coefficient indicates that when the long-run relationship between the *(GTH)* and *(HGF)* increases, the *(GTH)* decrease in next period.

Most of the independent variables in both Handysize and Panamax models significantly influence the system. However, the significant coefficient of *(PSET)* δ_1 in the first equation of both models means CAP protection measures significantly and positively influence the volume of grain transported by Handysize and Panamax.

Table 7.3a: Handysize Model

$$\Delta LGTH_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1,i} \Delta LGTH_{t-i} + \sum_{i=1}^{n} \alpha_{2,i} \Delta LHGF_{t-i} + \gamma_1 (LGTH_{t-1} + \beta_0 + \beta LHGF_{t-1})$$
$$+ \delta_{1,1} LPSET_t + \delta_{1,2} LWGP_t + \delta_{1,3} LBP_t + \delta_{1,4} LRGS_t + \delta_{1,5} LHFC_t + \varepsilon_{1,t}$$

$$\Delta LHGF_t = \varphi_0 + \sum_{i=1}^{n} \varphi_{1,i} \Delta LGTH_{t-i} + \sum_{i=1}^{n} \varphi_{2,i} \Delta LHGF_{t-i} + \gamma_2 (LGTH_{t-1} + \beta_0 + \beta LHGF_{t-1})$$
$$+ \delta_{2,1} LPSET_t + \delta_{2,2} LWGP_t + \delta_{2,3} LBP_t + \delta_{2,4} LRGS_t + \delta_{2,5} LHFC_t + \varepsilon_{2,t}$$

Coeff.	Coeff.	$\Delta LGTH$	$\Delta LHGF$
α_0	φ_0	16.033 [1.877] (8.540)	32.286 [-3.597] (8.974)
$\alpha_{1,i}$	$\varphi_{1,i}$	.0958 [4.130] (.0023)	-0.023 [-1.970] (.0143)
$\alpha_{2,i}$	$\varphi_{2,i}$	-0.130 [-0.741] (2.947)	0.5469 [2.947] (0.185)
γ_1	γ_2	-0.001 [-0.141] (0.009)	-0.0487 [-4.968] (0.048)
β_0		98.334	98.334
β		33.684 [0.153] (219.417)	33.684 [0.153] (219.417)
$\delta_{1,1}$	$\delta_{2,1}$	0.035 [1.982] (0.027)	-0.077 [-2.714] (0.028)
$\delta_{1,2}$	$\delta_{2,2}$	0.512 [1.404] (0.365)	0.728 [1.898] (0.383)
$\delta_{1,3}$	$\delta_{2,3}$	-0.0946 [-0.709] (0.133)	-0.148 [-1.005] (0.140)
$\delta_{1,4}$	$\delta_{2,4}$	1.011 [1.963] (0.023)	0.604 [1.832] (0.232)
$\delta_{1,5}$	$\delta_{2,5}$	-0.978 [-0.123] (0.0124)	-0.930 [-2.120] (0.0458)
R squared		0.73	0.88
R-bar squared		0.54	0.81
D.W		1.83	2.21
S.E		0.1.8	0.44
Skew		0.38 [0.31]	-0.41 [0.30]
Kurt		-0.50 [0.64]	-0.20 [0.95]
J.B		1.21 [0.54]	1.17 [0.50]
ARCH		1.81 [0.47]	2.83 [0.06]
B.L (Q_1)		2.43 [0.10]	0.41 [0.55]
B.L (Q_6)		13.4 [0.03]	2.3 [0.77]

Table 7.3b: Panamax Model

$$\Delta LGTP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1,i} \Delta LGTP_{t-i} + \sum_{i=1}^{n} \alpha_{2,i} \Delta LPGF_{t-i} + \gamma_1 (LGTP_{t-1} + \beta_0 + \beta LPGF_{t-1})$$
$$+ \delta_{1,1} LPSET_t + \delta_{1,2} LWGP_t + \delta_{1,3} LBP_t + \delta_{1,4} LRGS_t + \delta_{1,5} LPFC_t + \delta_{1,6} LCST_t + \varepsilon_{1,t}$$

$$\Delta LPGF_t = \varphi_0 + \sum_{i=1}^{n} \varphi_{1,i} \Delta LGTP_{t-i} + \sum_{i=1}^{n} \varphi_{2,i} \Delta LPGF_{t-i} + \gamma_2 (LGTP_{t-1} + \beta_0 + \beta LPGF_{t-1})$$
$$+ \delta_{2,1} LPSET_t + \delta_{2,2} LWGP_t + \delta_{2,3} LBP_t + \delta_{2,4} LRGS_t + \delta_{2,5} LPFC_t + \delta_{2,6} LCST_t + \varepsilon_{2,t}$$

Coeff.	**Coeff.**	$\Delta LGTP$	$\Delta LPGF$
α_0	φ_0	9.001 [1.474] (6.106)	-15.169 [-1.984] (7.644)
$\alpha_{1,i}$	$\varphi_{1,i}$	-0.059 [-0.335] (0.176)	-0.966 [-4.377] (0.220)
$\alpha_{2,i}$	$\varphi_{2,i}$	-0.052 [-0.443] (0.117)	0.072 [0.492] (0.147)
γ_1	γ_2	-0.476 [-2.770] (0.172)	1.296 [6.016] (0.215)
β_0		-0.744 [-4.853] (0.153)	-0.744 [-4.853] (0.153)
β		-15.345	-15.345
$\delta_{1,1}$	$\delta_{2,1}$	0.014 [1.965] (0.025)	0.038 [1.205] (0.032)
$\delta_{1,2}$	$\delta_{2,2}$	0.071 [0.240] (0.297)	0.312 [0.838] (0.372)
$\delta_{1,3}$	$\delta_{2,3}$	-0.031 [-0.208] (0.152)	0.118 [2.623] (0.019)
$\delta_{1,4}$	$\delta_{2,4}$	-0.473 [-1.397] (0.339)	0.604 [1.423] (0.424)
$\delta_{1,5}$	$\delta_{2,5}$	0.825 [1.811] (0.455)	-2.567 [-4.502] (0.570)
$\delta_{1,6}$	$\delta_{2,6}$	-0.739 [-1.439] (0.513)	2.360 [3.670] (0.643)
R squared		0.63	0.85
R-bar squared		0.42	0.76
D.W		1.92	2.11
S.E		0.14	0.18
Skew		0.42 [0.38]	-0.51 [0.28]
Kurt		-0.50 [0.58]	-0.17 [0.81]
J.B		1.57 [0.32]	1.28 [0.53]
ARCH		1.19 [0.44]	2.95 [0.02]
B.L (Q_1)		2.32 [0.18]	0.48 [0.57]
B.L (Q_6)		13.4 [0.05]	3.1 [2.25]

Skew and Kurt are the estimated centralised third and fourth moment of the data, denoted $\hat{\alpha}_3$ and $(\hat{\alpha}_4 - 3)$ respectively; their asymptotic distribution under the null are $\sqrt{T}\hat{\alpha}_3 \sim N(0,6)$ and $\sqrt{T}(\hat{\alpha}_4 - 3) \sim N(0,24)$.

The figure in (.) and [.] are t-statistics and probability values, respectively.

BL (Q_1) and (Q_6) is the Box-Ljung statistic for 1st and 6th order serial correlation in the residuals, the 5% critical values for these tests are 3.51 and 6.43, respectively.

ARCH is the F test for 6th order autoregressive conditional heteroscedasticity. The 5% critical values for this test is 1.43.

J-B is the Jarque-Bera (1980) test for normality. The 5% critical values for this test is $\chi^2(2) = 5.44$.

The standard errors are corrected for serial correlation and /or heteroscedasticity using the Newey-West method.

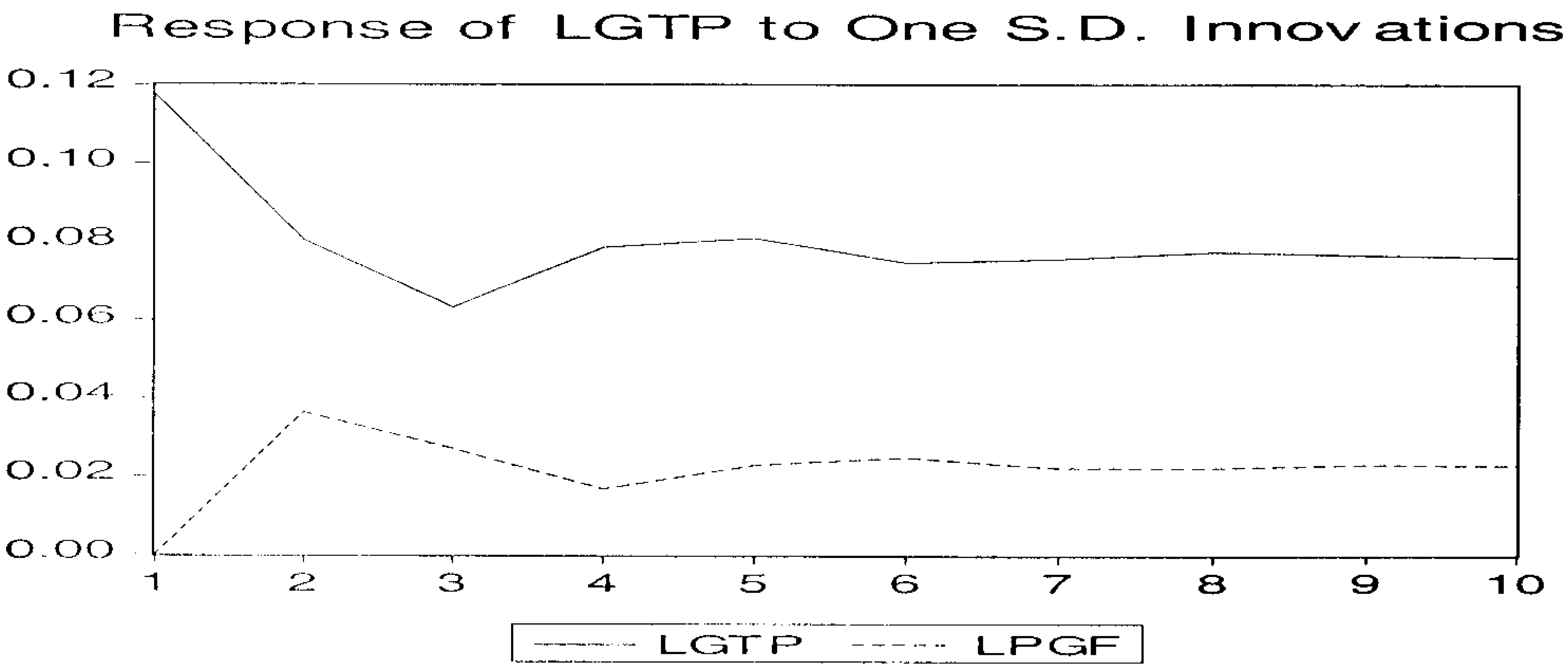
7.7 Impulse Response Analysis

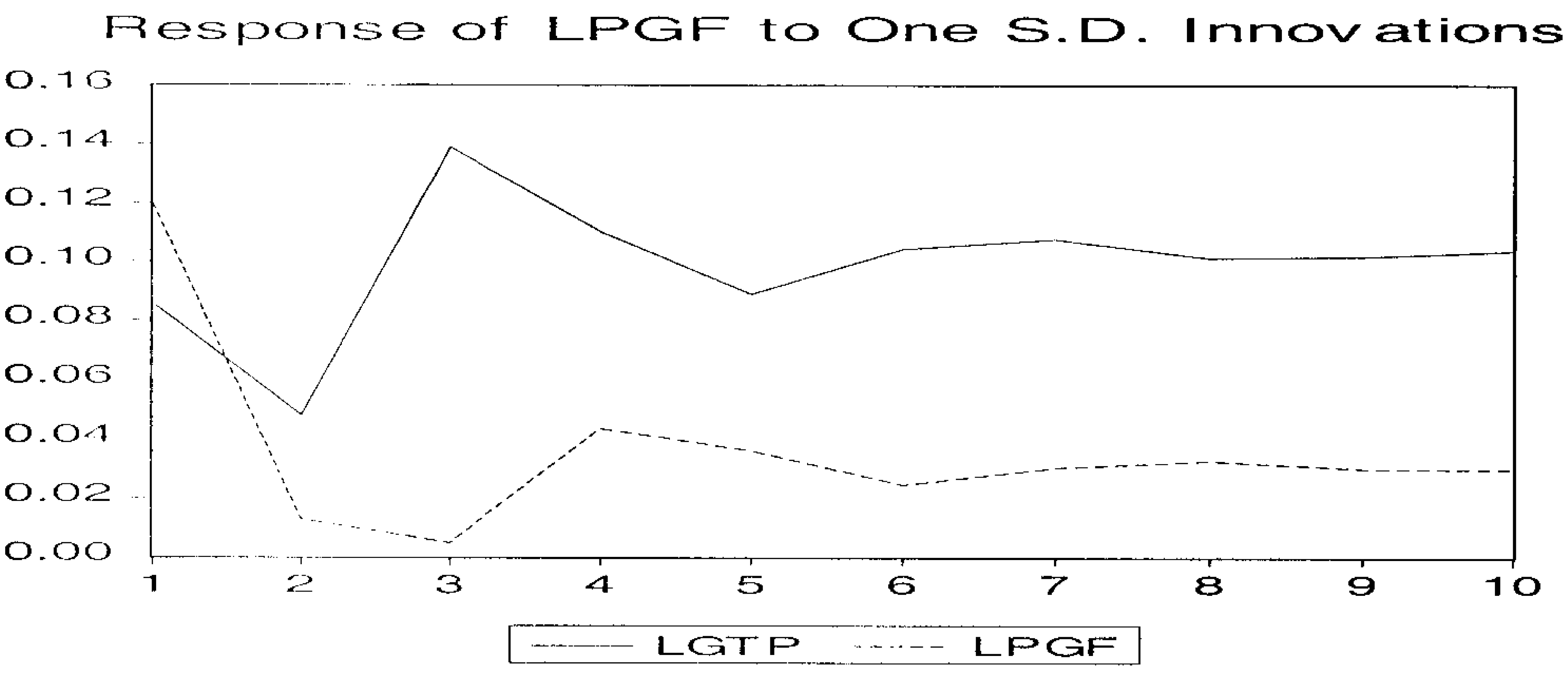
Figures 7.1 to 7.4 plots the results for General Impulse Response analysis (GIRs) based on the estimated VECM for the "Handysize" and "Panamax" subsectors to a shock, with a magnitude of one standard error. It illustrates that in the Handysize model, grain transported by Handysize (GTH) increases initially and then settles permanently at the previous level. This is also the same for Grain Freight rates (GFT).

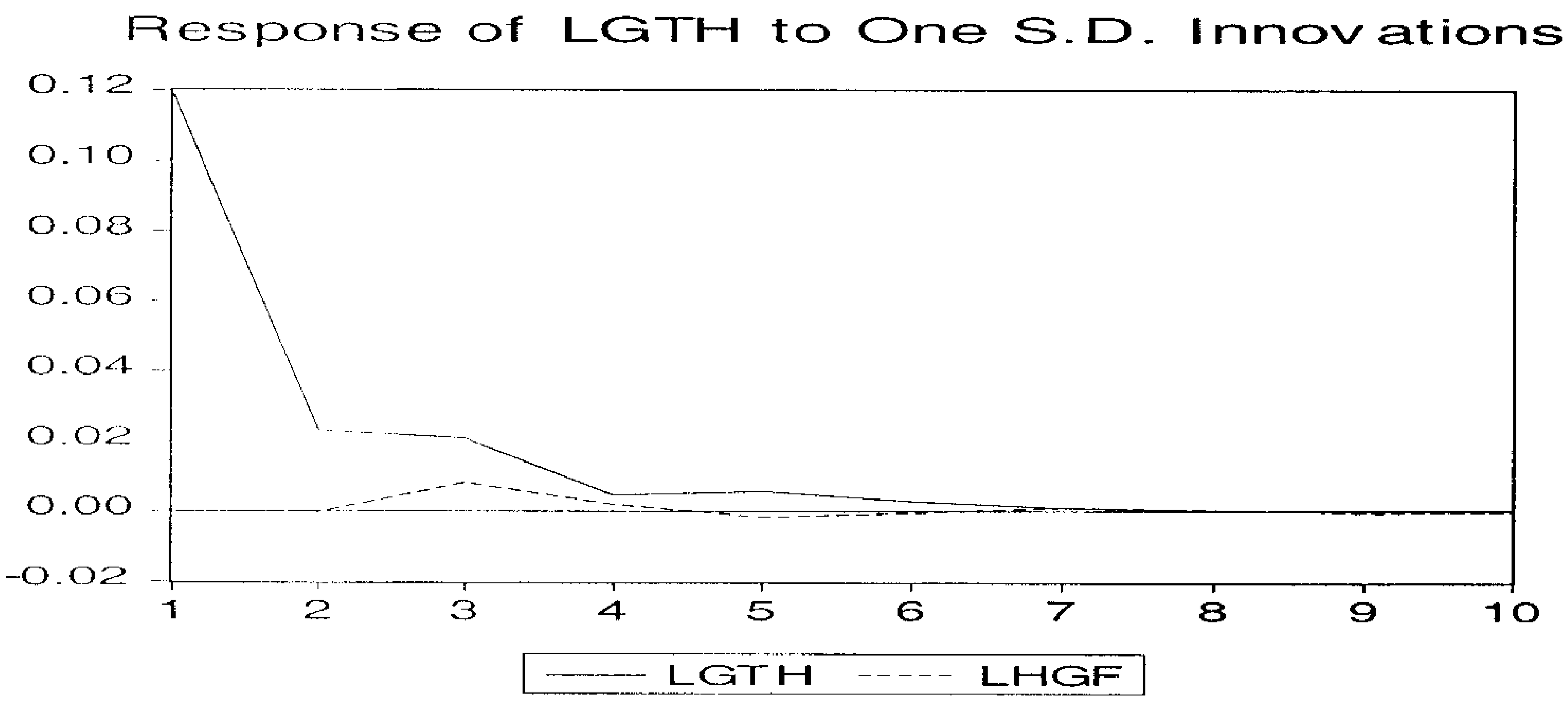
This can be explained, firstly by the fact that the variables are non-stationary and retain the shock for a long period (see Chapter Five). Secondly, the existence of long-run relationships between the variables and that the effects of shocks to one variable can be transmitted through the system. That means, once the system is in disequilibrium due to a shock to one variable, other variables respond by adjusting to the new level to restore long-run equilibrium relationship.

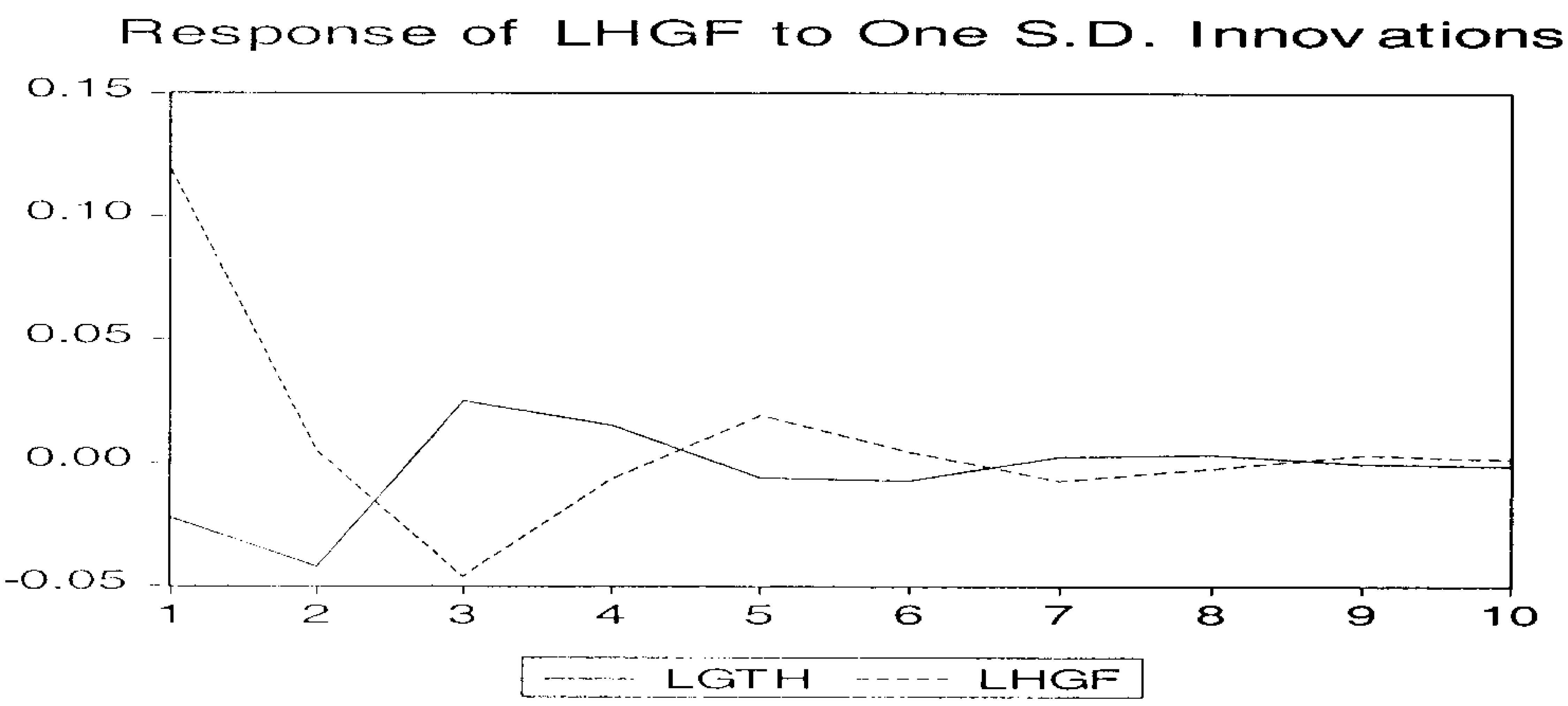
Furthermore, the figures for Handysize indicates the GIR of the two identified cointegrated vectors to a shock with magnitude of one standard error. The response of cointegrating vectors to shocks in Handysize model are negative and of a smaller magnitude than Panamax. The Panamax model is identical to the Handysize except for the fact that the response of cointegrating vectors to shocks are more significant for "Panamax" model. This means the system will respond to disequilibrium more promptly and efficiently.

Figure 7.1 - 7.4: Response of LGTP, LPGF, LGTH & LHGF to One S.D. Innovation





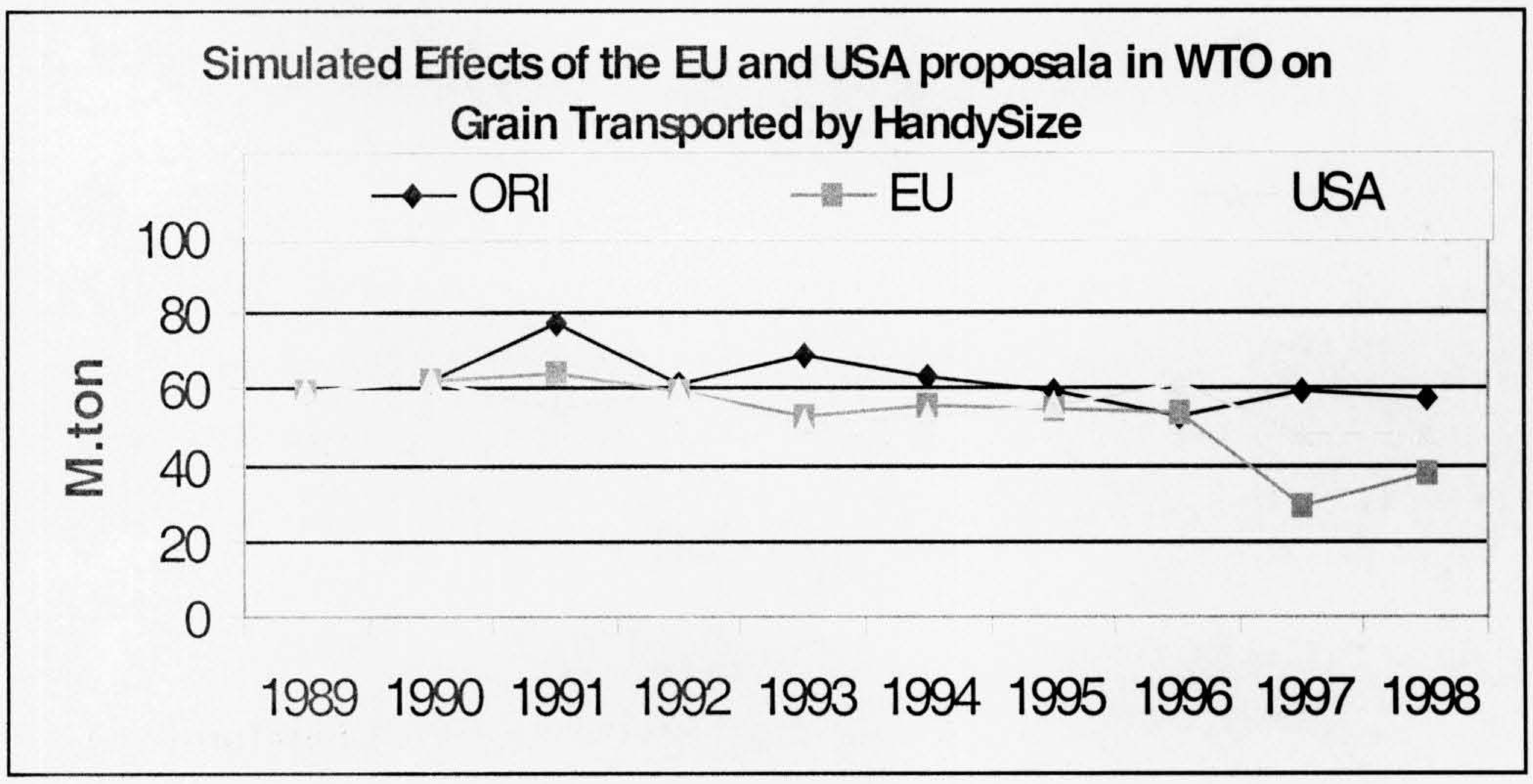




7.8 Simulation Analysis

This section investigates the possible impact of the EU and the USA proposals for partial liberalisation of agricultural support on the world grain market in Uruguay Round (WTO) of negotiation on "Panamax" and "Handysize" contribution in grain trade. The econometric models estimated in the previous section have been used for simulation analysis here. Therefore, similar quantitative results are expected. The assumptions of how the system responds to different policy measures are the same as Section 6.12 where simulation analysis is presented for "Capesize" vessels. These assumptions provide a basis for comparison of the simulation results with the econometric results.

Figure 7.5 & 7.6: Simulated Effects of the EU and USA Proposals in WTO on Grain Transported by Handysize, and on HandySize Grain Freight Rates



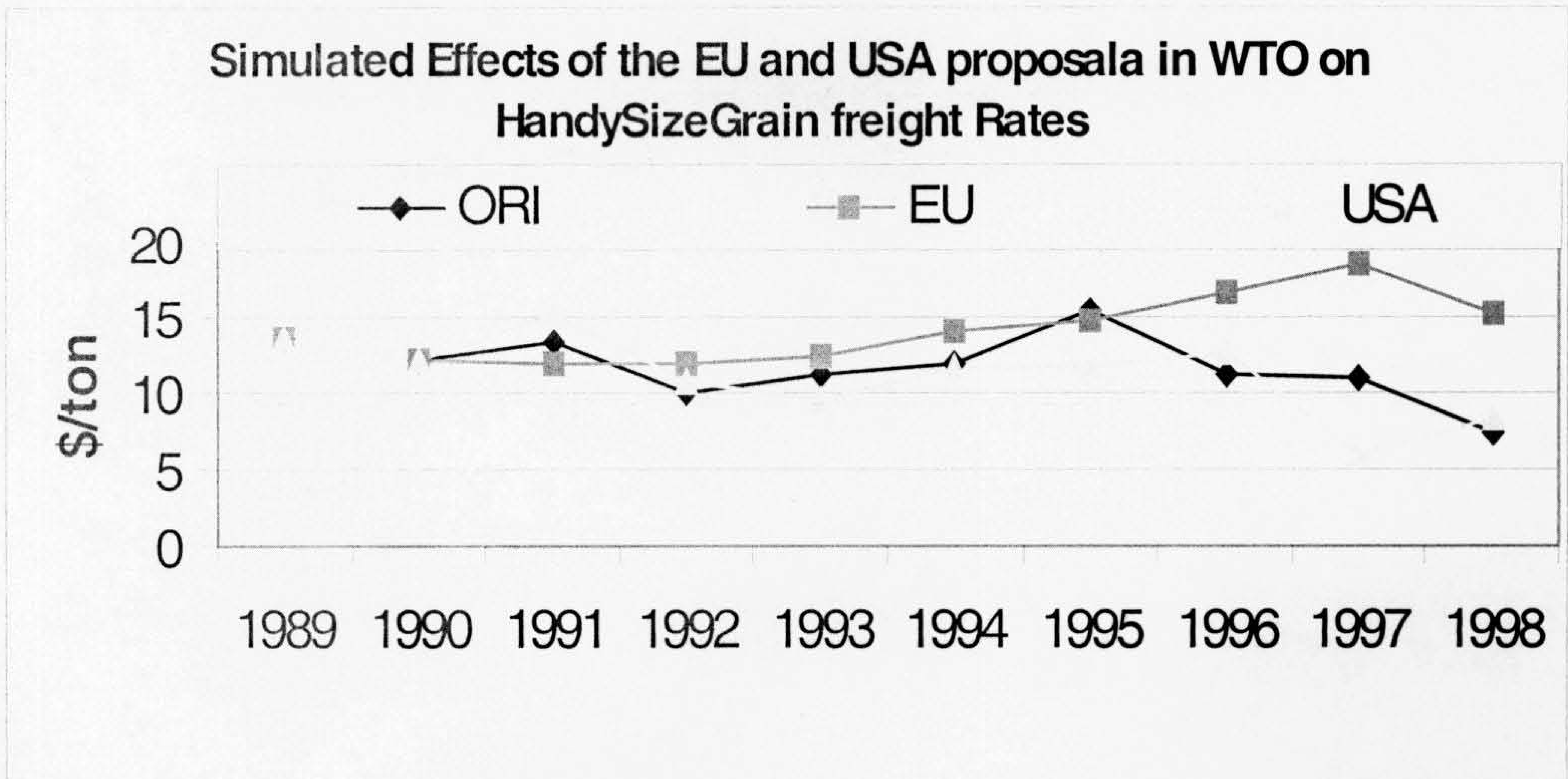
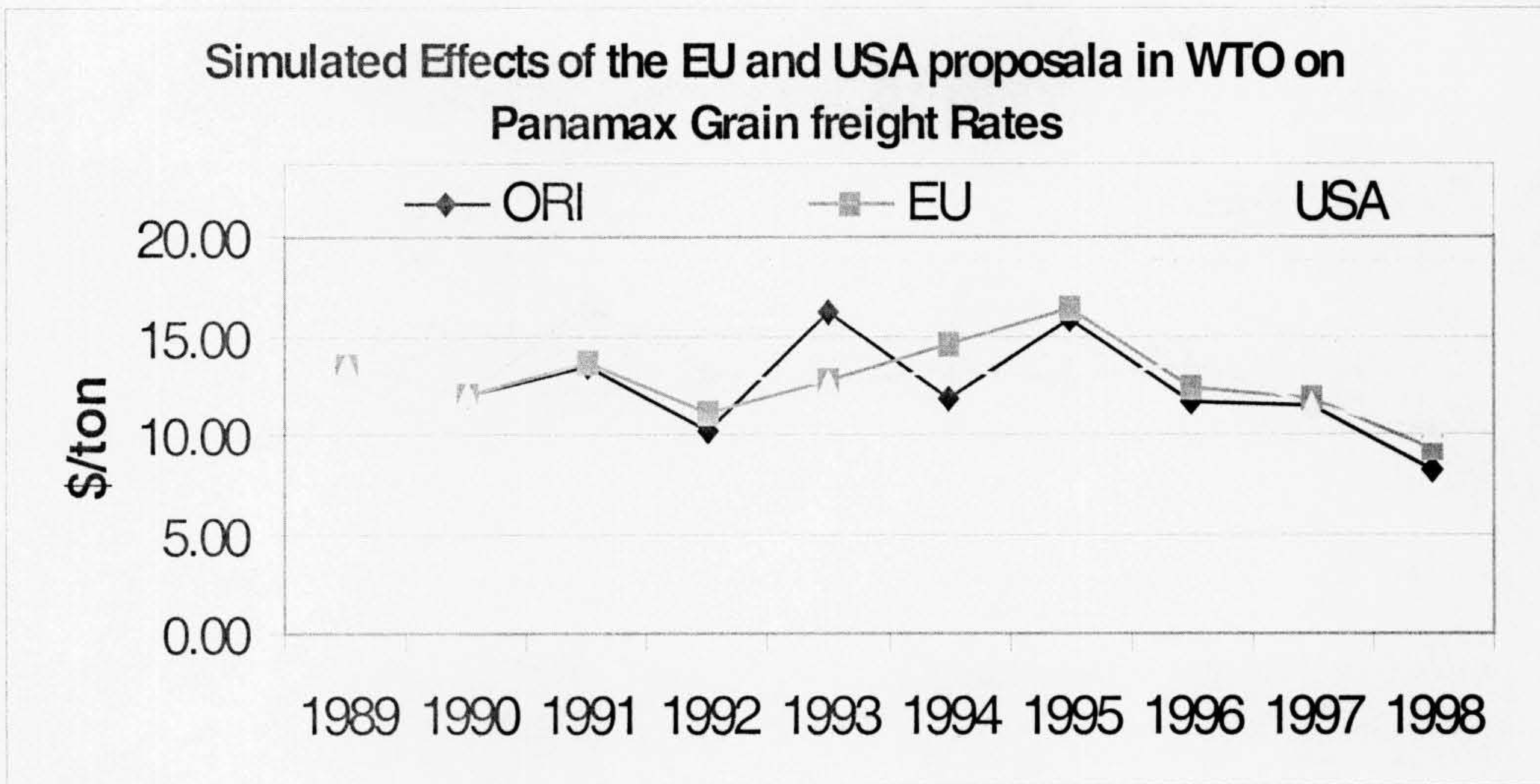
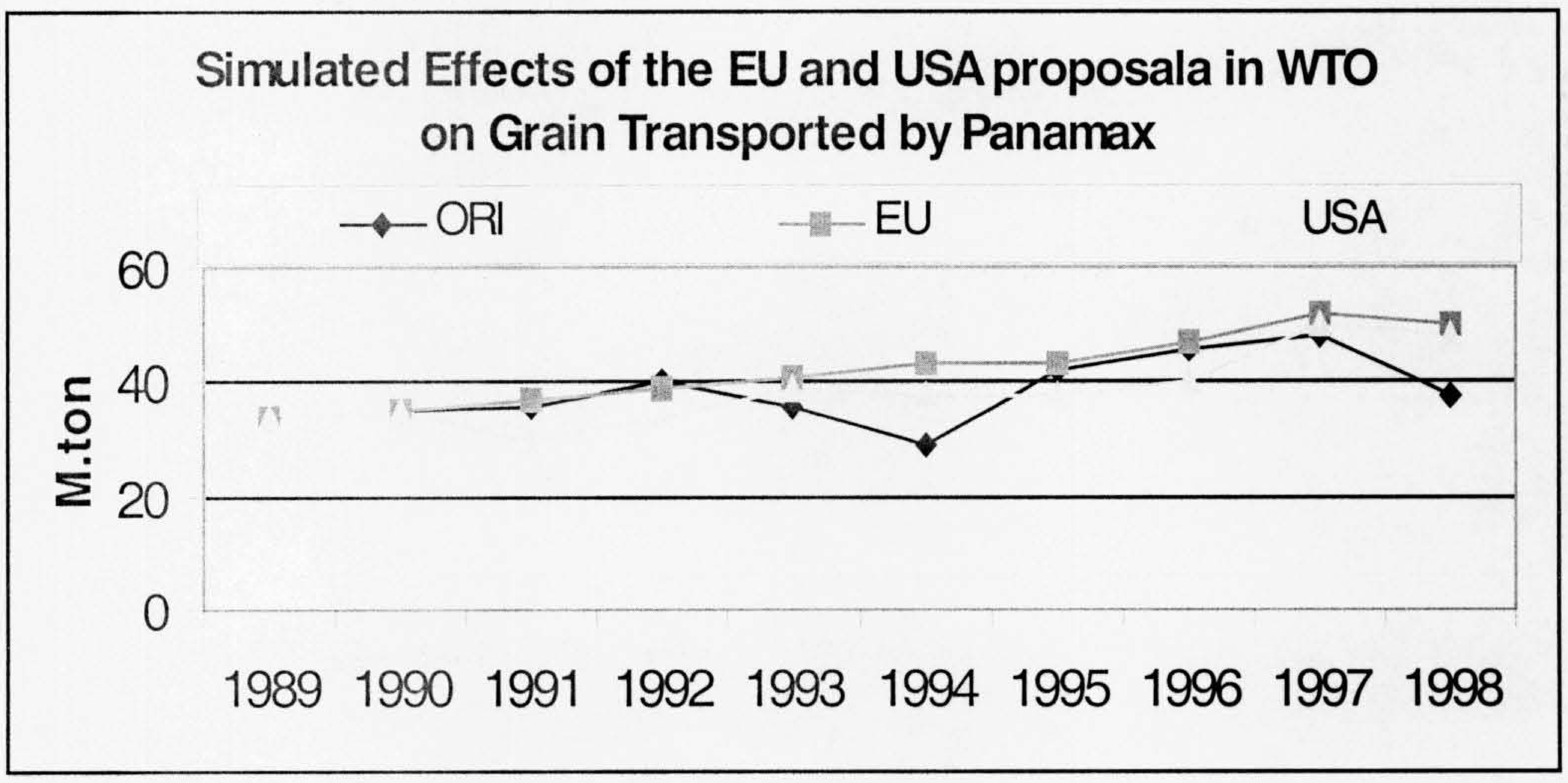


Figure 7.7 & 7.8: Simulated Effects of the EU and USA Proposals in WTO on Panamax Grain Freight Rates, and on Grain Transported by Panamax





7.9 Discussion

The EU and USA proposals as mentioned in Chapter Four will reduce both the main CAP policy instrument (threshold price)[210] as well as the export subsidy of the EU. This will affect domestic production and exports.

A comparison of the original results with the simulated results indicates that in the case of "Handysize" the US and the EU proposals will not change the volume of

210 See Chapter Four, Section 4.3 for further details.

grain trade dramatically. It means the volume of grain transported by Handysize will fluctuate around 60 M.tons per year as it did in the original case.

The Handysize grain freight rates also will not change dramatically as a result of any of the GATT proposals. This could be mainly due to involvement of this ship size in many grain routes and different commodity trades. The results discussed in the previous section showed that PSET (producer subsidy equivalents) in the EU influence the volume of grain trade by Handysize significantly. Given this, it could be expected that the reduction in EU exports due to any of the WTO proposals will be replaced by other grain exporters. Since there is no restriction (route and port constraint) for Handysize in grain trade, significant changes will not occur in the grain transported by Handysize and consequently in its freight rates.

Despite the significant influence of PSET in the original model, the simulation model illustrates that a reduction or removal of the protection measures in the EU would not affect the volume of grain transported by "Panamax" significantly. This could be due to an increase of world grain trade due to a reduction of CAP protection measures. Since there are few constraints for "Panamax" contributions to the grain trade, this ship size can find more opportunities in the grain trade. The other reason could be the involvement of this size of vessel in other dry bulk trades and consequently the influence of other dry bulk trades on freight grain rates.

7.10 Conclusion

The purpose of this chapter was to quantify for "Handysize" and "Panamax" vessels the impact of the CAP on the structure of demand for these ships. It was pointed out that due to limitation of data on trade matrices structural modelling was inappropriate in these cases. The use of VAR as an alternative to structural modelling was examined in this chapter. The VAR technique was employed to test the hypothesis that the demand for "Handysize" and "Panamax" vessels increased as a result of the expansion of EU grain exports. It was pointed out that this scenario was dissimilar to that of "Capesize" vessels discussed in the previous Chapter which were found to be largely influenced by the EU grain imports. The chapter also highlighted the importance of these vessels in the rest of the world grain and soybean trades. These observations are due to the fact that there is little or no port and route restrictions for "Panamax" and "Handysize" vessels in this trade, unlike as for "Capesize".

The models tested emphasised the role of EU grain exports in influencing the demand for these vessels and also considered the role of other sources of demand. The "Panamax" model accounted for additional variables, namely the coal trade and freight rate. The results showed that CAP protection measurers significantly and positively influenced the volume of demand for these ship sizes. These results supported the general hypothesise of the thesis as in the previous cases for "Capesize" vessels.

The simulation exercise revealed that changes to CAP protection measures would not affect the volume of demand for "Panamax" and "Handysize" vessels. This is because the versatility of these ships, due to the absence of port and route restrictions, makes them suitable for use in rest of the world grain and other trade.

CHAPTER EIGHT: CONCLUSION

8.1 Introduction

This chapter summarises and provides conclusions to the thesis. The objective of this study was to investigate the impact of the Common Agricultural Policy on shipping transport via its impact on the international grain trade. Proposals for further economic and monetary integration in the EU have stimulated an interest in the analysis of economic integration and the EU's external trade.

The findings of this study are of interest to ship operators, ship owners and charterers. This study is also of interest to those academics, consultants and other experts who are involved in modelling and forecasting shipping variables and the international grain market.

In particular, the study aimed to quantify the possible distorting effects of the European Union's Common Agricultural Policy (CAP) on the dry bulk shipping sector in size-disaggregated form. The study considers "Capesize", "Handysize" "Panamax" vessels. This is because the type of shipping service required depends on the cargo to be moved, as well as on ports and routes restrictions. This fact demands the shipping market to be highly disaggregated by sector and differentiated by size. Such differentiation suggests that the underlying supply and demand factors are different for each sub-market and external influences could affect these factors differently.

This study makes a number of valuable contributions to the literature on shipping data analysis, conceptualising shipping and trade theories, shipping market modelling as well as econometric estimation. The study fills a lacuna in the literature on the impact of CAP on the structure of demand and supply of grain in international market by incorporating the role of shipping transport. Instead of considering only conventional trade creation and diversion analyses as in previous studies, this thesis extends the literature by evaluating the size and pattern of demand that the external trade of the combined economies of the EU member states generated for shipping services due to economic and monetary integration.

8.2 Data Analysis, Conceptual Model and Theoretical Framework

Evaluation of the impact of any policy is subject to time. For the purposes of this thesis, a 28 year period (1970-1998) was considered to be long enough to capture the required impacts. Initial data analysis of port, route and shipsize contribution in grain trade was necessary to provide a foundation for constructing plausible theoretical arguments for the study hypotheses. Given that it was not possible to collect monthly data for all the series used in the estimation, annual data was used throughout the study.

Data analysis of the shipping industry and international grain statistics revealed interesting patterns in the international grain trade. The data analysis established that while dry bulk commodity trades such as iron ore and coal have exhibited a growth trend since 1980, the volume of seaborne grain trade has remained unchanged since 1980 at about 200 M.ton. Thus when compared to other major dry bulk commodities, the share of the international seaborne grain in the overall trade for bulk commodities has reduced.

However, the pattern of the international grain trade has changed dramatically since the 1970s. The EU's total grain imports reduced from 25 M.ton to 3 M.t during this time. The most important route regarding the EU's imports was the North Atlantic, where the U.S., Canada and the EU are involved in grain trade. Significantly, the EU grain imports from North America (USA and Canada) reduced from 20 M.ton to 2 M.ton since the mid 1970s. On the other hand, the EU's grain exports rose from 2 M.ton to 22 M.ton since the mid 1980s. The main destinations for the EU grain exports are the Middle East, North and East Africa and Far East. These changes in the pattern of the grain trade have affected the supply/demand equation for different shipping market sub-sectors, which are ''Handysize", "Panamax" and "Capesize".

The analysis of ship handling characteristics, port constraints and vessel size performance in grain trade showed that the only route by which "Capesize" carriers could contribute to the seaborne grain trade is the North Atlantic which covers EU grain imports from USA and Canada. This finding led to this study's argument that a reduction of the EU grain imports from North America limited the opportunity for "Capesize" vessels to contribute to the seaborne grain trade, while the expansion of the EU grain exports increased opportunities for "Panamax" and "Handysize" to contribute to this trade.

The use of the conceptual analysis is an important dimension of this study. Supply and demand relationships for grain market in international and EU level were manipulated graphically so as to conceptualise the effect of the CAP protectionism measures. The conceptual analysis of the CAP measures indicates that the measures influenced the EU grain market as well as the international market. During the life of the CAP, high producer and consumer prices not only shifted the supply curve to the right and slackened demand, but also led to a gradual downwards rotation of the supply curve due to a constant expansion of grain products within the EU.

This occurrence increased the level of the EU's self-sufficiency much more than 100%. Subsequently, with the help of the export subsidy the EU turned from a major grain importer to a main exporter. Since the EU is a large country (effectively involved in international trade), any changes in her supply and demand level affect the world grain market.

The theoretical framework established that the EU governments exert considerable control over grain prices, hence world prices are separated by policy measures. These policy measures play an important role in modelling international grain trade.

The insights drawn from the conceptual analysis led to the development of a number of interrelated hypotheses. The study's main hypothesis argues that, structural changes in the demand for and the production of grain (caused by the CAP) has altered the pattern and volume of demand for different shipsizes. This arises because of port and routes constraints for particular shipsizes. The hypotheses and general aims of the thesis dictated the economic model and econometric methodology adopted.

It was established in the study that there is no general theory of shipping transport which could be used to study the impact of the CAP on the structure of demand for shipping. Given the shortcomings of the existing literature, a theoretical framework based on recognition of freight rates and transport cost in grain trade (as a low value commodity trade) was specified. The framework hypothesesize the influence of external factors on the shipping markets. Furthermore, these hypotheses made it necessary for the study to employ highly disaggregated models based on shipping sub-sector and commodity trade to quantify the impact of CAP on structure of demand for shipping transport of grain.

The interaction between the international grain trade, other major dry bulk trades and grain freight market is hypothesised in this thesis. The study's sub-hypotheses states that the higher grain freight rate created a strong demand for grain shipping services which induced bulk carriers of other commodities such as iron ore and coal to carry grain. This shift could also have been caused by low demand in other dry bulk market. Moreover, the study argues that grain freight rates are influencing the volume and pattern of the international grain trade. This is because grain is a low value commodity trade for which the freight rate forms a significant proportion of its final price.

8.3 Econometric Estimation and Simulation Analyses (Findings)

The theoretical framework and economic models provided the basis for the construction of the econometric models. These models add a unique dimension to the development of shipping models. For the first time, different econometric techniques are utilised to differentiate the specific nature of individual sub-markets in the grain trade. Furthermore unlike most of the studies in the literature which failed to take into account the univariate properties of the variables including stationarity and incorporate interrelationship between grain trade and shipping variables and their stochastic properties, this study highlights these problems and brings forward specific solutions by using unit root and cointegration techniques.

Therefore the study provides new evidence on and insight into the interrelationship between the international grain trade and the shipping market. Consequently, the protectionist nature of the CAP and its impact on the shipping market is highlighted and quantified for first time.

At a more detailed level, the econometric process sought to quantify the effect of a reduction in EU grain imports from North America on the "Capesize" sub-sector and to determine the impact of an increase in EU grain exports on the "Panamax" and "Handysize" sub-sectors. The analytical framework adopted to address the above issues consisted of three different models for each sub-sector. A unique feature of the econometric models which were estimated is the high level of disaggregation of supply as well as demand. This study used the same variable (Producer Subsidy Equivalent) in each shipping sector model as an indicator of the CAP intervention in grain trade.

Since in the "Capesize" model the specific relationships between variables are based on an economic theory a structural econometric model was used in modelling the "Capesize" sector. The simultaneous equation framework made it possible to model variables that are related to each other in different ways and which affect each other simultaneously.

The formulation of a theoretical framework for the contribution of "Handysize" and "Panamax" ship sizes in grain and other dry bulk commodity trades was complicated as the ships cover many route and characteristics. This is unlike the case of the involvement of the "Capesize" in this trade and for this reason, structural modelling is not possible here.

The Vector Autoregression (VAR) method is used for estimating the impact of the expansion of the EU grain trade on the "Handysize" and "Panamax" market sub-sector. In these models as in the case of the "Capesize" model, the variables that influence the supply of these vessels in general terms are incorporated together with the other variables that influence the contribution of these size vessels in grain trade. Since the Panamax and "handysize" models contain co-integration relations, the VAR model is represented in VEC format.

These suggest that the co-integration relations are presumed to be *(1, -1)* relations and there is one common stochastic trend. Using the Johansen co-integration estimation could efficiently highlighted the number of co-integration relations, as well as the estimated co-integration parameters.

The significant and correctly signed coefficients on the variables from the results of the econometric estimation provided support for the *a priori* views regarding the relationships between the protectionist measure of CAP and the pattern and volume of international grain trade. They also highlighted the contribution of different ship sizes to this trade. To incorporate the expectation hypothesis which states that the past will reflect on the present, a lagged dependent variable was included in the model to estimate the short-term effects.

The results of the "Capesize" model revealed that the volume of grain transported by "Capesize" bulk carriers at time t, is significantly influenced by growth in the North Atlantic grain trade. Therefore, the results confirm that an increase in North Atlantic trade which is the EU grain import from North America would increase the demand for "Capesize" vessels in the grain trade. On the other hand, the CAP intervention in the grain trade has a negative and significant effect on North Atlantic grain trade (EU grain import). Meanwhile the EU grain consumption has a positive and significant impact on the North Atlantic trade. These findings suggest that the North Atlantic grain trade and consequently the volume of grain transported by "Capesize" are significantly influenced by the CAP protection measure.

The econometric analysis also demonstrates a positive relationship between the "Capesize" grain freight rates and the volume of grain transported by these ships. This indicates that "Capesize" operators would contribute more to the grain trade if the relative grain freight rates were high.[211] There is a strong negative relationship between "Capesize" grain freight rate and North Atlantic grain trade. This result indicates that the freight rate could highly influence the volume of international grain trade. Finally the results from three models expressed a dynamic relationship within the model by having positive and significant coefficient of the lagged dependent variables.

The results for "Handysize" and "Panamax" models revealed that the demand for these vessels increased in grain trade as a result of the expansion of EU grain export. Thus the demand for these shipsizes in the grain trade is significantly and positively influenced by the CAP protection measures.

The simulation models investigated the possible impact of the EU's and the USA's proposals for the partial liberalisation of agricultural support on the world grain market and on different shipsize contribution to the grain trade. These proposals were forwarded in the WTO's Uruguay Round (WTO) of negotiation. The results show that these two proposals decrease the threshold price and would bring the world price and the EU domestic price closer thereby increasing the EU's grain imports and consequently the demand for "Capesize" in grain trade. However the effect of the USA proposal is much larger than the EU proposal. In the case of "Panamax" and "Handysize" vessels both proposals would not affect the volume of demand for these shipsizes.

The structure of the theoretical model is the same as that of the econometric model estimated in Chapters Six and Seven. The assumption is that the variables of the model would follow extrapolative growth (unanticipated). It means that the historical trend is considered to be unchanged.

[211] Relative grain freight rates to iron ore and coal.

8.4 Estimated Results and Validation of the Hypotheses

This section provides a summery of the hypotheses, and validates them against the econometric results. The general hypothesis states that:

The formation and development of the EU together with implementation of the CAP have contributed to structural changes in the international grain market. Such structural changes have affected the pattern and volume of demand for different dry bulk carriers market sub-sector (Capesize, Panamax and Handysize). This mainly occurs because of port and route restriction.

The estimated results from three different models (Capesize, Panamax and Handysize) indicate that the pattern of demand for different shipsizes has been changed in grain trade. The North Atlantic grain trades have been dramatically reduced while new routes from the EU to Far East, Middle East and Africa are created. Consequently due to port restrictions in these regions, the demand for "Capesaze" vessels in grain trade have been reduced while because of less rustication for smaller vessels in theses routes the demand for "Handysize" and "Panamax" vessels were increased.

These results also support the Sub-hypotheses one that state:

Alternative to the traditional hypothesis in the shipping literature, it is more valuable to evaluate the size of demand that the external trade of the combined economies of the member states of the regional economic integration could generate for shipping services[212].

The "Handysize" and "Panamax" model used to test the hypothesis that the demand for "Handysize" and "Panamax" vessels increased as a result of the expansion of EU grain exports. It was pointed out that this scenario was dissimilar to that of the demand for "Capesize" vessels which were found to be largely influenced by the EU grain imports. These models also highlighted the importance of these vessels in the rest of the world grain and soybean trades.

These results support the Sub-hypotheses two that state:

[212] *The traditional hypothesis in the shipping literature argues that economic (regional) integration normally leads to relatively less demand for shipping transport services, because of diversion of longer hauls to shorter due to more intra-regional trade* (Wijnolst & Wergeland, 1997).

Changes in the pattern of international grain production and trade by the CAP, decreased the demand for "Capesize" and increased the demand for "Panamax" and "Handysize" bulk carriers.

The "Capesize" model demonstrates the importance of the "Capesize" grain freight rates for grain transported by such ships. The equation one in this model represents the demand side, the "Capesize" grain freight rate (CGF) demonstrates a positive and significant relationship with (GTC_t). This supports the sub-hypothesis three, which argues that "Capesize" operators would contribute more to grain trade if the relative grain freight rates are high.[213] It also supports the sub-hypothesis four that freight rate in low value commodity trades can influence the volume of the trade to some extent.

The models also indicate the importance of producer subsidy equivalent (PSET) for North Atlantic grain trade (NGT). (PSET) has a negative effect on (NGT) (EU grain import) and positive effect on the EU export (the demand for "Handysize and "Panamax"). Meanwhile, EU grain consumption has positive impact on (NGT). This shows the effect of "Capesize" grain freight rate (CGF) on (NGT). There is a strong negative relationship between (CGF) and (NGT). This result supports sub-hypothesis five which argues that, since grain is a low value commodity the freight rate highly influences the volume of its international trade.

Further the models specify that changes in North Atlantic soybean are affected by changes of EU soybean production (ESP) and consumption. Increases in EU production reduced the North Atlantic soybean trade while increase in EU soybean consumption increases this trade. Furthermore, the models specifie that producer subsidy equivalent in grain positively influences the North Atlantic soybean trade. This supports sub-hypothesis Six which argues that grain and soybean are substitutes for each other. Finally, the models also illustrate that "Capesize" grain freight rates influence the North Atlantic soybean trade significantly. This could be attributed to sub-hypothesis four which argues that the low value commodity trade is significantly influenced by freight rates. the North Atlantic soybean trade is also affected by its lagged value.

---

[213] Relative grain freight rates to iron ore and coal.

8.5 Scope of the Study and Recommendation for Future Research

It would be unrealistic to suggest that every possible aspects of the CAP impact on shipping transportation of grain has been covered in this study. Space and time limitations have imposed a compromised. However, there are questions left open for further research, and the author suggests some here.

The study is limited to bulk carriers. Within this category of ship type, the focus of the study is directed to the tramp service market, because it is assumed that most of the grain shipment is transported on tramp ships.

The thesis has been forced to use annual data; the reason is that, many of the variables examined are annual data. Therefore annul data is closest can be estimated in this thesis. However, whether monthly data will be available to future research and whether the result will be better than annual data is something to be discovering in the future research.

The conceptual analysis of the CAP provides a simplified version of the mechanism of the CAP. This may limit the use of the analysis for other purposes. First of all, the general theoretical framework is a partial equilibrium one. Thus the limitations which generally apply to this type of analysis are also applicable in this case. In addition, trade flow is assumed to be one way in the model which implies that the EU cannot simultaneously import and export grain and thereby charge import levies and pay export refunds at the same time. The study also assumed that 100% of grain surplus are exported and that foreign and domestic grain demand curves are constant. If this is not the case for every observation, the results could be affected. Finally it is important to note that the assumption that foreign supply curves are fixed and not responding to CAP or any technological developments is restrictive.

Ship performance analysis is based on potential trading route and port facilities for grain. Thus further development in port facilities may invalidate the entire hypothesis. However the driving force for any investment in port facilities will depend on the pattern and volume of trade which for grain depend upon reduction of trade restrictions.

REFERENCES AND BIBLIOGRAPHY

Abbott, P.C. (1979). "Modelling international grain trade with government controlled markets", *American Journal of Agricultural Economics*, **61**(1), 22-31.

Agraa, A. & Jones, A. (1981). *Theory of Customs Unions*, The University of Leeds Press.

Akaike, H. (1969). "Fitting autoregressive models for predictions", *Annals of Institute of Statistical Mathematics*, **21**, 243-47.

Anderson, K. & Hayami, Y. (1986), *The Political Economy of Agricultural Protection: East Asia in International Perspective*. With Aurelia George *et al.*, Allen and Unwin in association with the Australian National University, Australia-Japan Research Centre, Sydney.

Anderson, K. & Tyers, R. (1984). "European community grain and meat policies: effects on international prices, trade and welfare", *European Review of Agricultural Economics*, (Amsterdam), **11**, 367-94.

Anderson, K. & Tyers, R. (1991). "Global effects of liberalizing trade in farm products", Thames Essay, No. 55, Simon & Schuster International, Harvester Wheatsheaf for the Trade Policy Research Centre/University of Michigan Press, Ann Arbor, pp.xvi-99.

Ardy, B. (1987). "Instability in world grain markets: a comment", *Journal of Agricultural Economics*, **38**(2), 343-45.

Bale, M.D. & Lutz, E. (1981). "Price distortions in agriculture and their effects: an international comparison", *American Journal of Agricultural Economics*, **63**(1), 8-22.

Barrass & Madhavan, (1997). *European Economic Integration and Sustainable Development*, McGraw-Hill, London.

Basmann, R.L. (1957). "A generalised classical method of linear estimation of coefficients in a structural equation", *Econometrica*, **2**, 77-83.

Beenstock, M. (1985). "A theory of ship prices", *Maritime Policy and Management*, **12**(3), 215-25.

Beenstock, M. & Vergottis, A. (1989a). "An econometric model of the world market for dry cargo freight and shipping", *Applied Economics*, **21**, 339-56.

Beenstock, M. & Vergottis, A. (1989b). "An econometric model of world tanker market", *Journal of Transport Economics and Policy*, **23**, 263-80.

Beenstock, M. & Vergottis, A. (1993a). "The interdependence between the dry cargo and tanker markets", *Logistics and Transportation Review*, **29**(1), 3-38.

Beenstock, M. & Vergottis, A. (1993b), *Econometric Modelling of World Shipping*, Chapman & Hall.

Berg-Andreassen, J.A. (1996). "Some properties of international maritime statistics", *Maritime Policy and Management*, **23**, 381-95.

Berg-Andreassen, J.A. (1997a). "The relationship between period and spot rates in the international maritime markets", *Maritime Policy and Management*, **24**, 335-50.

Berg-Andreassen, J.A. (1997b). "Efficiency and interconnectivity in international shipping markets", *International Journal of Transport Economics*, **24**, 241-57.

Binkley, J.K. (1983). "Marketing costs and instability in the international grain trade", *American Journal of Agricultural Economics*, **65**(1), 57-64.

Binkley, J.K. & Bessler, D.A. (1983). "Expectations in bulk ocean shipping: an application of autoregressive modelling", *Review of Economics and Statistics*, 516-20.

Binkley, J.K. & Harrer, B. (1982). "Major determinants of ocean freight rates for grains: an econometric analysis", *American Journal of Agricultural Economy*, **63**, 47-57.

Binkley, J.K. & Revelt, M.E. (1981). *The Role of Transportation in International Agricultural Trade*, Purdue University Agricultural Experimental Station Bulletin No. 337, July.

Bjornson, B. & Innes, R. (1992). "Risk and return in agriculture: evidence from an explicit-factor arbitrage pricing model", *Journal of Agricultural and Resource Economics*, **17**(2), 232-52.

Blakeslee, L. & Lone, T. A. (1995). "Modelling optimal grain-marketing decisions when prices are generated autoregressively", *European Review of Agricultural Economics*, **22**(1), 87-102.

Blakeslee, L.L., Heady, E.O. & Framingham, C.F. (1973). *World Food Production, Demand and Trade*, Iowa State University Press, Ames.

Blandford, D. (1983). "Instability in world grain markets", *Journal of Agricultural Economics*, **34**(3), 379-95.

Blandford, D. (1993a). "An overview of the world grain economy". In: Blandford, D., Carter, C.A. & Piggott, R. (eds.) (1993), *North-South Grain Markets and Trade Policies*, Westview Press, Oxford, pp.1-29.

Blandford, D. (1993b). "North-south grain markets and trade policies: a synthesis". In: Blandford, D., Carter, C.A. & Piggott, R. (eds.) (1993), *North-South Grain Markets and Trade Policies*, Westview Press, Oxford, pp.357-87.

Blandford, D. & de-Gorter, H. (1993). "North-south grain markets and trade policies: the United States". In: Blandford, D., Carter, C.A. & Piggott, R. (eds.) (1993), *North-South Grain Markets and Trade Policies*, Westview Press, Oxford, pp.111-45.

Blandford, D. & Gauthier, M. (1993). "North-south grain markets and trade policies: the European community". In: Blandford, D., Carter, C.A. & Piggott, R. (eds.) (1993), *North-South Grain Markets and Trade Policies*, Westview Press, Oxford, pp.79-109.

Blandford, D. & Lynch, S. (1993). "North-south grain markets and trade policies: Cameroon". In: Blandford, D., Carter, C.A. & Piggott, R. (eds.) (1993), *North-South Grain Markets and Trade Policies*, Westview Press, Oxford, pp.147-72.

Bollerslev, T. (1986). "Generalised autoregressive conditional heteroscedasticity", *Journal of Econometrics*, **31**, 307-27.

Breckling, J. & Thorpe. S. (1987). *Effects of EC Agricultural Policies, a General Equilibrium Approach*, Bureau of Agricultural Economics and Centre for International Economics, Canberra, Australia.

Breckling, J., Thorpe, S. & Stoeckel, A. (1987). *Effects of EC Agricultural Policies, A General Equilibrium Approach: Initial Results*, Bureau of Agricultural Economics and Centre for International Economics, Canberra, Australia.

Buckwell, A.E., Harvey, D.R., Thompson, K.J. & Parton, K.A. (1982). *The Costs of the Common Agricultural Policy*, Croom Helm, London.

Bureau of Agricultural Economics (1998). *Course Grain Situation and Outlook*, Bureau of Agricultural Economics, Canberra.

Burniaux, J.M. & Waelbroeck, J. (1985). "The impact of the CAP on developing countries: a general equilibrium analysis". In: C. Stevens, & J. Verloren van Themaat (eds.) (1985), *Pressure Groups, Policies and Development*, Hodder & Stoughton, London.

Canova, F. (1995). "Vector autoregressive models: specification, estimation, inference and forecasting". In: M.H. Pesaran & M. Wickins (eds.) (1995), *Handbook of Applied Econometrics*, **1**, Basil Blackwell, Oxford.

Carter, C.A. (1988). "Trade liberalisation in grain markets", *Canadian Journal of Agricultural Economics*, 36(4), part 1, 941-50.

Carter, C.A., Hickson, A.B. & Kraft, D.F. (1984). "The welfare effects of export constraints on the Canadian feed grain market", *Canadian Journal of Agricultural Economics*, **32**(1), 25-36.

Carter, C. (1984). *Pooling Sales Versus Forward Selling and the Management of Risk: The Case of Wheat*, Westview Press, London.

Carter, C. & Gardiner, W. H. (1988). *Elasticities in International Agricultural Trade*, Westview Press, London.

Carter, C., McCalla, A.F. & Schmitz, A. (1989). *Canada and International Grain Markets: Trends, Policies, and Prospects*, Supply and Services Canada, Ottawa.

Charemza, W. & Gronicki (1981). "An econometric model of world shipping and shipbuilding", *Maritime Policy and Management*, **8**, 21-30.

Chisholm, T. & Tyers, R. (1985), "Agricultural protection and market insulation policies: applications of a dynamic multisectoral model". In: J. Piggot, & J. Whalley (eds.) (1985), *New Developments in Applied General Equilibrium Analysis*, Cambridge University Press, Cambridge.

Coffin, H. (1970). *An Econometric Analysis of Import Demand for Wheat and Flour in World Markets*, Ph.D. thesis, University of Connecticut.

Coffin, H.G. (1984). "Western grain transportation initiatives and agriculture in eastern Canada", *Canadian Journal of Agricultural Economics*, **32**(2), 269-81.

Commission of the European Community (undated). *The Agricultural Situation in the European Community*, Commission of the European Community, Brussels.

Cramer, G.L. (1993). *World Grain Trade*, Westview Press, Boulder and Oxford.

Cramer, G.L. & Wailes, E.J. (eds.) (1993), *Grain Marketing*, 2nd edn., Westview Press, Oxford.

Deaton, A. & Laroque, G. (1992). "On the behavior of commodity prices", *Rec. Econ. Stud.*, **59**, 1-23.

Deaton, A. & Laroque, G. (1994). *Competitive Storage and Commodity Price Dynamics*, Working Paper INSEE-CREST, No. 9460, October.

Demekas, D.G. (1988). "The effect of the common agricultural policy of the European community: a survey of the literature", *Journal of Common Market Studies*, **XXVII**(2).

Demelo, J.A. & Panagrarya (1992). *The Regionalism in Trade Policy*, World Bank.

Dickey, D.A. & Fuller, W.A. (1979). "Distributions of estimators for autoregressive time series with a unit root", *Journal of the American Statistical Association*, **74**(366), 427-31.

Dickey, D.A. & Fuller, W.A. (1981). "Likelihood ratio statistics for autoregressive time series with a unit root", *Econometrica*, **49**, 1057-72.

Drewry (1986). *Grain*, Drewry Shipping Consultants Ltd., London.

Drewry (1990). *The Market for Capesize (10000- 15000) Bulk Carriers*, Drewry Shipping Consultants Ltd., London.

Drewry (1992). *Forecast Dry Bulk Carriers Profitability, 1992-97*, Drewry Shipping Consultants Ltd., London.

Drewry (1994). *Option For Bulk Carriers Trading*, Drewry Shipping Consultants Ltd., London.

Drewry (1996) *Dry Bulk Freight Rates and Chartering*, Drewry Shipping Consultants Ltd., London.

Drewry (1997a). *Option For Bulk Carriers Trading*, Drewry Shipping Consultants Ltd., London.

Drewry (1997b). *The Market For Handymax Dry Bulk Carriers In The 1990s*, Drewry Shipping Consultants Ltd., London.

Drewry (1997c). *Handy Bulk Carriers, Trading Environment & Prospects for Profitability to 2000*, Drewry Shipping Consultants Ltd., London.

Drewry (1997d). *Growth Prospects For Iron Ore And Coking Coal*, Drewry Shipping Consultants Ltd., London.

Drewry (1997e). *"Capesize" Bulk Carriers, Market Trends,* Drewry Shipping Consultants Ltd., London.

Drewry (1998a). *Market Outlook For Bulk Carriers, Supply, Demand, Employment Prospects and Profitability*, Drewry Shipping Consultants Ltd., London.

Drewry (1998b). *Panamax Bulk Carriers, Market Prospects and Profitability 1995-2000*, Drewry Shipping Consultants Ltd., London.

Dunn, J.W. (1987). "Forecasting ocean freight rates", *Transportation and Competitiveness of U.S. Agricultural Products in World Markets: Proceedings of a Research Symposium*, December, USDA, ERS, Washington, D.C.

Durbin and GS Watson (1951) "Testing for serial correlation in least squares regression II" *Biometrica*, 38,159-78

Economic Research Service (1996). *World Agricultural Outlook and Situation*, USDA, Washington D.C.

Engle, R. (1982). "Autoregressive conditional heteroskadusticity, with estimates of the variance of United Kingdom inflations", *Econometrica*, **50**, 987-1008.

Engle, R.F. & Granger, C.W.J. (1987). "Cointegration and error correction representation, estimation and testing", *Econometrica*, **55**(2), 251-76.

Engle, R.F. & Granger, C.W.J. (eds.) (1991), *Long-Run Economic Relationship*, Oxford University Press, Oxford.

Eriksen, I.E. (1983). "The demand for bulk ship services", *Norwegian Maritime Research*, **2**(1), 22-6.

Evans, J.J. (1994). "An analysis of efficiency of the bulk shipping markets", *Maritime Pol. Management*, **21**(4), 311-29.

Evans, J. & Marlow, P (1997). *Quantitative Methods in Maritime Economics*, (2nd edn.), Fairplay Publications Ltd.

FAO (undated). *Production Year Book*, FAO.

Fearnley (1965). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (1970). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (1975). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (1980). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (1985). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (1990). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (1995). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (1996). *Fearnley's Statistics for Maritime Transport of Bulk Cargo*, Fearnley and Eagers Chartering Co., Oslo.

Fearnley (2000). *World Bulk Trade*, Fearnley and Eagers Chartering Co., Oslo.

Fedeler, J.A. & Heady, E.O. (1976). "Grain marketing and transportation interdependencies: a national model", *American Journal of Agricultural Economics*, **58**(2).

Fuller, S.P., Piumsomboon, M. & Phillips, D. (1982). "International transfer efficiency at grain ports: an analysis of traffic congestion", *N. Cent. Journal of Agricultural Economics*, **2**, 1-10.

Gawei & Addy Suhut (1996). *Common Agricultural Policy Towards Cereals: the Instruments and their Effects*, internal working paper, London School of Economics, London.
Geraci, V.J. & Prewo, W. (1977). "Bilateral trade flows and transportation costs", *Review of Economics and Statistics*, **59**, 67-74.

Gerken, E. (1986). *The Determinants of European Agricultural Trade Interference*, Working Paper No. 254, Kiel Institute of World Economics, Kiel.

Glen, D. (1987). *Differentiation in the Oil Tanker Market*, Ph.D. thesis, London Business School, University of London, London.

Glen, D. (1990). "On the emergence of differentiation in the oil tanker market, 1970-78", *Maritime Policy and Management*, **17**(4), 289-312.

Glen, D. (1997). "The market for second-hand ships: further results on efficiency using cointegration analysis", *Maritime Policy and Management*, **24**, 245-60.

Glen, D., Owen, M. & Van der Meer, R. (1981). "Spot and time charter rates for tankers, 1970-1977", *Journal of Transport Economics and Policy*, **1**, 45-58.

Goss, R.O. (1967a). "The turnaround of cargo liners and its effects on sea transport costs", *Journal of Transport Economics and Policy*, **1**(1), 75-89.

Goss, R.O. (1967b). "Towards an economic appraisal of port investments", *Journal of Transport Economics and Policy*, **1**(3), 249-72.

Granger, C.W.J. & Newbold, P. (1974). "Spurious regressions in econometrics", *Journal of Econometrics*, **2**, 111-20.

Greene, W.H. (1980). "On the estimation of a flexible frontier production model," *J. Econometrics*, **13**(May), 101-17.

Greene, W.H. (1997). *Econometric Analysis*, Prentice Hall.

Gujarati, D. (1995). *Basic Econometrics*, (3rd edn.), McGraw-Hill.

Hale, C. & Vanags, A. (1989). "Spot and period rates in the dry bulk market: some test for the period 1980-1986", *Journal of Transport Economics and Policy*, 281-91.

Hale, C. & Vanags, A. (1992). "The market for second-hand ships: some results on efficiency using cointegration", *Maritime Policy and Management*, **19**(1), 31-140.

Hall, P. (1994). "Testing for a unit root in time series with pre-test data based model selection", *Journal of Business and Economic Statistics*, **12**, 461-70.

Hamilton, J.D. (1989). "A new approach to the economic analysis of nonstationary time series and business cycle", *Econometrica*, **57**, 357-84.

Hamilton, J.D. (1994). *Time Series Analysis*, Princeton University Press, Princeton.

Harling, K.F. (1983). "Agricultural protectionism in developed countries: analysis of systems of intervention". *European Review of Agricultural Economics*, **10**, 223-47.

Harris, J.M. (1983). *Ocean Fleet Shipping Rates, Capacity and Utilization*, USDA, ERS, Washington, D.C.

Harris, R. (1996). *Using Cointegration Analysis in Econometric Modelling*, Harvester Wheatsheaf, Prentice Hall.

Hawdon, D. (1978). "Tanker freight rates in short and long-run", *Applied Economics*, **10**, 203-17.

Heaps, T., Munro, J.M. & Wright, C.S. (1992). "A location model of grain production and transportation", *Annals of Regional Science*, **26**(2), 111-34.

Heaps, T., Munro, J.M. & Wright, C.S. (1994). "Simulation of the optimal structure of a regional transport system", *Canadian Journal of Regional Science*; **17**(1), 23-43.

Heaver, T.D. (1968). *The Economics of Vessel Size*, National Harbours Board, Ottawa.

Heaver, T.D. & Studer, K.R. (1972). "Ship size and turnround time: some empirical evidence", *Journal of Transport Economics and Policy*, **VI**(January), 32-50.

Heid, W.G. Jnr. (1993). "Grain supply and utilisation". In: G.L. Cramer & E.J. Wailes (eds.) (1993), *Grain Marketing*, 2nd edn., Westview Press, Oxford, pp.61-91.

Heifner, R.G. & Wright, B.H. (1993). "Pricing grains". In: G.L. Cramer & E.J. Wailes (eds.) (1993), *Grain Marketing*, 2nd edn., Westview Press, Oxford, pp.159-81.

Helmuth, J.A. & Hadwiger, D.F. (eds.) (1993). *International Agricultural Trade and Market Development Policy in The 1990s*, Contributions in Economics and Economic History, Greenwood Press, London.

Hsu, J.L. & Goodwin, B.K. (1995). "Dynamic relationship in the market for ocean grain freighting services", *Canadian Journal of Agricultural Economics*, **43**(2), 271-84.

International Monetary Fund (1988). *The Common Agricultural Policy of the European Community*, International Monetary Fund, Washington, DC.

International Grain Council (2000). *World Grain Statistics*, International Grain Council.

International Wheat Council (undated). *Trade Matrix*, International Wheat Council.

Jabara, C.L. (1981). "Effect of monetary compensatory amounts in determining rates of production from EC grain import levies", *Canadian Journal of Agricultural Economics*, **29**(1), 63-70.

Jarque, C.M. & Bera, A.K. (1981). "Efficient test for normality, homoscedasticity and serial dependence of regression residuals", *Economics Letters*, **6**, 255-59.

Johansen, S. & Juselius, K. (1990). "Maximum likelihood estimation and inference on cointegration with reference to demand for money", *Oxford Bulletin of Economics and Statistics*, **52**, 169-210.

Johansen, S. & Juselius, K. (1992). "Testing Structural hypothesis in a multivariate cointegration analysis of the PPP and UIP for UK", *Journal of Econometrics*, **53**, 211-44.

Johansen, S. (1991). "Estimation and Hypothesis testing of cointegration vectors in gaussian vector autoregression models", *Econometrica*, **59**, 1551-580.

Johansen, S. (1988). "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control*, **12**, 231-54.

Johnson, D.G. (1973). "The impact of free trade on north American agriculture", *American Journal of Agricultural Economy*, **55**, 294-99.

Johnson, D.G. (1976). "Increased stability of grain supplies in developing countries: optimal carryovers and insurance", *World Development*, **4**(12), 977-87.

Johnson, D. & Wilson, W.W. (1995). "Canadian rail subsidies and continental barley flows: a spatial analysis", *Logistics and Transportation Review*, **31**(1), 31-46.

Johnson, R.L. (1991). "The soybean complex spread: an examination of market efficiency from the viewpoint of a production process", *Journal of Futures Markets*, **11**(1), 25-37.

Josling, T.E. (1979). "Questions for farm policy in an enlarged European community", *The World Economy*, **2**(3), World Bank, Washington, DC, 343-62.

Josling, T. (1977). "Grain reserves and government agricultural policies", *World-Development*, **5**(5-7), 603-11.

Josling, T. (1994). "Review of reforming farm policy: toward a national agenda", *Journal of Economic Literature*, **32**(1), 177-78.

Kavussanos, M.G. (1996a). "Comparisons of volatility in the dry-cargo ship sector: spot versus time charters, and small versus larger vessels", *Journal of Transport Economics and Policy*, January, 67-82.

Kavussanos, M.G. (1996b). "Price Risk modelling of different size vessels in tanker industry using autoregressive conditional heteroscedasticity (ARCH) models", *The Logistics and Transportation Review*, **32**(2), 161-76.

Kavussanos, M.G. (1996c). "Highly disaggregated models of seaborne trade", *Maritime Pol. Management*, **23**(1), 27-43.

Kavussanos, M.G. (1997). "The dynamics of time-varying volatilities in different size second-hand ship prices of the dry-cargo sector", *Applied Economics*, **29**, 433-44.

Kendall, P.M.H. (1972). "A theory of optimum ship size", *Journal of Transport Economics and Policy*, **6**(May), 128-46.

Knudsen, O. & Nash, J. (1990). *Redefining "the Role of Government in Agriculture for the 1990s*, World Bank, Washington, DC.

Koester, U. (1977). "The redistributional effects of the common agricultural financial system", *European Review of Agricultural Economics*, **4**, 321-45.

Koester, U. (1982). *Policy Options for the Grain Economy of the European Community: Implications for Developing Countries*, Research Report 35, International Food Policy Research Institute, Washington DC.

Koester, U. (1985). "Agricultural market intervention and international trade", *European Review of Agricultural Economics*, **12**, 87-103.

Koester, U. & Schmitz, P.M. (1982). "The EC sugar market policy and developing countries", *European Review of Agricultural Economics*, **9**, 183-204.

Koo, W.W., Thompson, S.R. & Larson, D.W. (1988). "Effects of ocean freight rate changes on the U.S. grain distribution system", *Logistics and Transportation Review*, **24**(1), 85-100.

Koop, G., Pesaran, M.H. & Potter, S. (1996). "Impulse response analysis in nonlinear multivariate models", *Journal of Econometrics*, **74**, 119-47.

Koopmans, T.C. (1939). *Tanker Freight Rates and Tankship Building*, Haarlem, Holland.

Larue, B. & Ker, A. (1993). "World price variability versus protectionism in agriculture: a causality analysis", *Review of Economics and Statistics*; **75**(2), 342-46.

Loo, T. & Tower, E. (1988). "Agricultural Protectionism and the less developed countries: the relationship between agricultural prices, debt servicing capacities and the need for development air", paper presented at the conference on Agricultural Policies and the Non-farm Economy, 26-27 May, Washington, DC .

Lutkepohl, H. (1990). "Asymptotic distribution of impulse response functions and forecast error variance decomposition of vector autoregressive models", *Review of Economics and Statistics*, 72, 116-25.

Lutkepohl, H. (1993), cited in A.W. Veenstra (1999), *Quantitative Analysis of Shipping Market*, Delft University Press.

Lutkepohl, H. & Reimers, H.E. (1992). "Impulse response analysis of cointegrated system", *Journal of Economic Dynamics and Control*, **16**, 53-78.

Mackel, C., Marsh, J. & Revell, B. (1984). "The common agricultural policy", *Third World Quarterly*, 6(1), 131-44.

MacKinnon, J. (1991). *Critical Values for Cointegration Tests*,. In: R.F. Engle & C.W.J. Granger (eds.) (1991), *Long-Run Economic Relationship*, Oxford University Press, Oxford.

Maddala, G.S. (1992). *Introduction to Econometrics*, 2nd edn., Macmillan, New York.

Matthews, A. (1985b). *The Common Agricultural Policy and the Less Developed Countries*, Gill and Macmillan, Dublin.

Matthews, A. (1985b). "The CAP and developing countries: a review of the evidence". In: C. Stevens & J. Verloren van Themaat (eds.) (1985), *Pressure Groups, Policies and Development*, Hodder & Stoughton, London.

McCalla, A.F (1980). "Performance of international grain-marketing systems: discussion", *American Journal of Agricultural Economics*, **62**(5), 906-07.

McCalla, A.F. (1966). "A duopoly model of world wheat pricing", *Journal of Farm Economics*, **48**, 711-27.

McConville, J. (1999). *Economics of Maritime Transport, Theory and Practice*, Witherby & Co. Ltd..

McCorriston, S. (1992). *A Model of the World Cereals Market*, University of Exeter, Exeter.

Meike, K.D. & deGorter, H. (1988). "Impacts of the common agricultural policy on international wheat prices", *Journal of Agricultural Economics*, **39**(2), 217-30.

Meike, K.D. & deGorter, H. (1989). "Efficiency of alternative policies for the EC's common agricultural policy", *American Journal of Agricultural Economics*, **71**(3), 592-603.

Morris, C.N. (1980). "The common agricultural policy", *Fiscal Studies*, **1**(2), 15-35.

Muscatelli, V.A. & Hurn, S. (1992). "Cointegration and dynamic time series models", *Journal of Economic Surveys*, **6**(1), 1-43.

Naatsuka, S. (1986). *The Demand and Supply of Grain in the World and its Impact on Shipping*, Japan Maritime Research Institute.

Naylor, R., Falcon, W. & Zavaleta, E. (1997). "Variability and growth in grain yields, 1950-94: does the record point to greater instability?", *Population and Development Review*, **23**(1), 41-58.

Nerlove, M. (1988). *The Dynamics of Supply: Estimation of Farmers' Response to Price*, Johns Hopkins University Press, Baltimore.

Newman, M.D. (1993). "Grain marketing in European community". In: G.L. Cramer & E.J. Wailes (eds.) (1993), *Grain Marketing*, 2nd edn., Westview Press, Oxford, pp.397-422.

Osterewald-Lenum, M. (1992). "A note with quintiles of the asymptotic distribution of the ML cointegration rank test statistics", *Oxford Bulletin of Economics and Statistics*, **54**, 461-72.

Patterson, P.M. & Abbott, P.C (1994). "Further evidence on competition in the US grain export trade", *Journal of Industrial Economics*; **42**(4), 429-37.

Perron, P. (1988). "Trends and random walks in macroeconomic time series: further evidence from a new approach", *Journal of Economic Dynamics and Control*, **12**, 297-332.

Perron, P. (1990). "Testing for a unit root in a time series with changing mean", *Journal of Business and Economic Statistics*, **8**, 153-62.

Pesaran, M.H. & Shin, Y. (1996). "Cointegration and speed of convergence to equilibrium", *Journal of Econometrics*, **71**, 117-43.

Pesaran, M.H. & Wickins, M. (eds.) (1995). *Handbook of Applied Econometrics*, **1**, Basil Blackwell, Oxford.

Peterson, E., Wesley, F., Viscencio, H.B. & Fuller, S. (1988). "A welfare analysis of port user fees: the case of grain and soybean exports", *Southern Journal of Agricultural Economics*, **20**(2), 101-08.

Phillips, P.C.B. & Hansen, B.E. (1990). "Statistical inference in instrumental variables regression with I(1) processes", *Review of Economic Studies*, **57**, 99-125.

Phillips, P.C.B. & Perron, P. (1988). "Testing for unit roots in time series regression", *Biometrica*, **75**, 335-46.

Piggot, J. & Whalley, J. (eds.) (1985). *New Developments in Applied General Equilibrium Analysis*, Cambridge University Press, Cambridge.

Pindyck, R.S. & Rubinfeld, D.L., *Econometric Models and Economic Forecasts*, McGraw-Hill.

Pirrong S.C. (1993). "Contracting practices in bulk shipping markets: a transactions costs expansion", *Journal of Law and Economics*, **36**, 937-76.

Reimers, H.E. (1992). "Comparisons of tests for multivariate cointegration", *Statistical Papers*, **33**, 335-59.

Roatry, M.J. (1985). "The EEC common agricultural policy and its effects on less developed countries", *National Westminster Bank Quarterly Review*, (February), 2-17.

Robinson, R. (1978). "Size of Vessels and Turnround Time", *Journal of Transport Economics and Policy*, **12**, 161-78.

Rochdale Report (1970). *Committee of Enquiry Into Shipping*, Cmnd.4337, H.M.S.O., London.

Roehner, B.M. (1996). "The role of transportation costs in the economics of commodity markets", *Journal Agr. Amer. Econ.*, **78**(May, 339-53.

Runkle, D.E. (1987). "Vector autoregression and reality", *Journal of Business and Economic Statistics*, **5**, 437-42.

Said, S.E. & Dickey, D.A. (1984). "Testing for unit roots in autoregressive moving average models of unknown order", *Biometrika*, **71**, 599-607.

Sampson, G.P. & Yeast, A.J. (1977). "An evaluation of the common agricultural policy as a barrier facing agricultural exports to the European economic community", *American Journal of Agricultural Economics*, **59**(1), 99-106.

Sampson, G.P. & Yeast, A.J. (1978). "The incidence of transport costs on exports from the United Kingdom", *Journal of Transport Economics and Policy*, **12**, 196-202.

Samuelson, P.A. (1952). "Spatial price equilibrium and linear programming", *American Economic Review*, **42**, 283-303.

Sargan, J.D. & Bhargava, A. (1983). "Testing residuals from least square regression for being generated by gaussian random walk", *Econometrica*, **51**, 153-74.

Sarris, A.H. & Freebairn, J. (1983). "Endogenous Price Policies and International Wheat Prices", *American Journal of Agricultural Economics*, 65, 2 (1983), 214-24.

Sarris, A. H., "Grain Imports and Food Security in an Unstable International Market", *Journal of Development Economics*, 7(4) (Dec. 1980), 489-504.

Sarris, A.H. (1981). *Empirical Models of International Trade in Agricultural Commodities: In Imperfect Markets and Agricultural Trade.* With A.F. McCalla & T.E Joslining (eds.), Allanheld, Montclair, New Jersey.

Saunders, C. (1975). *From Free Trade to Integration in Western Europe*, Hatham House.

Schmidt, S.C. & Vandenborre, R.J. (1992). "Preference patterns in the world coarse grain trade", *Canadian Journal of Agricultural Economics*, **18**(1), 19.

Schmitz, A.F. & Bawden D.L. (1973). *The World Wheat Economy: An Empirical Analysis*, Giannini Foundation Monograph No. 32, University of California, Berkeley.

Schnittker, J.A. (1993). "An assessment of international export market development efforts and recommendations for the 1990s". In: J.A. Helmuth & D.F. Hadwiger (eds.) (1993). *International Agricultural Trade and Market Development Policy in The 1990s*, Contributions in Economics and Economic History, Greenwood Press, London, pp.177-88.

Schultz, T.W. (1964). *Transforming Traditional Agriculture*, Yale University Press, New Haven.

Schwarz, G. (1978). "Estimating the dimension of a model", *Analysis of Statistics*, **6**, 461-64.

Schwert, G.W. (1987). "Effects of misspecification on tests for unit roots in macroeconomic data", *Journal of Monetary Economics*, **20**, 73-105.

Shaffer, J.D. (1996). "Review of 'The Economics of Agriculture', volume 2. Papers in honor of D. Gale Johnson", *Journal of Economic Literature*, **34**(2).

Shaw, G.K. (1984). *Rational Expectation*, Harvester Press.

Shei, SY. & Thompson, R.L. (1977). "The impact of trade restriction on price stability in the world wheat market", *American Journal of Argicultural Economics*, **59**, 628-38.

Sims, C.A. (1980). "Macroeconomics and reality", *Econometrica*, **48**, 1-48.155 of 614.

Spencer, J. (1986). "Trade liberalization through tariff cuts and the European economic community: a general equilibrium evaluation". In: T.N. Srinivasan & J. Whalley (eds.) (1986), *General Equilibrium Trade Policy Modeling*, MIT Press, Cambridge, Massachusetts.

Srinivasan, T.N. & Whalley, J. (eds.) (1986). *General Equilibrium Trade Policy Modeling*, MIT Press, Cambridge, Massachusetts.

Stevens, C. & Verloren van Themaat, J. (eds.) (1985). *Pressure Groups, Policies and Development*, Hodder & Stoughton, London.

Stock, J.H. & Watson, M.W. (1988). "Testing for common trends", *Journal of the American Statistical Association*, **83**, 1097-107.

Stopford, M. (1997). *Maritime Economics*, 2nd edn., Routledge, London.

Strandenes, S.P. (1984). *Price Determination in the Time-Charter and Second-Hand Markets*, Working paper No. 06, Centre for Applied Research, Norwegian School of Economics and Business Administration.

Stewart & Gill (1998), 2nd Edition, Prentice Hall

Svendsen, A.S. (1958). "Sea transport and shipping economics", *Bremen Weltschiffahsts Archiv*.

Thomas, R.L. (1997). *Modern Econometrics*, Addison Wesley, Lonodon.

Thomson, K.J. & Harvey, D.R. (1981). "The efficiency of the common agricultural policy", *European Review of Agricultural Economics*, **8**, 57-83.

Tinbergen, J. (1931). "Ein schiffbauzyclus?", *Weltwirtschaftliches Archiv*, **34**, 152-164.

Tinbergen, J. (1934). "Scheepsruimte en vrachten", *De Nederlandsche Conjunctuur*, March, 23-35.

Trela, I., Whalley, J. & Wigle, R. (1987). "International trade in grains: domestic policies and trade impacts", *Scandinavian Journal of Economics*, **89**(3), 271-83.

Tweeten, L. (1967). "The demand for U.S. farm output", *Food Research Institute Studies*, **8**, 343-70.

Tyers, R. (1985). "International impacts of protection: model structure and results for EC agricultural policy", *Journal of Policy Modeling*, **7**(2), 219-52.

Tyers, R. (1986). "Details of the simulation model of world grain and meat markets". In: K. Anderson & Y. Hayami, (1986), *The Political Economy of Agricultural Protection: East Asia in International Perspective*. With Aurelia George *et al.*, Allen and Unwin in association with the Australian National University, Australia-Japan Research Centre, Sydney, pp.152-61.

Tyers, R. & Anderson, K. (1986). *Distortions in World Food Markets: A Quantitative Assessment*. Background paper for the World Bank World Development Report, World Bank, Washington DC.

Tyers, R. & Anderson, K. (1987a). *Liberalizing OECD Agricultural Policies in the Uruguay Round: Effects on Trade and Welfare*, Working Paper in Trade and Development No. 87/10, Australian National University, Canberra.

Tyers, R. & Anderson, K. (1987b). "Global interactions and trade liberalization in agriculture", *Economic Policies and World Agriculture.*

Tyers, R. & Anderson, K. (1988). *Imperfect Price Transmission and Implied Trade Elasticities in a Multi-Commodity World*, Westview Special Studies in International Economics and Business series, Westview Press, London.

Tyers, R. & Anderson, K. (1991), *Disarray in World Food Market*, World Bank, Wasahington DC.

UNCTAD (1996). *Review of Maritime Transport*, UNCTAD.

USDA (1999). *Agricultural Statistics; World Agricultural Outlook and Situation*, USDA, Washington D.C.

Valdes, A. & Zietz, J., (1980) *Agricultural Protection in OECD Countries: Its Cost to Less Developed Countries* (Washington, DC: International Food Policy Research Institute) Research Report 21.

Veenstra, W.A. (1999). "The term structure of ocean freight rates", *Maritime Policy and Management*, **26**, 279-93.

Veenstra, W.A. (1999). "Quantitative analysis of shipping markets" Delft University Press.

Veenstra, W.A. & Franses (1999). "A cointegration approach to forecasting freight rates in the dry bulk shipping sector", *Transportation Research A*, **31**, 447-458.

Vergottis, A. (1988). *Econometric Model of World Shipping*, Ph.D. thesis, City University Business School, London.

Viscencio, H.B. & Fuller, S. (1986). "Effects of port user fees on export grain flow patterns", *Southern Journal of Agricultural Economics*, **18**(2), 25-37.

Viscencio, H.B. & Fuller, S. (1987). "Estimated effect of deepened U.S. gulf ports on export-grain flow patterns and logistics costs", *Logistics and Transportation Review*, **23**(2), 139-54.

Watson, J. (1994). *Reputation and Outcome Selection in Supergames*, University of California, San Diego Department of Economics Working Paper 94-15.

Weiss, A.A. (1986). "Asymptotic theory for ARCH models: estimation and testing", *Economic Theory*, **2**, 107-31.

Wergeland, T. (1981). *Norbulk: a Simulation Model of Bulk Freight Rates*, Working Paper No. 12, Norwegian School of Economics and Business Administration, Bergen.

West, K.D. (1987). "A specification test for speculative bubbles", *Quarterly Journal of Economics*, **102**, 553-80.

Whalley, J. (1985a). "Hidden challenges in recent applied general equilibrium exercises". In: J. Piggot, & J. Whalley (eds.) (1985), *New Developments in Applied General Equilibrium Analysis*, Cambridge University Press, Cambridge.

Whalley, J. (1985b). *Trade Liberalization Among Major World Trading Areas*, MIT Press, Cambridge, Massachusetts.

White, H. (1980). "A Heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity", *Econometrica*, **48**, 58-68.

Wijnolst, N & Wergeland, T.(1997). *Shipping*, Delft University Press.

Wilson, W.W. (1993). "Commodity options". In: G.L. Cramer & E.J. Wailes (eds.) (1993), *Grain Marketing*, 2nd edn., Westview Press, Oxford, pp.229-74.

Winters, A. (1987). "The economic consequences of agricultural support: a survey", *OECD Economic Studies*, **9**, 7-54.

Witzke, H. (1986). "Endogenous supranational policy decisions: the common agricultural policy of the european community", *Public Choice*, **48**(2), 157-74.

Working, H. (1960). "Note on the correlation of the first differences of averages in a random chain", *Econometrica*, **28**, 916-18.

Wright, B.H. & Heifner, R.G. (1993). *Pricing Grains*, Westview Press, Oxford.

Wright, G. (1993). "Expectations in the shipping sector", *International Journal of Transport Economics*, **20**(1), 67-76.

Zannetos, Z.S. (1966). *The Theory of Oil Tank Shipping Rates*, MIT Press, Massachusetts.

APPENDICES

APPENDIX 1: BULK COMMODITY PRICES AND FREIGHT COSTS

BULK COMMODITY PRICES AND FREIGHT COSTS* (US dollars per tonne)

Cargo	From	To	Cargo Size	Fob Price	Approximate Freight Rate	Fob + freight	Freight Cost as % of Landed Cost
Iron Ore	Australia	Japan	Cape	17.1	7.0	24.1	29
	Brazil	N.Europe	Cape	17.4	7.0	24.4	29
Steam	Australia(NS	Japan	Cape	40.9	8.5	49.4	17
Coal	W)	N.Europe	Cape	32.9	8.2	41.1	20
	S.Africa	N.Europe	Cape	37.5	7.5	45.0	17
	Colombia						
Coking	Australia	Japan	Cape	51.0	8.0	59.0	14
Coal	(Queensland)	N.Europe	Cape	48.0	7.0	55.0	13
	USEC						
Maize	US Gulf	Japan	Panamax	124,5	32,5	157	21
Wheat	US Gulf	N.Africa	Handy	177.0	33.0	210.0	16
	Argentina	China	Handy	147.5	45.0	192.5	23

* Estimates based on the mid-1997 position.

** Average of shredded and No.1 heavy melting.

*** Indicative CIF price in the UK.

Source: Drewry Shipping Consultants

APPENDIX 2: The Principle of ARCH Model

Engle (1982) test uses the following auxiliary regression on the square of residuals. This is done to see if the past values of the residuals significantly effect the current values.

$$e_t^2 = \gamma + \sum_{i=1}^{p} \delta_i \; e_{t-i}^2 + v_t$$

The significance of the past values of the square residuals can be tested by LM or F tests.

The measurement of time varying volatility of a time series through Autoregressive Conditional Heteroscedastisity models first introduced in a seminal paper by Engle (1982). In this type of models, the variance of the residuals (equivalent to error term variance) in the regression equation is conditional on its past values and the model is called Autoregressive Conditional Heteroscedastisity (ARCH). Engle suggested the following model in order to condition the variance on the past values of the square residuals.

$$Y_t = \beta_1 + \sum_{i=1}^{n} \beta_i X_i + \varepsilon_t \qquad \varepsilon_t \sim IN(0.\sigma_t^2) \;\; t = 1,...,T$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{m} \alpha_i \varepsilon_{t-i}^2$$

Where Y_t is the dependent variable, X_t are the independent variables and the α_i, β_i are the parameters of interest. Notice that if the parameters of the squared error terms are not statistically significant, then variance will be constant and there will not be any heteroscedasticity in the error terms.

Bollerslev (1986) extended the idea in the class of ARCH to the more flexible form of General Autoregressive Conditional Heteroscedastisity (GARCH). In the more general form (GARCH) variance is conditioned on both its past values as well as past values of the error terms.

$$Y_t = \beta_1 + \sum_{i=1}^{n} \beta_i X_i + \varepsilon_t \qquad \varepsilon_t \sim IN(0.\sigma_t^2) \quad t = 1,...,T$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{m} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{n} \lambda_i \sigma_{t-j}$$

where the variables are same as before and $\alpha_t, \beta_t, \lambda_t$ are the parameters of interest. Significance of λ_t parameters in the model indicate the dependence of the current value of the variance on its past values. Again it can be said that if the parameters of past values of squared errors and variance are not statistically significant, then the variance of the regression is constant.

The number of the lagged error terms and variances in the equation is called the order of ARCH or GARCH model [denoted as ARCH (m) or GARCH (m,n)]. It is cleat that a GARCH (m,0) model is the same as ARCH (m) model. Although many versions of the GARCH models have been introduced since Engle's first paper on this area. But the most common type of model used in the literature extensively to model the economic variables is GARCH (1,1).

APPENDIX 3: The Model of Two Ways Trade in Grain (Simultaneous Import and Export)

The two-way trade in wheat is accommodated by specifying EU food demand from imported (M) and domestic (D) supplies as functions of both the import (threshold) price P^t and the domestic (intervention) price P:

$M = M(P^t, P)$, with $M_{pt} < 0$, $M_p > 0$, and (1)

$D = D(P, P^t)$, with $D_p < 0$ and $D_{pt} > 0$ (2)

where M_{pt}, M_p, D_p, and D_{pt} are first derivatives of the dependent variable with respect to the subscribed variable.

The excess demand (Z) in the rest of the world for EC wheat is given by:

$Z = Z(P^w)$, with $Z_{pw} < 0$ (3)

where P^w is the world wheat price. The EC excess supply of wheat (to domestic food and world demands) is represented by:

$S = S(P)$, with $S_p > 0$ (4)

where S is the excess supply function for 'low quality' wheat and is domestic production net of non-food demand which includes feed, inventory (public and private) and residual uses. The relationship between domestic and world prices is given by:

$P = P^w + s$ (5)

where s is normally greater than zero and represents the variable per unit export restitution payment. The import threshold price is related to the world price by a variable per unit import levy t:

$P^t = P^w + t$ (6)

where $t > s$ is the normal situation, thus implying that

$P^t \geq P$ (7)

By definition, exports (E) from the EC are

$$E = S - D \qquad (8)$$

and net trade (NT) is

$$NT = E - M = S - D - M \qquad (9)$$

Clearing prices on the world market are determined by equating the EC's net trade to world demand:

$$S - D - M = Z \qquad (10)$$

The impacts of EC policy can be illustrated by substituting equations (1) to (4) into equation (10), totally differentiating, and solving for

$$\frac{d\,P^w}{d\,p^t} = \frac{-\left[M_{p^w} + D_{p^t}\right]}{Z_{p^w}} \qquad (11)$$

and

$$\frac{d\,P^w}{dP} = \frac{-\left[D_p + M_p - S_p\right]}{Z_{p^w}} \qquad (12)$$

Conditions (11) and (12) show that increases in threshold and intervention prices have a negative impact on world prices, assuming the other price is held constant, if $M_{P^t} + D_{P^t} < 0$ and $D_p + M_p - S_p < 0$, representative. These conditions can be expressed using elasticity as

$$\in_{Pt}^{Pw} = \frac{-\left[\in_{p^t}^{M}(M/Z) + \in_{p^t}^{D}(D/Z)\right]}{\in_{p^w}^{Z}} \qquad (13)$$

and

$$\in_{p}^{pw} = \frac{-\left[\in_{p}^{D}(D/Z) + \in_{p}^{M}(M/Z) - \in_{p}^{S}(S/Z)\right]}{\in_{pw}^{Z}} \qquad (14)$$

where $\in^i_j$ is the elasticity of i with respect to j. In a two-goods world the Cournot aggregation condition of consumer demand theory implies that the elasticity of demand from domestic supplies with respect to the threshold price ($\in^{D_t}_p$) is less than the direct price elasticity of import demand ($\in^{M_t}_p$), provided the expenditure share of imported wheat is smaller than the expenditure share of domestic wheat. However, this does not appear sufficient to sign the derivative (11) of the elasticity (13). A similar argument holds for (12) and (14). In general, it seems more likely that (14) will be negative than (13) because of the inclusion of the $\in^S_P$ term. Note also that a large value of $\in^Z_{pw}$ reduces the impact of EC price changes on world price levels.

The effect of EC price policies on EC trade is shown in equation (15) to (18). Increasing the intervention price or reducing the threshold price, while holding the other constant, increases *gross* exports by the Community (equation 15 and 16) but the effect on *net* trade is indeterminate (equation 17 and 18).

$$\in^E_P = \in^S_P(S / E) - \in^D_P(D / E) > 0 \qquad (15)$$

$$\in^E_{pt} = - \in^D_{pt}(D / E) < 0 \qquad (16)$$

$$\in^{NT}_P = \in^S_P(S / NT) - \in^D_P(D / NT) - \in^M_P(M / NT) \gtreqless 0 \qquad (17)$$

$$\in^{NT}_{pt} = - \in^D_{pt}(D / NT) - \in^M_{pt}(M / NT) \gtreqless 0 \qquad (18)$$

An econometric model of the EC wheat sector is developed in the next section in order to obtain estimates of these parameters that determine the impact of EC price policies on EC wheat trade and world prices.

APPENDIX 4: ALTERNATIVE MEASURES OF PROTECTION FOR CEREALS, 1988 ($ PER UNIT)

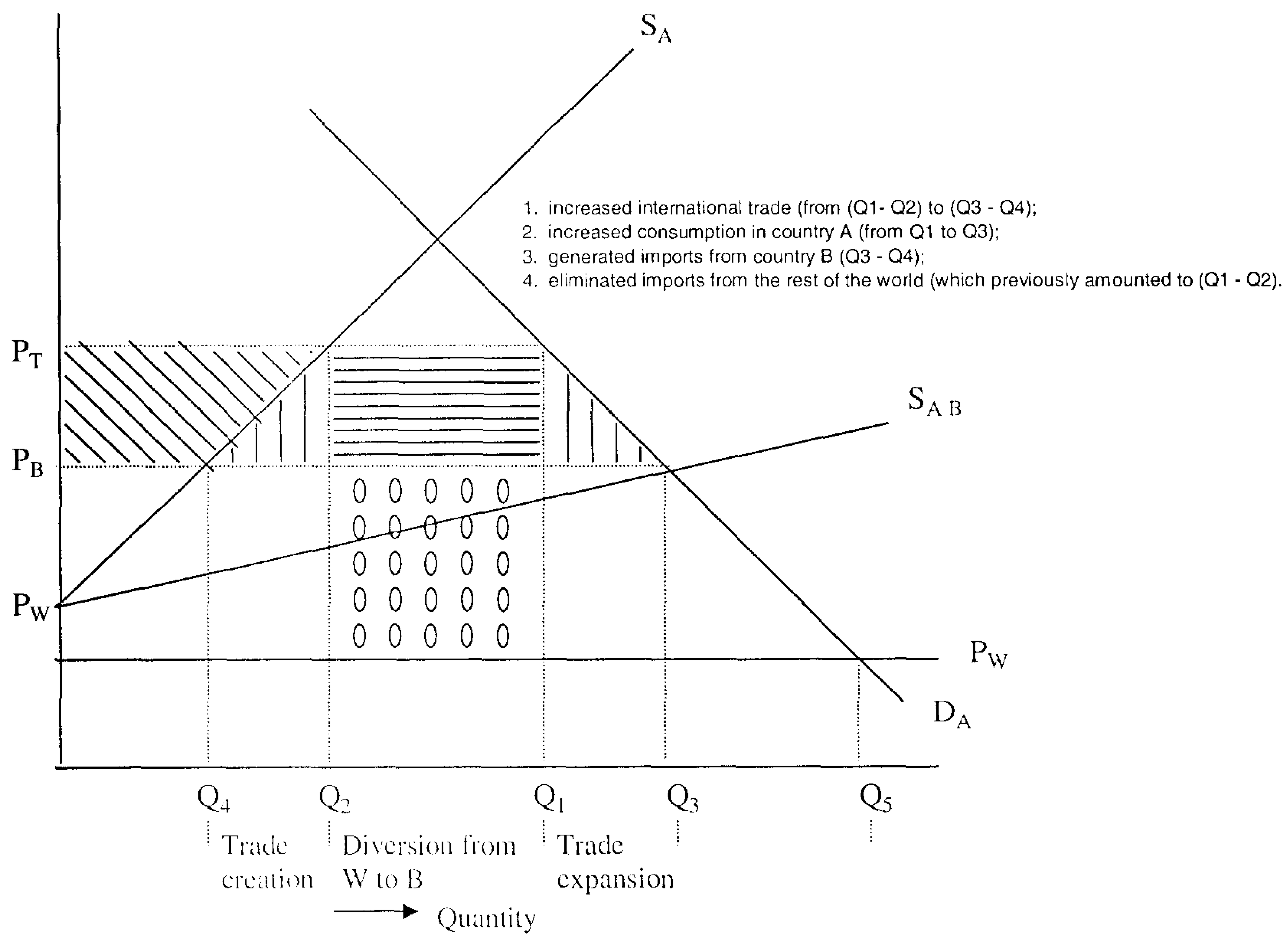
	Wheat			Coarse grains		
	PSE	TDE	Producer to border price differences	PSE	TDE	Producer to border price differences
Australia	14.0	0.0	-46.7	7.8	0.0	0.0
Austria	182.5	195.2	198.7	110.7	122.8	102
Canada	78.8	21.5	6.2	25.2	11.5	8.9
Finland	475.8	372.9	373.2	410.1	325.5	322.3
Japan	1372.9	1077.2	1035.1	1357.3	1055.7	1044.5
N. Zealand	16.0	0.0	0.0	3.0	0.0	0.0
Sweden	78.6	82.9	83	69.6	70.7	72.2
U.S.A.	68.0	23.8	11.3	55.0	9.1	0.0
EU	62.6	52.1	57.3	66.2	61.4	61.1

Source: OECD (1989).

APPENDIX 5: A Model of Customs Union Effects on International Trade

As Barrass and Madhavan (1997) illustrated the economic effect of a customs union in following diagram. Countries *A* and *B* form a custom union. The Figure illustrates the relationships between the price of the good, the quantity demanded, and quantities supplied under different tariff regimes.

Trade creation, diversion and expansion



The demand in country *A* is given by the curve D_A. S_A represents the supply in country *A*. P_W is the world market price.[214] If imports into country *A* are subject to tariff $(P_T - P_W)$ where P_T is the consumer price in country *A* and P_W is world price. At price P_T the producer in country *A* would produce Q_2, total consumption is Q_1, with the balance $(Q_1 - Q_2)$ accounted for by imports from the rest of the world at P_W plus tariff. If country *A* joins in a customs union with country *B*, imports from *B* will no longer be subject to the tariff. The tariff-free supply of the good is then shown by

[214] It is assumed that the world market is perfectly competitive.

the curve S_{AB}. which represents the aggregate amounts (depending on the level of price) that the industries in both *A* and *B* are prepared to supply to *A*'s market. Imports from the rest of the world continue to be subject to the tariff, and so in the customs union it is cheaper to import (free of tariffs) from country B than from the rest of the world. The new market price in country *A* is P_B, and consumption increases from Q_1 to Q_3. The new level of demand (Q_3) is met by a combination of supply from country *A* (Q_4) (the quantity that A's industry is prepared to supply at price P_B), and imports from B $(Q_3 - Q_4)$. (This is the quantity that *B* is prepared to export to A at price P_B). Imports from the rest of the world cease, because their price after the tariff is levied (P_T) renders them uncompetitive following the formation of the customs union between *A* and *B*.

Some trade has been created, and some diverted from low-cost suppliers in the rest of the world, and also from high-cost suppliers in country A.

In terms of the figure, it could be assumed that the effects of the EU policy on structure of demand for international shipping are measured as follows:

Gross increase in trade $(Q_3 - Q_4)$
Minus Trade diversion $- (Q_1 - Q_2)$
Equals Net increase in trade,
comprising Trade creation $= (Q_2 - Q_4)$
plus Trade expansion $+ (Q_3 - Q_1)$

The single market is the nucleus of the European community. The central is integration of the economies of member states within an economic entity, which is greater than the sum of its parts.

APPENDIX 6: Different Stages of Economic regional Integration

Different stage of the economic (regional) integration could be classified as follows:

1. *Sectional Integration*, i.e. the removal of barriers to trade in output of a single industry, for example in the European Coal and Steel Community (ECSC);
2. *Free Trade Area*, where member states remove all trade barriers among themselves but retain their freedom with regard to the determination of their policies *vis-à-vis* the third country, e.g. the European Free trade Association (EFTA) and the Latin American Free Trade Area (LAFTA),etc.[215]
3. *Customs Unions*, which is very much like free trade areas, expect that member countries are obliged to contact common external relations. For instance, they must adopt common external tariffs on imports from the outside world. The European Economic Community (EEC) was in this sense, a custom union, but there was more to it than just that;
4. *Common Markets*, which are customs union that also allow for free factor mobility across member state, i.e. capital, labour and enterprise should move without hindrance between the member states, e.g. East African Common Market (EACM), and the EC (in Its time)
5. *Complete Economic Union*, which are common markets that call for complete unification of monetary and fiscal policies, i.e. there is a central authority which controls these aspects so that existing nations become regions of the union, such as the EU (since 1992).
6. *Complete political integration*, where the participants become literally one nation, i.e. the central authority not only controls monetary and fiscal policies but also has a central parliament with the sovereignty of the member states governments, i.e. the former Soviet union.

[215] EFTA excludes agricultural products from its arrangements.

APPENDIX 7: A Model of Full Political Integration for the EU

Penteland (1973) is as follows:

	National States	Superstate
Political	Pluralism: a community of sovereign states	Federalism: a federation of states
Economic	Functionalism: a transitional net work of organisations performing specific tasks	Neo-functionalism: a supranational state

Source: Penteland (1973)

Elements of all of these models can be found in the EU Treaty. The intergovernmental provision for political co-operationare principally a manifestation of pluralism; and in so far as activities are co-ordinated between countries there are elements of functionalism.

The super-state model represents an opposite extreme. Federalism would depict the community as a framework for a United States of Europe', similar to the United States of America, with a separate tire of government above those of member states. From the neofunctionalist perspective, the interaction of economic interests is a driving force which shifts loyalties to new centres, and which is liable to render the nation state absolute. The community in this scenario is an entity distinct from the sum of its member states.

When the community was first established, Europe was divided by superpower dominated blocs, and member states' economies were recovering from the ravages of war. The present economic context is different in many ways. The European Community has enjoyed many years of sustained economic growth and political stability. Meanwhile, the community has proceeded with economic integration, but it has also become more diverse, as its membership has enlarged. Changes which have occurred in Europe since the Second Word War are also manifested in the global economy. International trade and investment have increased, and tariff barriers have been lowered. The European Community, as a result of its integration into a single market, is now a major economic entity in its own right, and to a large extent is the conduit for its member states' influence on the global economic system.

APPENDIX 8: Grain Ports Specification

ANALYSIS OF THE DRY BULK FLEET BY LENGTH, BEAM AND DRAFT

BULK CARRIERS; LENGTH OVERALL

Dwt Range	10-30,000		30-50,000		50-80,000		80-100,000		100-150,000		150,000+		Total	
Metres	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt
<120	7	77	-	-	-	-	-	-	-	-	-	-	7	77
120-130	66	756	-	-	-	-	-	-	-	-	-	-	66	756
130-140	75	959	-	-	-	-	-	-	-	-	-	-	75	959
140-150	287	4,678	-	-	-	-	-	-	-	-	-	-	287	4,678
150-160	357	7,098	1	32	-	-	-	-	-	-	-	-	358	7,130
160-170	460	10,723	1	32	-	-	-	-	-	-	-	-	461	10,755
170-180	486	12,806	180	6,061	-	-	-	-	-	-	-	-	666	18,867
180-190	304	8,065	670	25,268	-	-	-	-	-	-	-	-	974	33,333
190-200	32	866	412	15,976	10	529	-	-	-	-	-	-	454	17,371
200-210	1	24	113	4,527	32	1,683	-	-	-	-	-	-	146	6,234
210-220	-	-	36	1,592	80	4,349	-	-	-	-	-	-	116	5,941
220-230	2	57	25	954	505	31,966	2	174	-	-	-	-	534	33,151
230-240	-	-	-	-	55	3,710	3	255	1	110	-	-	59	4,075
240-250	-	-	-	-	50	3,711	9	798	1	105	-	-	60	4,614
250-260	-	-	-	-	46	3,263	17	1,423	20	2,307	-	-	83	6993
260-270	-	-	-	-	1	74	-	-	89	11,115	-	-	90	11,189
270-280	-	-	-	-	-	-	-	-	70	9,971	2	302	72	10,273
280-290	-	-	-	-	-	-	-	-	21	2,931	12	1,981	33	4,912
290-300	-	-	-	-	-	-	-	-	2	297	50	8,851	52	9,148
300-310	-	-	-	-	-	-	-	-	4	585	16	2,972	20	3,557
310-320	-	-	-	-	-	-	-	-	-	-	9	1,898	9	1,898
320+	-	-	-	-	-	-	-	-	-	-	2	501	2	501
Unspecified	10	246	12	494	2	135	1	91	10	1,284	1	188	36	2,438
Total	2,087	46,355	1,450	54,936	781	49,420	32	2,741	218	28,705	92	16,693	4,660	198,850

Source: Drewry Shipping Consultants (based on vessel information as recorded by Clarkson Research Services Ltd.)

BULK CARRIERS; DRAFT

Dwt Range	10-30,000		30-50,000		50-80,000		80-100,000		100-150,000		150,000+		Total	
Metres	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt	No.	'000 Dwt
<7.0	2	[illegible]	-	-	-	-	-	-	-	-	-	-	2	39
7.0-7.5	15	184	-	-	-	-	-	-	-	-	-	-	15	184
7.5-8.0	45	516	3	106	-	-	-	-	-	-	-	-	48	622
8.0-8.5	118	1,541	-	-	-	-	-	-	-	-	-	-	118	1,541
8.5-9.0	135	2,094	-	-	-	-	-	-	-	-	-	-	135	2,094
9.0-9.5	327	6,138	1	32	-	-	-	-	-	-	-	-	328	6,170
9.5-10.0	616	14,128	32	1,160	-	-	-	-	-	-	-	-	648	15,288
10.0-10.5	503	12,793	56	2,011	-	-	-	-	-	-	-	-	559	14,804
10.5-11.0	293	8,080	531	18,972	1	59	-	-	-	-	-	-	825	27,111
11.0-11.5	21	561	527	20,095	6	350	-	-	-	-	-	-	554	21,006
11.5-12.0	3	87	185	7,632	14	767	2	175	-	-	-	-	204	8,661
12.0-12.5	2	43	96	4,051	230	13,377	-	-	-	-	-	-	328	17,471
12.5-13.0	1	27	12	581	144	8,865	5	433	-	-	-	-	162	9,906
13.0-13.5	-	-	1	33	258	16,733	2	177	1	110	-	-	262	17,053
13.5-14.0	1	29	-	-	74	5,276	3	245	1	100	-	-	79	5,650
14.0-14.5	1	27	-	-	49	3,624	14	1,164	8	877	-	-	72	5,692
14.5-15.0	-	-	-	-	4	305	1	84	9	1,091	-	-	14	1,480
15.0-15.5	-	-	-	-	1	64	4	373	21	2,502	-	-	26	2,939
15.5-16.0	-	-	-	-	-	-	-	-	40	5,037	-	-	40	5,037
16.0-16.5	-	-	-	-	-	-	-	-	56	7,490	1	183	57	7,673
16.5-17.0	-	-	-	-	-	-	-	-	54	7,805	3	499	57	8,304
17.0-17.5	-	-	-	-	-	-	-	-	22	3,002	15	2,436	37	5,438
17.5-18.0	-	-	-	-	-	-	-	-	1	145	23	3,949	24	4,094
18.0-18.5	-	-	-	-	-	-	-	-	-	-	39	7,288	39	7,288
18.5+	-	-	-	-	-	-	-	-	-	-	9	1,966	9	1,966
Unspecified	4	68	6	263	-	-	1	90	5	546	2	372	18	1,339
Total	2,087	46,355	1,450	54,936	781	49,420	32	2,741	218	28,705	92	16,693	4,660	198,850

Source: Drewry Shipping Consultants (based on vessel information as recorded by Clarkson Research Services Ltd.)

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Loading Equipment
Canada - Great Lakes / St. Lawrence (cont'd)	Port Colborne	Robin Hood dock	305	7.6			Elevator.
		Wharf No. 20	275	5.8			Elevator.
	Thunder Bay	Canada Malting dock	305			63	Elevator.
		Cargill Elevator Berth	300			176	Elevator.
		Manitoba Pool 1	273			170	Elevator.
		Manitoba Pool 3	335			150	Elevator.
		Mckellar Island	262				Elevator.
		Mission River	550				Elevator.
		Richardson Terminal	274			209	Elevator.
		Saskatchewan Pool 4A & 4B	414			223	Elevator.
		Saskatchewan Pool 7A	518			363	Elevator.
		Saskatchewan Pool 7B	341	Same as Pool 7A.			Elevator.
		Superior PH Berth	351			40	Elevator.
		United Grain Growers	452			231	Elevator.
		United Grain Growers M Dock	378			91	Elevator.
		Western Grain By-Products	300			30	Elevator.
	Windsor	Windsor Grain Terminal	396	8.2			
Canada - Maritimes	Halifax	HPC Elevator - Pier 28	171	12.2	1,000	144	
	St John	Ports Canada - 3A-B	312	10.1	1,680	40	
Canada - Pacific	Prince Rupert	Ridley Island - Prince Rupert Grain	240	14.5	4,000		3 ship loaders with conveyor, 4,000tph.
	Vancouver	Alberta Wheat Pool	274	15.3		283	Spouts.
		Pacific Elevators	244	9.8			
		Pioneer Terminals	180	15.2	2,000	108	Two loaders.
		Saskatchewan Wheat Pool	230	12.2		240	5 spouts at both inshore & outshore berths.
		United Grain Terminal		11.6	1,000	102	Two belt system.
China	Dalian	Dong Bu Area	222	12.0			
		Gan Jing Zi	260	15.0			
		Xi Bu Area	220	12.0			
	Shanghai	Ming Sheng - 5 Berths	969	10.0			
	Tianjin	Area No.2 - 2 Berths	246	11.5		35	
	Zhenjiang	District No.4 - 6 Berths	1352	12.0			8 Shore cranes.
France	Bayonne	Grain Silo - Maisca	130	7.0	450	60	
	a) Bordeaux	Blaye Grain Terminal		8.1	700	130	1 gantry, loading 11,000 tpd & bag facility, 2,400 tpd.
	a)	Down River Bassen Grain Terminal		10.5	900	195	2 gantries, loading 12,000 tpd.
		Letico		9.5	1,200	80	1 gantry loader, loading 15,000 tpd.
	a)	SICA (shares with STE Aquitaine)		10.0	900	115	2 gantry 12,000 tpd

(cont'd)

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Loading Equipment
Australia (cont'd)	Port Lincoln	Berths 4 & 5	348	14.9	4,000		2 travelling loaders.
	Port Pirie	Berth No.2	183	8.2	800		Conveyor belt with 5 spouts.
	Portland	Berths 1 & 2	396	11.0	1,200		2 travelling loaders.
	Wallaroo	Berths 1-2 N & S	172	8.2	800		Conveyor belt.
	Albany	Bulk Han'ling Ltd : No. 3 Berth	227	12.2	1,600		3 loading booms and spouts.
	Fremantle	Kwinana Grain Jetty	291	16.8	5,000		Conveyors and loaders.
	Geraldton	No.3 Berth	203	9.4	1,000		2 automatic loaders.
Belgium	Antwerp	Northern Shipping Terminal	300	10.7			2 loaders with telescopic spiral chutes, loading 3,000 tpd.
	Antwerp	Samga	850	9.8	1,300	120	Loading 15,000t per 2 shift.
	Ghent	Euro-Silo (Loading) No.96	210	12.3			3 loading, 2 mobile & 1 fixed tower, 15.24 max airdraft.
Brazil	Paranagua	Cargill - Berth 12		10.1	500	20	1 loading tower.
		New Grain Terminal	162	10.1	3,000	110	2 loading towers, plus 2 vertical storage.
		Port Silo - Berth 1		9.4	300	10	1 loading tower.
		Sanbra - Berth 6	180	8.2	700	92	2 fixed & 1 movable towers.
		Socopar - Berth 2		9.4	300	64	1 loading tower.
	Rio de Janeiro	Berth 22	240	7.1			
		Berth 5	280	8.8			
	Rio Grande	Cesa Silo	150	8.8		50	2 towers with pneumatic suction, loading & discharge.
		Cotrijui Grain Terminal	265	11.3	1,000	200	8 tubes & 2 belts.
		Potrobas Wheat & Soyabeans	413	11.3	1,200	400	
	Santos	Macuco Quay- 3 Terminals	200	11.0	3,000	69	6 Conveyors, 60-150 tph.
Canada - Great Lakes / St. Lawrence	Comeau Bay	Cargill Grain Terminal	178	11.6	3,000	441	Elevator.
	Montreal	Port of Montreal: Elevator No.4	395	10.7	3,000	260	
	Quebec	Anse au Folon		11.3		76	
		St Charles River Estuary		11.0	3,600	225	5 bridge towers, 1 conveyor & up to 440t mobile cranes.
	Sorel	Les Elevators de Sorel	190	10.7			Elevators.
	Collingwood	Collingwood Terminals	396	6.4			
	Goderich	Wharf A	425	7.4			
		Wharf B	140	7.4			
	Midland	Canada Steamship Lines		7.3		74	
		Canadian National Railway		7.0		126	
		Maple Leaf Mills Elevator		5.8		119	
	Port Colborne	Canada Starch Dock	120	8.2			loading by ship's gear only.

MAJOR GRAIN PORTS

Grain Loading Ports

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Loading Equipment
Argentina	Diamante	Elevator Berth - Northern End	160	9.1	1,000	20	Elevator has 6 chutes, using any 2 simultaneously.
	Ramallo	Elevator Wharf	145		500	20	Two loading belts.
	Rosario	FACA	130	9.1	1,200	19	Floating jetty.
		Genaro Garcia - Private	140	10.7	1,000	7	Elevator.
		Punta Alvear - Private	144	10.7	1,800	60	Elevator with 3 towers.
		Unit III	80	9.1	400	80	
		Unit IV	145	8.8	500	35	
		Unit VI - Elevator Berth	250	9.5	1,500	125	9 chutes & 5 belts loading 300 tph each.
	San Lorenzo	ACA Elevator Wharf		9.1	1,800	55	2 belts serving 4 chutes.
		Vicentin/Duperial Pier			1,200		3 chutes.
	San Lorenzo (San Martin)	Dempa Wharf	100	10.7	500	110	1 fixed loading tower.
		El Quebracho - Cargill			1,000	37	3 loading tubes.
		El Transito Wharf	140	9.8	500	26	2 fixed loading towers.
		IMSA Elevator Wharf	150	9.1	1,500	85	4 chutes & 2 belts.
		San Lorenzo	180	12.2	2,200		4 loading chutes, 2 only at once.
	San Nicolas	Elevator Wharf	220		1,500	91	2 belt loading 2 tubes (6 available)
	San Pedro	Elevator Berth	218		500	90	1 elevator loading via 7 telescopic chutes.
	Santa Fe	Unit 1	240	7.3	2,400	68	3 elevators, main one 3 belts & 8 chutes.
	Villa Constitucion	Elevator Berth	175	8.2	700	205	2 belts serving 7 chutes, only 2 at once.
	Bahia Blanca (Ing White)	Central Grain Elevator - Berths 5 & 8	600		960	145	Each berth has 5 spouts and fed by 2 belts.
		New Elevator - Berth 9	234	11.7	2,800	221	Elevator damaged in 1985 and presently unusable.
	Buenos Aires	New Port - Basin D	585		4,500	170	Elevator delivers 13,500 tph to 3 vessels.
	Mar del Plata	Overseas Basin - North Side	300	9.1	800		Two belts with 8 tubes, can load 2 vessels.
		Overseas Basin - South Side	470	9.1	700		Two loading towers.
	Quequen	Berth 3	220	9.8	1,200	70	2 loading belts with pipe fitted with trimmer.
		Berth 4 - 5 : National Grain Board	230	9.2	350	80	4 belts serving 8 tubes.
		Berth 6	120	9.8	600		2 belts serving 7 tubes.
Australia	Brisbane	Fisherman Islands Grain	240	13.0	2,200	60	
		Pinkenba Wheat Wharf	400	10.5	1,500	122	
	Gladstone	Auckland Point No.2	255	11.3	1,600	82	2 mobile gantry loaders.
	Newcastle	West Basin No.3	245	11.6	4,000	170	4 travelling gantry loaders.
	Sydney	Glebe Island	229	11.6			Loading gantry with 4 heads.
	Port Kembla	Grain Berth	290	16.3	5,000	260	2 loaders.
	Adelaide	Berth No.27	204	10.7	800		2 loaders.
	Port Giles	Bulk Berth	256	11.6	800		5 loading booms.
	Geelong	Bulk Grain Pier	201	11.0			4 spout loader.

(cont'd)

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Loading Equipment
France (cont'd)	a) Bordeaux	STE Aquitaine		10.0	900	40	2 gantry 12,000 tpd
		Up river Bassen River Terminal		12.5	1,200	80	1 gantry, loading 15,000 tpd.
	Dunkerque	Agro-Bulk Centre					1 loader, loading 7,000 tpd.
	a)	SICA Nord Cereales	300	13.8	1,000	215	1 gantry crane, airdraft 24.8m & 27m outreach.
	a) La Rochelle	Terminal Lombard	400			450	Grain berth with 2 gantry cranes, loading 18-20,000 tpd.
	a) Le Havre	Le Havre Grain Centre	300	12.5	1,200	95	
	a) Nantes/St Nazaire	Roche-Maurice Terminal	747	8.5	1,400	150	2 gantries, loading 20,000 tpd.
	a) Rouen	Socomac I		9.8	600	60	1 mobile loader, 3,300t per shift.
	a)	Socomac II		9.0	450	27	1 mobile loader, 3,300t per shift.
	a)	UCACEL	250		5,800	500	8 pipes, loading 50,000 tpd.
	a) Sete	Multibulk Terminal	200	13.2		20	5,000tpd loading.
Greece	a) Thessaloniki	Thessaloniki Port authority	160	9.3		20	1 silo tower pipe.
Saudi Arabia	Dammam	Berth No.1 - Grain Terminal	240	13.5	480		2 pneumatic loaders.
	Jeddah	Private Wharf		13.5	200		Gantry booms, vacuum pipes & conveyor.
S Africa	Cape Town	Collier Jetty			1,000	27	Continuous elevator.
	Durban	Maydon Wharf No.8	172	9.8	1,290	35	4 sprouts.
Spain	a) Cadiz	Muelle Exterior Quay	774	6.0			Same as discharge.
	a) Gijon	Port of Gijon	576	8.0	2,000		2-30t, 5-12t cranes & 2 mobile conveyors.
Sweden	a) Helsingborg	Grain Quays 601-5	400	13.5	250	250	Loading 1,000 tph.
	Norrkoping	Djuron - Grain Terminal	160	12.2	500		Travelling loader.
	Stockholm	Berths 630-8					
UK	Edinburgh	Leith Docks Imperial Grain Silo	197	9.2	500	56	2-30m & 4-20m conveyors.
		Leith Docks	300	9.2	700		2 mobile conveyors with telescopic spouts and throwers
	Grimsby-Immingham	Immingham Grain Silos	223	10.4		12	Loader with, 5,000 tpd.
	Hull	Humberside Grain Terminal	198	10.4	1,200	60	Mobile tower.
	Ipswich	Cliff Quay	990	8.2	700	11	8 portal jib cranes 3-35t.
	Middlesbrough	Teesbulk Handling		10.9	1,000	8	
	Newcastle	Tyne Grain Terminal		10.5	1,000	37	1 loader & trimmer, 5-8,000 tpd loading.
	Southampton	Continental Grain		10.5	1,000	16	
USA - Great Lakes	Chicago	Cargill Grain Elevator	366	8.2	1,633	626	5 loading spouts.
		Continental Grain - Elevator B	312	8.2	1,100	185	5 loading spouts.

(cont'd)

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Loading Equipment
USA - Great Lakes (cont'd)	Chicago	Continental Grain - Elevator C	305	8.2	4,350	177	8 loading spouts.
	Duluth-Superior	Cargill B-1	328	8.2		54	4 spouts.
		Cargill B-2	328	8.2		212	2 spouts.
		General Mills	580	8.2		103	2 spouts.
		Harvest State No.1	213	9.2		218	10 spouts.
		Harvest State No.2	380	8.2		299	6 spouts.
		International Multifoods	283	8.2		112	1 spout.
		Peavey Co. Connors Point	241	9.2		95	6 spouts.
		Peavey Co. Elevator M	244	8.5		57	
		Peavey Co. Globe Elevator	189	8.2		109	3 spouts.
	Erie	Erie Grain Elevator	299	7.3	70		
	Milwaukee	Cargill	360	6.4		82	Elevator.
		Continental Grain Elevator	233	8.5		95	Elevator.
	Oswego		305	6.4		27	
	Toledo	Anderson Elevator Dock	320	8.2	1,360	191	
		Cargill Elevator	244	8.2	1,360	109	
		Mid-States Terminal	310	8.2		245	
USA - Atlantic	Albany	APDC Terminal		9.8	1,360	367	
	Baltimore	Berth 7 - Indiana Grain	305	10.7	2,040	87	3 conveyor booms & 3 spouts.
		Canton Grain Elevator, 2 Berths	432	10.1	2,177	107	2 loaders, 4 conveyors and 5 spouts.
	Charleston	North Charleston Container Terminal	194			41	
	Chesapeake	Cargill Grain Terminal	305	12.2			
	Norfolk	Cargill Terminal	290	12.2	1,633	186	2 gantry loaders.
	Norfolk - Sewells Point	Continental Grain Elevator	259	12.2	1,360	90	3 loaders.
USA - Gulf / Mississippi	Baton Rouge	Burnside Terminal - 5 Berths	267	12.2	1,000		2 gantry cranes & conveyor.
	Beaumont	Continental Grain Elevator	250	12.2	1,875	95	
	Brownsville	Public Grain Elevator	122	10.4	1,000	103	
	Corpus Christi	Producers Grain			1,500	174	
		Public Grain Elevator	274		1,000	136	
	Destrehan	Bunge Elevator	213	12.5	1,900	115	2 loading belts.
		St. Charles Elevator	328	12.5	2,000	168	2 loading belts.
	Galveston	Elevator B - Bunge Corp	259	12.8	160		
		Union Equity	248	12.8	85		
	Houston	Cargill		12.2	1,900	155	
		Elco Shipside Elevator	152	9.8	680	54	
		Public Grain Elevators	213	11.0	2,180	163	
		Union Equity Grain elevator	299	12.2	1,200	163	
		Woodhouse Grain Elevator		11.6	1,000	326	
	Mobile	Public Grain Elevator, 4 Berths	300				
	Myrtle Grove	Myrtle Grove	152	14.6	3,250		4 spouts.

(cont'd)

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Loading Equipment
USA - Gulf / Mississippi (cont'd)	New Orleans	Ama - Farmer's Export Elevator	168	12.2	2,000		4 loading arms.
		Continental Grain Elevator - Westwego	1,100	12.2	5,000		4 loading belts.
		Public Grain Elevator - Berth No.2	204	12.2	550		2 loading belts.
		Public Grain Elevator - Berth No.3	198	12.2	550		2 loading belts.
		Public Grain Elevator - Berth No.4	194	12.2	1,100		2 loading belts.
	Pascagoula	Elevator Berth West Harbour	238	11.6		85	
	Paulina	St. Elmo Elevator		13.6	1,500	51	
	Port Arthur	Texaco Island Elevator				46	Elevator with 4 spouts.
USA - Pacific	Kalama	Harvest States Cooperatives	183	12.2	1,500	174	Loader, 2 vertical & horizontal conveyors with 7 spouts.
		Peavey Grain Company	172	12.2	3,000	54	1 belt & 4 sprouts.
	Longview	Continental Grain Elevator, Berth 4				141	Elevator & 6 gantry spouts.
	Portland (Oregon)	Bunge Corp. Elevator		12.2	1,200	41	1 belt & 5 spouts.
		Columbia Grain Elevator - Terminal 5		12.2	1,800	110	2 belts & 3 spouts.
		Louis Dreyfus Corp Elevator		12.2	1,200	41	1 belt & 6 spouts.
	a)	Portland Bulk Terminal, Terminal 4		12.2	2,400	218	1 belt & 2 spouts.
	Sacramento	Pier 5	183	9.8	600	30	1 loader & conveyor system.
	Seattle	Cargill Grain Terminal - Pier 86	183	21.3	3,000	114	Twin belt conveyor.
	Tacoma	Continental Grain Elevator	244	21.3	2,400	82	
	Vancouver	United Grain Corp	305	12.2	2,400	136	7 spouts loading 40,000 bushels per hour.
Uruguay	Montevideo				320		2 mobile grain vacuvators & 10 smaller machines.
	Nueva Palmira		240		900	75	Cranes & barges.

Note: (a) Transshipment

Sources: *Various Port Directories*
Port Authority Contacts
Drewry Shipping Consultants Ltd.

(cont'd)
MAJOR GRAIN PORTS

Grain Discharge Ports

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Discharge Equipment
Algeria	a) Algiers	Agha Basin		9.8		25	
Belgium	Antwerp	Cargill - Canal dock B2	235	16.8	400	32	2 mobile elevators.
	a)	Samga - Quays 48-50, Lefebvre Dock	450	9.8	1,000	120	2 mobile elevators.
	a)	Sobelgra - 6th Harbour Dock	620	14.6	2,000	106	4 pneumatic elevators.
	Ghent	Euro-Silo (Discharge) No.97	270	12.3	2,400	245	2 screw unloaders & 2 vacuum elevators, max airdraft 15.24m.
	a)	Ghent Grain Terminal	800	12.3	2,800	360	1 grab crane & 2 mobile pneumatic elevators.
	Zeebrugge	Combined Terminal Operators	850	13.5			8-40t cranes with grabs & 5,000 tpd discharge rate.
Cyprus	a) Limassol	Grain silo				30	
Egypt	Damietta	2 Berths	300	14.5		100	
	Port Said	Sherrif Basin - 2 berths	510	8.2	400	24	
	Safaga	General Cargo Berth					
Finland	Helsinki	Silli Quay - West Harbour	177	5.0			Pneumatic unloader.
	a) Naantali	2 Berths	200	13.5	500		
France	Brest	Quai 6th Est	165	10.0		62	3 cranes & conveyor belt, discharging 6-7,000 tpd.
		Quai 6th Sud	230	12.0		Same as Quai 6th Est	3 cranes, 8-30t & conveyor belt 1,000tph, rate 9-11,000tpd.
	a) Le Havre	SHGT Multibulk Centre	251	14.0	1,700	45	2 gantry cranes.
	a) Lorient	Port de Commerce	568	10.0		193	12 cranes, 2 contin & 1 grab gantries, rate 30,000 tpd.
	a) Nantes/St Nazaire	Montoir Agri-Bulk Terminal	820		1,450	400	2 continuous unloaders & 5 15t cranes, rate 20,000 tpd.
	a)	Saint Nazaire	850	8.5		30	6 cranes 6-12t, discharging 2,080 tpd.
Germany	a) Brake	J Muller				120	1 elevator, 600 tph, also use Karl Gross's.
	a)	Karl Gross Silo			1,200	80	1 elevator, 600 tph, also use J Muller's.
	a) Bremen-Bremerhaven	Bremen Lagerhaus Gesellschaft	275	10.6	1,200	150	3 elevators.
	a) Emden	Emder Lagerhaus		11.5			1 elevator, discharging 5,000 tpd.
	Hamburg	GTH Getreide Terminal	270	12.0	900	80	4 elevators.
		Hansa-Lagerhaus Stroh	270	12.0	1,000	140	3 elevators.
		NHG - Kohlbrand Pier	200	11.3	1,200		1 elevator.
	a)	NHG - Neuhofer Pier	285	13.8	1,660	188	2 pneumatic elevators & 1 mechanical unloader.
		Rethe Speicher Mackprang	270	12.8	1,200	137	11 elevators.
		Silo P. Kruse Betriebs-GmbH	270	14.0	800	60	3 elevators.
	a) Kiel	Nordhafen	1,068	9.5	200	77	

(cont'd)

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Discharge Equipment
Germany (cont'd)	a) Nordenham	Midgard	188	12.2	1,300	45	2 elevators 3-400tph discharge.
Indonesia	Jakarta - Tanjung Priok	Boga sari	200	9.6			
	Surabaya - Tanjung Perak	Nilam Timur - Grain Terminal	140	8.5			
Iraq	Basrah	Grain Silo Berth	213	8.8	1,050	65	
Ireland	a) Cork	Ringaskiddy Deepwater Terminal	335	13.5	800	40	2 high output grab cranes.
Italy	a) Leghorn	Cappellini Basin - Free Wharf	246	8.7	200		
	a) Naples	Pontile Silos		11.0	1,700	90	
	Savona	Cereol Silos	150	12.2	1,700	65	2 slewing grabs & 1 conveyor belt to silo, 1,200 tph.
	a)	Savona Silos	128	10.8	1,000		2 pneumatic mobile towers, with 4 pipes.
	a) Venice	Venice Grain & Feedstuff Terminal	1,070	10.0	2,160		5 pneumatic elevators, 2 bridge cranes & 4 quay cranes.
Ivory Coast	Abidjan	Grand Moulins D'Abidjan			150	30	
Japan	Hakata	Hakozaki Pier	467		400	40	1 pneumatic unloader & 3t gantry crane.
		Suzaki Pier - 7 Piers	553	10.5	1600	175	4 pneumatic unloaders & 7 silos 10-69kt storage.
	Nagoya	Chita Futo Wharf	160	12.0			
		Nisshin Wharf	150	12.0			
		Toyo Grain Terminal	255	12.0			
		Wharf No.8	185	10.0			
	Yokkaichi	No.2 wharf			600	57	2 pneumatic unloaders & conveyor.
	Yokohama	Ajinomoto Pier	113	9.0			
		Kokusai Futo - 5 berths	348	17.5			
		National Govt Silo Pier	130	10.0			
		Nippon Flour Mills	163	9.0			
		Showa Sangyo	169	9.2			
Malta	a) Valletta	Magazine Wharf	250	13.0	1100	86	
Malaysia	Port Kelang	Wharf 30			600	51	3 pneumatic unloaders.
Mexico	Lazaro Cardenas	Grain Terminal					
Morocco	a) Casablanca	Mole du Commerce - 20-24 & T3-4	250	9.5	600	30	3 gantry cranes at 200tph.
	Jorf Lasfar	Berth 14	Lighter before going to Casablanca.				
	a) Safi	Silo Quay	270		200	24	
	Tangier	New Mole - C1-2	200	8.7			

(cont'd)

Country	Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Discharge Equipment
Netherlands	a) Amsterdam	IGMA Grain Terminal	366	15.0	3,350	72	2-16t screw floating cranes, 1x25t & 1x12t floating cranes, 33,000 tpd rate.
	a)	OBA Bulk Terminal		13.7			2 travelling gantry cranes & floating crane.
	a) Groningen	EMG Faktos	150	3.8		25	
	Rotterdam	GEM Europoort Terminals I - Inside	370	18.0	4,400		5 floating elevators.
	a)	GEM Europoort Terminals I - Outside	580	18.0	4,000	110	6 pneumatic shore unloaders.
	a)	GEM Europoort Terminals II	230	16.0	3,000	100	3 shore elevators.
	a)	Interstevedoring Botlek Terminal	490	13.0	3,500	92	1 floating pneumatic & 2 shore pneumatic, 750-800 tph.
Norway	a) Stavanger	Stavanger Havnesilo	165	15.2	1,000	195	2 pneumatic towers & mechanical discharging installation.
Poland	Gdynia	India Quay	1,009	11.0	1,650		18 elevators, both shore & floating.
	Szczecin	Zbozowe Quay	200	8.7			Elevator.
Portugal	Aveiro	South Terminal - General Cargo	400	5.5			
	Leixoes	APDL Terminal	180	9.3			5 shore cranes.
	a) Lisbon	Beato Grain Terminal	200	18.0	1,200	120	2 pneumatic unloaders.
		Silopor Leixoes	200	9.0		115	2-15t cranes, 7,000 tpd discharge.
	a)	Silopor Trafaria	250	17.0	3,000	200	3 pneumatic unloaders, 1,000 tph each.
	a)	Togol - Berth 1		14.5	2,100	100	2 pneumatic & 1 mechanical unloaders.
		Togol - Berth 2			1,200		Mobile overhead crane.
Senegal	Dakar	Berths 41-5		10.2			
Sierra Leone	Freetown	Berth 1			80		Suction & conveyor system.
South Korea	Busan	Pier No.5	371	12.5	800	83	2 unloaders & 450 tph conveyor belt.
	a) Inchon	Pier No.7	604	14.5	800	326	
	Ulsan	USC Terminal			1,500		2 unloaders.
Spain	Barcelona	Contradique Wharf - East Side	241	13.1	1,200	145	Pnuematic dischargers.
	Bilbao	Adosado Silos del Abra	293	14.0	720		4 luffing cranes & conveyor.
	a) Cadiz	Marques De Comillas Quay	250	10.0			4-6t & 2-12t cranes with grabs.
	a)	Zona Franca de Cadiz	325	9.0			2-12t, 3-6t & 203-9t grabs & conveyor belt, 200 tph.
	La Coruna	La Coruna Multiport		16.5			8-16t cranes, discharge 30,000 tpd.
	Malaga	Quay No.2	450	10.5	200	15	
	a) Santander	ROAS Terminal	950	13.0			11-16t, 4-12t, 7-6t cranes & 2 pneumatic unloaders, 160 tph each.
	Tarragona	Cargill Espana			800	130	Mechanical & pneumatic unloaders plus 12-16t cranes.

[illegible] (cont'd)

Country		Port	Terminal	Berth Length (Metres)	Berth Depth (Metres)	Handling Rate (tph)	Storage ('000 t)	Ship Discharge Equipment
Spain (cont'd)		Tarragona	Silos de Tarragona		11.9		165	2-16t & 12t cranes, discharging 10-12,000 tpd.
Sudan		Port Sudan	Berth No.15	196	11.3		50	
Taiwan		Kaohsiung	Berth 33	200	10.5			
			Berth 44	200	10.4			
			Berths 71-2 - Far East Silo	330	14.0			3 unloaders & 6 suckers.
Tunisia		Bizerte	Quai Cerealier	200	9.8			
		Sfax	NW Quay	550	10.6			
Turkey		Mersin		310	12.0		100	
			Berth 13	503	10.0		Combined with above.	
	a)	Akatlar-Istanbul	Toros Terminal	187	16.0	1,700	130	3 jetty grabs, 1 pneumatic & 1 chain unloader.
UK	a)	Belfast	Port of Belfast		10.2		185	12t travelling grab & suction.
	a)	Liverpool	Royal Seaforth Grain Terminal		12.8		133	2 marine towers with bucket elevators.
		Leith	Imperial Dock			1,980	56	3 travelling elevators.
			Western Harbour - Private Facility				59	2 travelling elevators.
	a)	Tilbury	PLA Tilbury Grain Terminal	274	12.8	2,400	100	2 marine elevator towers & pneumatic booms.
U.A.E.		Jebel Ali	Quay 1 - Berths 3-4		13.3	800		
		Mina Zayed - Abu Dhabi	Berth 19	225	10.5	240	60	
Former USSR		Kaliningrad - Baltic						
		Kherson - Black Sea						
		Klaipeda - Baltic	Winter / New Harbour					
		Novorossiysk - Black Sea		250	11.5			
		Odessa - Black Sea	Berth No.7			600		2 pneumatic unloaders.
		Poti - Black Sea						
		Riga - Baltic		225	10.1	350		Elevator.
		Novotallinskiy - Baltic	East Basin	335	18	2,500	300	
		St Petersburg (Leningrad)						
		Tuapse - Black Sea		220	12			Shore cranes.
		Ventspils - Baltic						

Note: (a) Transshipment

Sources: *Various Port Directories*
Port Authority Contacts
Drewry Shipping Consultants

APPENDIX 9: Constructing Data for Capesize Freight rates

First stage:

The aim of this stage is to calculate the grain spot rate equivalent back to 1980 based on time-charter rates. A method of converting time-charter rate ($/day) into their spot rate equivalent ($/ton) introduced by Zannetos (1966) and used by Glen *et al.* (1981), Hale and Vanags (1992) and Veenstra (1999), has been used here to convert the grain time charter rates into its spot rate equivalent.

This approach assumes that the charter vessel is employed in a particular route (here North Atlantic, US Gulf to Rotterdam). Then respective voyage costs are estimated, using vessel particulars (speed and consumption etc.) and added to time charter rates. The following table presents details of the typical vessel:

Table Appendix 8.1: Fuel Consumption for Clarkson's Standard Capesize, as Quoted in Shipping Intelligence Weekly

Year of Build	Early 1990s
Dwt	100,513
Speed – Loaded	13.5
Speed – Ballast	13.5
Consumption at sea (t/day):	
Loaded	41.4

Ballast	33.5
MDO	0
Consumption in Port (t/day):	
FO	1
MDO	4

Source: Clarkson's Shipping.

Finally the total cost is structured by the amount of cargo (in ton) to obtain spot equivalent of time-charter rates on a dollar per ton ($/ton) basis. In this way the conversion adds voyage costs fluctuates to time-charter rates. The following model was used:

[(TCR* DUR) + VOC] / TON = SPE ($/Ton)

Drewry Shipping Consultants provided the Time-charter rate data. There is a need to calculate voyage duration and cost. To calculate the duration, assumptions are made regarding speed of the ship and time spent in loading and discharging ports. Furthermore, distance is assumed to be 3300 miles, which is the distance between Rotterdam and Hampton Roads. With reference to Clarkson Shipping Company, the speed of the ship is assumed to be 13.5 N. miles /h for a modern ship. Port stay is 2.5 days for a large ship in Rotterdam which is the same as at Hampton Roads. There is no consideration regarding anchorage or waiting for berth. Therefore, the port stay is considered to be five days in a round trip. A consultant with Clarkson research department suggests that consumption for a large ship be assumed to be 13 ton/d. Data regarding port charges is provided by Rotterdam and Hampton Roads port authorities. Data for fuel oil and diesel oil prices is provided by Clarkson Shipping Company.

DIS / SPS*24 = DAS + PRS = DUR

Therefore voyage cost could be calculated as follows:

SFC = SDC +PDC = TFC
TFC + PTC = VOC

Where:

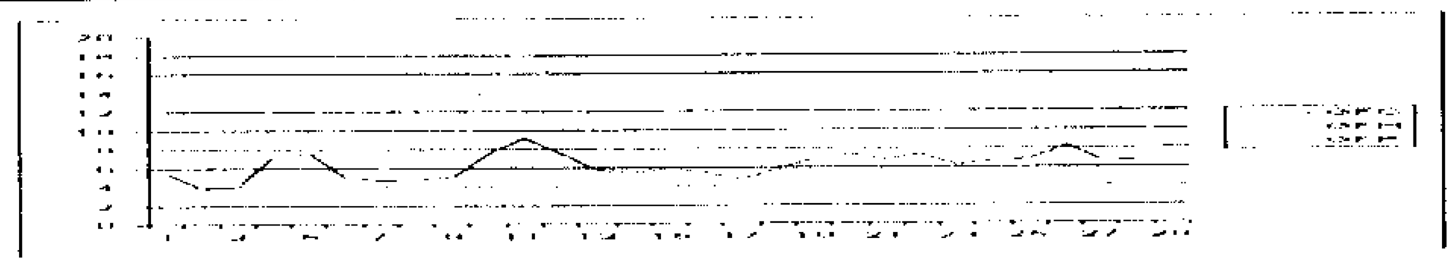
SFC	At sea Fuel oil consumption	DUR	Duration

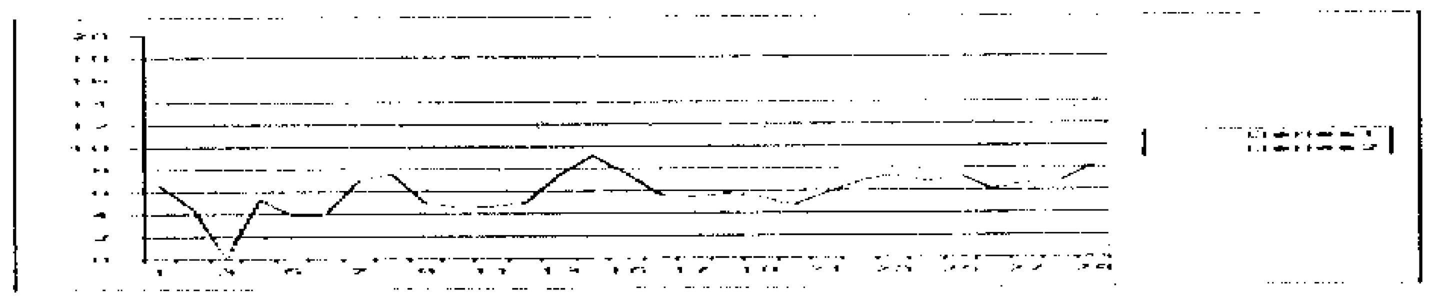
SDC	At sea Diesel oil consumption	TON	Tonnage
PDC	At Port Diesel oil Consumption	SPE	Spot Equivalent
TFC	Total fuel cost	DIS	Distance
FR_t	Freight Rates (including operating cost)	SPS	Speed at See
PTC	Port Charges (Hampton Rods charges + Rotterdam charges)	DAS	Day at See
PRS	Port Stay	TC_t	Time Charter Rates (including Operation Cost)
VOC	Voyage cost		

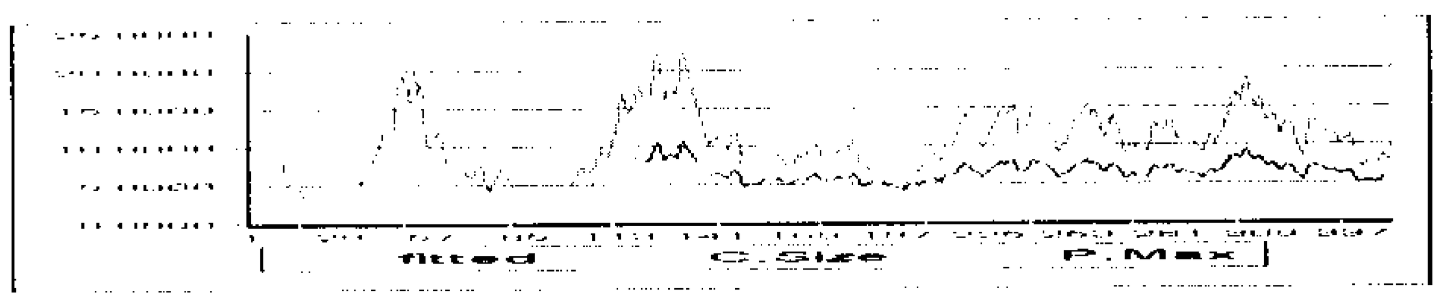
Data Process for First Stage:

$/t	Rotterdam Bunkers 380 cst	Rotterdam Bunkers 180 cst	Time Charter Rates ($per day)	T/C*du+v.c	Freight Rates($/Ton)
Jan '80	177.00	189.55	13800	645557.98	8.07
Feb '80	145.00	157.55	16175	630349.98	7.58
Mar '80	153.00	165.55	16175	641031.98	8.01
Apr '80	145.00	[illegible]	16775	644909.98	8.06
May '80	177.00	[illegible]	13800	645647.98	8.07
Jun '80	157.00	[illegible]	15800	629437.98	7.87
Jul '80	155.00	[illegible]	16575	647079.90	8.10
Aug '80	152.00	[illegible]	13800	625182.98	7.81
Sep '80	155.00	[illegible]	16175	635419.03	7.94
Oct '80	185.00	[illegible]	15975	652001.03	8.15
Nov '80	214.00	225.00	16175	680640.03	8.51
Dec '80	231.00	241.10	16575	703050.93	8.79
Jan '81	209.00	217.40	16575	669751.48	8.37
Feb '81	214.00	222.40	16775	678766.48	8.48
Mar '81	211.00	221.40	16375	667757.48	8.35
Apr '81	213.00	221.40	16175	662557.48	8.28
May '81	202.00	210.40	15000	623318.48	7.79
Jun '81	176.00	183.00	14200	581515.88	7.27
Jul '81	170.00	178.40	12625	537240.48	6.72
Aug '81	172.00	182.00	11050	499196.88	6.24
Sep '81	163.00	174.80	10275	473834.08	5.92
Oct '81	170.00	181.80	9275	463137.08	5.66
Nov '81	179.00	190.80	8875	449908.00	5.62
Dec '81	177.00	188.80	8300	433660.08	5.42
Jan '82	170.00	183.40	7400	402071.76	5.03
Feb '82	167.00	177.90	6125	366712.26	4.58
Mar '82	168.00	178.00	5325	345687.16	4.32
Apr '82	168.00	177.20	5925	360147.96	4.50
May '82	171.00	181.90	4725	333428.26	4.17
Jun '82	170.00	180.90	4550	327919.26	4.10
Jul '82	169.00	179.00	4350	320996.16	4.01
Aug '82	162.00	172.00	4150	310523.16	3.88
Sep '82	157.00	167.00	4150	306838.16	3.84
Oct '82	173.00	184.50	4150	320395.66	4.00
Nov '82	174.00	[illegible]	3950	315764.86	3.95
Dec '82	163.00	[illegible]	3950	306696.46	3.83
Jan '83	173.00	[illegible]	3950	312509.55	3.91
Feb '83	165.00	[illegible]	4925	329289.96	4.12
Mar '83	155.00	[illegible]	5125	326249.96	4.08
Apr '83	165.00	[illegible]	5125	332421.65	4.16
May '83	169.00	[illegible]	5125	336666.75	4.21
Jun '83	163.00	[illegible]	4925	327431.65	4.09
Jul '83	160.00	[illegible]	4550	314595.75	3.93
Aug '83	171.00	[illegible]	5525	347565.65	4.34
Sep '83	173.00	[illegible]	5925	360232.75	4.50
Oct '83	171.00	[illegible]	5725	353474.75	4.42
Nov '83	172.00	[illegible]	7300	399714.55	5.00
Dec '83	174.00	[illegible]	7100	390012.55	4.89
Jan '84	174.00	[illegible]	7100	384246.53	4.80
Feb '84	173.00	[illegible]	7900	406799.63	5.08
Mar '84	173.00	[illegible]	8675	426619.63	5.33
Apr '84	185.00	191.70	10850	490869.63	6.14
May '84	186.00	191.80	9275	449784.53	5.62
Jun '84	192.00	194.00	9075	446232.33	5.58
Jul '84	179.00	[illegible]	8300	415955.33	5.20
Aug '84	176.00	[illegible]	8475	410010.33	5.23
Sep '84	177.00	[illegible]	8475	419606.33	5.25
Oct '84	182.00	[illegible]	9275	443582.33	5.54
Nov '84	183.00	[illegible]	9275	446050.33	5.58
Dec '84	183.00	[illegible]	8875	433002.33	5.41
Jan '85	185.00	[illegible]	8675	429369.38	5.37
Feb '85	192.00	194.00	8675	434612.38	5.43
Mar '85	172.00	175.00	8475	415331.38	5.19
Apr '85	170.00	[illegible]	8675	419033.38	5.24
May '85	140.00	[illegible]	8475	390853.38	4.89
Jun '85	134.00	[illegible]	8100	377368.38	4.72
Jul '85	136.00	138.00	7100	351208.30	4.39
Aug '85	141.00	140.00	6325	341022.38	4.26
Sep '85	144.00	148.00	7100	359388.38	4.49
Oct '85	135.00	138.00	7100	352168.38	4.40
Nov '85	147.00	154.00	7500	374642.38	4.68
Dec '85	144.00	[illegible]	7900	380308.38	4.75
Jan '86	139.00	[illegible]	7400	386806.23	4.84
Feb '86	95.00	[illegible]	7300	349001.23	4.36
Mar '86	96.00	[illegible]	7400	352440.23	4.41
Apr '86	76.00	[illegible]	6900	326299.23	4.08
May '86	60.00	[illegible]	7100	314948.23	3.94
Jun '86	53.00	[illegible]	7100	309614.23	3.87
Jul '86	49.00	[illegible]	7100	305419.23	3.82
Aug '86	62.00	[illegible]	7200	319884.23	4.00
Sep '86	79.00	[illegible]	7500	339758.23	4.25
Oct '86	74.00	[illegible]	[illegible]	345394.23	4.32
Nov '86	74.00	[illegible]	[illegible]	334216.23	4.18
Dec '86	74.00	76.00	[illegible]	313415.23	3.92
Jan '87	97.00	101.00	[illegible]	354893.03	4.44
Feb '87	85.00	90.00	[illegible]	334124.03	4.18
Mar '87	95.00	[illegible]	[illegible]	352406.03	4.41
Apr '87	113.00	116.00	[illegible]	365948.03	4.57
May '87	113.00	116.00	7900	392180.03	4.90
Jun '87	110.00	113.00	7900	389851.03	4.87
Jul '87	110.00	113.00	8475	404861.03	5.06
Aug '87	110.00	112.00	10075	445802.03	5.57
Sep '87	95.00	99.00	11050	460366.03	5.75
Oct '87	98.00	101.00	11850	483473.03	6.04
Nov '87	91.00	94.00	11850	478320.03	5.98
Dec '87	84.00	88.00	12825	499266.03	6.24
Jan '88	82.00	85.00	13025	504530.43	6.31
Feb '88	73.00	77.00	14800	544208.43	6.80
Mar '88	65.00	68.00	17775	614457.43	7.68
Apr '88	86.00	90.00	17275	618645.43	7.73
May '88	75.00	78.00	16775	596457.43	7.46
Jun '88	76.00	96.00	14800	558379.43	6.98
Jul '88	69.00	91.00	14800	554394.43	6.93
Aug '88	71.00	74.00	14800	541721.43	6.77
Sep '88	61.00	70.00	15000	543415.43	6.79
Oct '88	57.00	64.00	15000	538891.43	6.74
Nov '88	61.00	63.00	15975	563732.43	7.05
Dec '88	70.00	74.00	16275	580431.43	7.26
Jan '89	71.56	75.50	16775	588068.08	7.35
Feb '89	69.94	74.13	18250	625186.705	7.81
Mar '89	88.10	91.70	18750	651561.63	8.14
Apr '89	92.25	95.94	18950	660147.0175	8.25
May '89	89.13	94.50	18950	658789.08	8.23
Jun '89	93.40	96.85	18250	642115.98	8.03
Jul '89	87.88	90.50	18250	637439.33	7.97
Aug '89	85.13	88.35	18550	643769.605	8.05
Sep '89	86.03	89.15	18750	649822.68	8.12
Oct '89	97.83	100.63	18750	658720.455	8.23
Nov '89	96.06	98.63	18750	657192.455	8.21
Dec '89	109.10	113.50	18550	663896.63	8.30
Jan '90	92.88	97.00	18750	672891.46	8.41
Feb '90	89.50	93.63	18250	667108.585	8.34
Mar '90	84.30	88.00	18550	660576.96	8.26
Apr '90	78.25	83.00	17950	641147.96	8.01
May '90	75.38	79.88	17275	621013.585	7.76
Jun '90	60.20	64.13	15800	570406.31	7.13
Jul '90	70.75	74.38	14800	552326.685	6.90
Aug '90	113.60	119.60	14800	588248.36	7.35
Sep '90	133.63	138.88	14800	604098.336	7.55
Oct '90	142.63	150.69	12825	562525.8975	7.03
Nov '90	138.70	147.20	13325	572400.76	7.16
Dec '90	143.63	153.13	14025	594317.835	7.43
Jan '91	142.38	[illegible]	13825	587462.105	7.34
Feb '91	75.13	[illegible]	14800	548785.73	6.86
Mar '91	70.40	[illegible]	14600	548612.03	6.86
Apr '91	71.13	[illegible]	14800	553865.73	6.92
May '91	71.45	[illegible]	14800	554462.03	6.93
Jun '91	91.88	[illegible]	17775	629782.90	7.87
Jul '91	71.63	[illegible]	17275	617837.105	7.72
Aug '91	69.40	[illegible]	17275	616576.63	7.71
Sep '91	69.19	[illegible]	17275	616994.73	7.71
Oct '91	80.06	[illegible]	17275	626276.855	7.82
Nov '91	88.00	[illegible]	16775	618012.63	7.73
Dec '91	74.25	[illegible]	17950	637982.98	7.97
Jan '92	66.30	[illegible]	17775	637056.68	7.96
Feb '92	66.00	[illegible]	16775	609652.98	7.62
Mar '92	74.17	81.25	15800	591365.73	7.39
Apr '92	75.00	81.38	14300	552931.855	6.91
May '92	81.50	87.30	13325	532043.68	6.65
Jun '92	91.88	95.75	11850	500246.23	6.25
Jul '92	90.00	93.30	11350	485241.68	6.07
Aug '92	89.88	93.75	10850	472350.73	5.90
Sep '92	91.88	95.75	10350	460886.23	5.76
Oct '92	103.10	106.40	10350	468852.58	5.86
Nov '92	93.75	97.75	10650	469974.23	5.87
Dec '92	77.63	82.63	10850	463636.605	5.80
Jan '93	71.15	78.00	11050	462390.43	5.78
Feb '93	70.75	77.75	11650	477899.18	5.97
Mar '93	78.88	84.38	12050	493658.805	6.17
Apr '93	79.90	85.90	12350	507749.53	6.28
May '93	73.00	79.25	14300	546293.93	6.83
Jun '93	60.63	67.75	14800	552324.18	6.90
Jul '93	59.30	65.70	13825	525297.73	6.57
Aug '93	62.75	68.75	13825	527568.18	6.59
Sep '93	61.13	67.63	14800	551958.065	6.90
Oct '93	65.38	71.00	15000	559910.43	7.00
Nov '93	62.75	69.75	13750	526379.68	6.58
Dec '93	55.20	61.50	13500	513416.93	6.42
Jan '94	63.00	68.75	14000	535602.08	6.70
Feb '94	78.63	83.38	12500	507458.705	6.34
Mar '94	78.38	83.50	11500	481784.83	6.02
Apr '94	74.80	78.90	12500	504009.43	6.30
May '94	80.13	85.00	13000	521765.83	6.52
Jun '94	87.63	92.13	13000	527184.955	6.59
Jul '94	96.50	100.20	14500	572215.13	7.15
Aug '94	86.13	90.25	15250	584573.08	7.31
Sep '94	75.00	78.20	17000	620581.13	7.76
Oct '94	89.13	92.63	19000	683379.465	8.54
Nov '94	102.88	106.38	20500	732693.205	9.16
Dec '94	96.10	99.40	19000	688423.93	8.61
Jan '95	108.50	111.50	21000	766095.9925	9.58
Feb '95	103.38	106.13	20500	749259.305	9.37
Mar '95	106.20	109.10	22000	790657.83	9.88
Apr '95	105.19	107.88	23500	829023.805	10.36
May '95	107.88	110.50	22000	791952.43	9.90
Jun '95	93.60	97.00	21750	775244.93	9.69
Jul '95	81.38	84.38	21500	759062.305	9.49
Aug '95	83.25	86.31	21500	760472.2425	9.51
Sep '95	87.50	[illegible]	20000	724696.43	9.06
Oct '95	85.88	89.50	19500	710863.43	8.89
Nov '95	85.50	89.75	19000	672148.18	8.40
Dec '95	102.80	107.05	17000	659491.38	8.24
Jan '96	103.63	107.38	15500	615923.465	7.70
Feb '96	95.50	99.50	14500	584096.34	7.30
Mar '96	106.60	110.20	14000	579469.39	7.24
Apr '96	113.38	119.63	15000	612503.715	7.66
May '96	99.60	103.60	14500	587014.99	7.34
Jun '96	88.63	92.58	14500	578777.965	7.23
Jul '96	88.13	93.38	14000	566362.465	7.08
Aug '96	97.40	102.50	13500	560266.09	7.00
Sep '96	114.50	119.63	12500	547762.465	6.85
Oct '96	122.50	127.50	12500	554368.09	6.93
Nov '96	116.50	121.63	13500	575856.715	7.20
Dec '96	120.38	124.63	14500	603994.965	7.55
Jan '97	110.20	115.00	15750	611732.05	7.65
Feb '97	96.38	103.00	15750	602174.05	7.53
Mar '97	89.75	94.88	16000	602022.175	7.53
Apr '97	86.13	91.25	15000	573183.3	7.16
May '97	84.60	[illegible]	15000	572676.45	7.16
Jun '97	86.63	91.75	15000	573415.3	7.17
Jul '97	89.38	94.63	16500	614508.675	7.68
Aug '97	76.80	[illegible]	17500	629240.9434	7.87
Sep '97	97.50	102.13	18500	672171.175	8.40
Oct '97	104.60	109.40	19000	690870.65	8.64
Nov '97	107.30	112.25	17500	679987.3	8.50
Dec '97	88.69	93.13	16500	614156.675	7.68
Jan '98	73.50	78.50	15000	563496.66	7.04
Feb '98	69.00	73.88	15000	559916.535	7.00
Mar '98	67.25	72.25	16000	584465.91	7.31
Apr '98	79.75	[illegible]	[illegible]	593032.205	7.42
May '98	73.20	77.90	14500	549729.26	6.87
Jun '98	67.38	72.25	13500	519158.41	6.49
Jul '98	66.70	70.90	11000	452931.26	5.66
Aug '98	62.63	[illegible]	10500	436926.035	5.45
Sep '98	66.25	69.38	11500	464701.285	5.81
Oct '98	69.50	72.00	12000	479809.16	6.00
Nov '98	60.50	[illegible]	11000	447012.41	5.59
Dec '98	55.80	59.00	10500	430558.16	5.38

Data Process for Second Stage:







APPENDIX 10: STATISTICAL TESTS FOR THE REGRESSION, SIMULTANEOUS AND VAR MODEL

This appendix discuses different specification tests; i.e. serial correlation LM test, Arch LM test etc. to find the number and nature of the explanatory variables to include into the models of the study. The specification error arises from inability to formulate the model precisely. It could be associated with the underlying economic theory that does not explain the functional form of the model. Following sections present and discuss the various specification tests and approaches to solve the problem of miss-specification.

Newey-West-Robust Estimator

Data series may have individual observation(s) that is disproportionate effects on the sample regression. This is sometimes happened when one uses OLS estimation. If there is an observation(s) with large residual, the OLS minimises the sum of squares of the residuals, such large residuals strongly influence the OLS estimator.

This problem could be detected by applying OLS estimator and check the residuals. If the residual is large then there could be a sign of this problem. However, the OLS estimator is very sensitive to violation of the classical assumptions. Hence it is sometimes essential to use some estimator which is less sensitive to violation of classical assumptions. Such estimators are called robust estimators.

There is different robust estimation, such as Least absolute residual (LAR) also knows as mean absolute deviation. This estimator designed to minimise the sum of the absolute values of the residuals rather than the sum of their squares as in OLS. LAR is defined as $s^* = \sum w_i / e_i$ which estimator is minimising a weighed sum of the absolute values of the residuals. However, in OLS $s^* = \sum e^2_i$ which s^* are equal to absolute values of the residuals.

Newey and West (1987) suggested a robust and consistent estimator for autocorrelated disturbances with an unspecified structure as follows:

$$s^* = s_0 + \frac{1}{T} \sum_{j=1}^{l} \sum_{t=j+1}^{T} w(j) e_t e_{t-j} [x_{t}x'_{t-j} + x_{t-j} x'_t]$$

where $w(j) = 1 - \frac{j}{l+1}$

In this case the maximum lag L must be determined in advance to be large enough that autocorrelations at lags longer than L are small enough to ignore.

Durban-Watson Statistic: Autocorrelation

One of the assumptions underlying a great of the time-series analysis is that the error terms in different observations of the variables are not related. When error terms are correlated there is a problem of autocorrelation. It exists if the value of the disturbance term associated with one observation is correlated with the disturbance term of the adjacent observation that called autocorrelation. This occurs frequently with time-series data.

There is four different type of autocorrelation which further categorise in two main categories, positive autocorrelation and negative autocorrelation. Positive autocorrelation means if a positive disturbance term in one period is associated with positive disturbance term in next, or a negative disturbance term in period one is associated with a negative disturbance in the next. Negative disturbance term means if a positive disturbance term in one period is associated with a negative disturbance term in the next, or a negative disturbance term in one period is associated with a positive disturbance term in the next.

Autocorrelation could arise when some 'shock' is applied to the system and the effects of the shock last for several periods. The system may react very sluggishly to external shocks. The other cause of autocorrelation is an omitted variable or variables that may generate the shocks to the system. Furthermore autocorrelation sometimes caused by an incorrect functional form such as applying a linear estimation to a non-linear relationship.

The major problem with autocorrelation is that it may cause the researcher to accept a partial regression coefficient as being significantly different from zero when it is not. This occurs because the estimated standard error of the coefficient has a sampling distribution that causes the error variance of the estimated coefficients to be wrong. This also may cause over-estimates or under-estimates of the partial regression coefficients.

Therefore it is important to test for autocorrelation whenever time series data is analysed. Most of the computer packages calculate the Durbin-Watson statistics using Durbin and GS Watson (1951) test of hypothesis $\gamma = o$. The Durbin Watson test is based on the statistic

$$DW = d = \frac{\sum_{t=2}^{n}(e - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

where e_t, $t=1,\dots,n$ are lest square's residuals. This test is mostly used for non-dynamic models that are models without any lagged dependent variables. Hence, the following discussion is restricted initially to the case,

$$y_t = x_t'\beta + \mu_t; \qquad \mu_t \sim NID \quad (0,\sigma^2; t = 1,\dots,n)$$

and e_t are the OLS residuals from this model.

Even under the null hypothesis of no serial correlation, the distribution of (1) is not entirely straightforward, as it depends on the observed regressor matrix *X*. However, it is possible to obtain upper and lower bounds for critical values, which depend only on the number of observation *(n)* and the number of regressors *(k)*. Table below gives lower bounds *(dl)* and upper bounds for selected values of *(du)* for selected value of *(n)* and *(k)*.

Durbin-Watson statistic are summarised in the following table:

Value of d	0	dl	du	2	4-du	4-dl	4
	Positive Autocorelation	Don't Konw	No Autocorelation		Don't Konw	Negative Autocorelation	

There is an important drawback about this test that is the uncertainty where we do not know whether or not the data illustrate an autocorrelation. In a dynamic model however testing for serial correlation should carried out before describing an estimation method that is appropriate if serial correlation is present. Hence in this study for serial correlation also Breusch-Godfrey LM tests and Q statistic also is implemented.

Langrange Multiplier (Lm) Test

The procedures for likelihood ratio (LR) test, and the Langrange Multiplier (LM) test are developed within the framework of maximum likelihood estimation by using the asymptotic normality of the ML estimators. This is because some other estimator is equivalent to that obtained by maximising the likelihood function, or it is some approximation to maximum likelihood. Therefore in this thesis only the LM testis used.

The objective of the LM test is to test the validity of a set of (p) independent linear restrictions (Stewart, 1998). If $H=\theta$, where θ is a $(m\times 1)$ vector of parameters, the basic assumption is that there should be a model that satisfies whatever conditions are necessary to establish that

$$\sqrt{n}(\tilde{\theta}-\theta)\xrightarrow{D}Q^{-1}\eta\sim N(0,Q^{-1})$$

Where $Q=\lim n^{-1}(\theta)$ then in the context of Least Squares estimation will be as follows:

$$\sqrt{n}H(\tilde{\theta}-\theta)\xrightarrow{D}HQ^{-1}\eta\sim N(0,HQ^{-1}H')$$

and under $H_0: H\theta=h$:

$$\sqrt{n}(H\tilde{\theta}-h)\xrightarrow{D}HQ^{-1}\eta\sim N(0,HQ^{-1}H')$$

$$\Rightarrow n(H\tilde{\theta}-h)'[HQ^{-1}H']^{-1}(H\tilde{\theta}-h)\xrightarrow{D}\kappa^2\sim\kappa_g^2$$

$$\Rightarrow (H\tilde{\theta}-h)'[H(n^{-1}Q^{-1})H']^{-1}(H\tilde{\theta}-h)\xrightarrow{D}\kappa^2\sim\kappa_g^2$$

In practice, $n^{-1}Q^{-1}$ is replaced by $I^{-1}\tilde{\theta}$
with set of P restrictions which are feasible and contain no redundancies. If H_0 is stated that the restrictions are valid then test statistics base on ML estimator $\tilde{\theta}_R$ is as follows:

$$LM = D\ln L(\tilde{\theta}_R)'[I(\tilde{\theta}_R)]^{-1}D\ln L(\tilde{\theta}_R)$$

If H_0 is true $\tilde{\theta}_R$ expected to be close to the unrestricted estimator $\tilde{\theta}$. Expansion of $D\ln L(\tilde{\theta}_R)$ about $\tilde{\theta}$ provide the approximation:

$$D\ln L(\tilde{\theta}_R)\cong D\ln L(\tilde{\theta})+D^2\ln L(\tilde{\theta})(\tilde{\theta}_R-\tilde{\theta})$$

Since $D\ln L(\tilde{\theta})=0$

$$D \ln L(\tilde{\theta}_R) \cong D^2 \ln L(\tilde{\theta})(\tilde{\theta}_R - \tilde{\theta})$$

and

$$LM = (\tilde{\theta} - \tilde{\theta}_R)' D^2 \ln L(\tilde{\theta})' [I \tilde{\theta}_R)]^{-1} D^2 \ln L(\tilde{\theta})(\tilde{\theta} - \tilde{\theta}_R)$$

Under the null hypothesis, $\tilde{\theta}_R$ and $\tilde{\theta}$ are both consistent estimator of θ and

$$p \lim n^{-1} I(\tilde{\theta}_R) = Q$$
$$p \lim [n^{-1} D^2 \ln L(\tilde{\theta})] = Q$$

If H_0 is true, LM has the limiting distribution approximately κ^2, with p degrees of freedom. As Stewart (1998) stats there could be "considerable advantage in using an LM test, rather than Wald test. The former uses only unrestricted estimators, which are appropriate under H_1, and the latter uses both restricted and unrestricted estimators to obtain both restricted and unrestricted values of the maximised log likelihood".[216]

It is applicable whether the disturbances follow an AR(p) or MA(p) process, where p can be any positive order. It could also be used to specify whether or not lagged values of the dependant variable appear among the regressor.

Correlograms and Q-Statistics

Correlograms and Q-Statistics test check the autocorrelation and partial autocorrelations of residuals up to any specific number of lags. It also gives the Ljung-Box Q Statistics for serial correlation. This test could apply to residuals from least squares, two stage least squares, and non-linear test squares estimation. Using the E-views computer package for computing the probability of Q-Statistics, degrees of freedom are automatically adjusted for the inclusion of ARMA terms.

The Durbin-Watson is an important test for autocorrelation which perform partial test. This is because it is need both an intercept in the regression and no lagged dependant variables among the regressors. It is important to test for further order autocorrelation. Therefore there is a need for an approach in dynamic model which use the lagged dependent variable to test autocorrelations and partial autocorrelations of the residuals up to any specific number of lags. The Ljung - Box Q-Statistic provide and is given by :

216 For more details see Stewart & Gill (1998).

$$Q_{LB} = T(T+2)\sum_{j=1}^{p}\frac{r_j^2}{T-j}$$

where r_j is the j^{th} autocorrelation and T is the number of observations. Q can be used to test the hypothesis that all of the autocorrelations are zero; that is, that the series is white noise. Under the null hypothesis Q is distributed as κ , with degrees of freedom equal to the number of autocorrelations, P.

Arch LM Test

If the data violates the assumption that the disturbance terms all have the same variance, the heteroscedasticity exists in the disturbances. This is including any systematic changes in the size of the error terms, it means the variance of error terms varies directly with the size of the error term. If the variance of error terms is constant, the condition is known as Homoscedasticity.

The Homoscedasticity cause the partial regression coefficients to be either too large or too small, depending on the exact pattern representing the heteroscedasticity. ARCH LM test is designed to diagnose the particular specification of heteroscedasticity, it is Autoregressive conditional heteroscedasticity (ARCH) (Engle, 1982:987-1008). This particular test is performed to detect if in the data series the size of residuals appeared to be related to the size of recent residuals. The test is based on the regression of the squared residuals on lagged, squared residuals. Therefore, there is a need to specify the number of lagged residuals to include. For three lagged residuals the model will be as follows:

$$\mu_t^2 = \beta_1 + \beta_2\mu_{t-1}^2 + \beta_3\mu_{t-2}^2 + \beta_3\mu_{t-3}^2$$

F-Statistic and a TR^2 statistic are the test results, base on κ^2 distribution, each with the relevant probability value. The κ^2 statistic is the output of the LM test and provides an asymptotic κ^2 distribution with degrees of freedom equal to the number of lagged, squared residuals. This statistic rests on the null hypothesis that coefficients of the lagged squared residuals are all zero, i.e. there is no ARCH.

Skewness and Kurtosis – (Histogram and Normality Test)

There is a large literature regarding normality test, mostly concern about how far estimate of the third and fourth moments, $\hat{\mu}_3$ and $\hat{\mu}_4$, deviated from zero and $3\hat{\sigma}^4$, respectively where $\hat{\sigma}^2$ is an estimated of $E[e_t^2] = \sigma^2$. Hence scale versions of μ_3 and

μ_4 could be considered as illustration of Skewness and Kurtosis respectively Bera and Jarque (1981) suggest the following formulas: Skewness is :

$$S = \frac{\frac{1}{T}\sum_{t=1}^{T}(y_t - \bar{y})^3}{\sigma^3}$$

Kurtosis is :

$$K = \frac{\frac{1}{T}\sum_{t=1}^{T}(y_t - \bar{y})^4}{\sigma^4}$$

The Skewness of distribution refers to its degree of symmetrical distribution (or lack of it). If it is zero there is a normal distribution, and if the upper tail of distribution is thicker than the lower tail, Skewness is positive.

Kurtosis of a distribution refers to peakness of the distribution and thickness of its tails. For normal distribution Kurtosis is 3, while if distribution has thicker tails than the normal distribution, Kurtosis is more than 3.

The Jarque -Bera statistic tests whether a series is normally distributed using the following:

$$\frac{T-k}{6}[S^2 + \frac{1}{4}(K-3)^2]$$

where T is the number of observations, k is zero when there is an ordinary series being tested and the number of regressors when examining residuals to an equation, S is Skewness and K is Kurtosis, using κ^2 distribution with 2 degrees of freedom, test the null hypothesis of normality.

<u>The Standard Errors of the Estimate</u>

The standard error of estimate (SEE) provides information about statistical reliability of the regression coefficients (the predictive power of the model). The (SEE) is directly related to the stochastic error term μ. This provide information about the estimated of error term (the residual) as well as providing a measure of the "spread" of the data around the estimated regression line. The size of the (SEE) on its own is not importance; whether it is large or small in absolute terms does not matter. The important issue is its size relative to the mean of the dependant. The smaller the ratio of the SEE to the mean of dependant, the greater is the productive power of the model. If Y is the dependant variable and X is the matrix of the independent variables, the least squares regression coefficients are:

$$b = (X'X)^{-1} X'y$$

The fitted values are

$$y^f = Xb$$

and the residuals are

$$\mu = y - y^f$$

The standard error of the regression is the standard deviation of the residuals:

$$s = \sqrt{\frac{1}{T-k} \mu' \mu}$$

Where T is the number of observations and k is the number of regressors, including the constant.

The covariance matrix of the estimated coefficients and the standard errors of the estimated coefficients are the square roots of the diagonal elements of this matrix.

$$s^2 (X'X)^{-1}$$

The standard error of the estimated coefficient is used to determine the statistical significance of the coefficient. It refers to how significant the estimated partial regression coefficient represents the true regression coefficient.

R-bar-squared

Multiple determination or R^2 provides a measure of how good the model it means how well the model explain the data. It represents the proportion of the variation in the dependant variable explained by the variation in the independent variables, defined as

$$R^2 = 1 - RSS/TSS$$

$$=1-\sum e_t^2 \Big/ \sum (y-\bar{y})^2$$

Since RSS/TSS is between 0 and 1, R^2 also lies between 0 and 1. The prefect fit is when all the residuals are equal to zero, then RSS is equal to zero and R^2 is equal to 1. and if $RSS=TSS$ and R^2 is equal to zero the estimated equation is so poor that non-of the variation in the dependant variable is explained.

It is possible to increase the R^2 by adding explanatory variables to the model. This gives no indication of goodness of fit if R^2 increased this way. Then the adjusted measure is a better indicator for goodness of fit, defined as:

$$\bar{R}^2 = 1-[(1-R^2)(n-1) \Big/ (n-k)$$

where n is number of observations and k is number of explanatory variables. To prevent the problem that discussed above formula has been weighting in term $(n-1) \big/ (n-k)$.

The Akaike and Schwarz Information Criterion

Both Akaike (1969) and Schwarz (1978) criterion provide a means for model selection, in terms of accuracy of estimation and the best approximation. The base arguments for Akaike criterion (AIC) started from following denotation

$$Y = \alpha X = e = \alpha_1 X_1 + \alpha_2 X_2 + e$$

where Y is a n dimensional vector of observation; $X = [X_1, X_2]$ is a $(T\times K)$ matrix of constant of rank m ; X_1 and X_2 are known matrices of dimension $(T \times K_1)$ and $(T \times K_2)$ respectively, with $m_1 + m_2 = m$; α is m-dimensional vector of unknown parameters that is partitioned into components α_1 and α_2. e is a $(T\times K)$ normal random vector with mean vector zero and covariance matrix $\sigma^2 I_K$ with the scalar σ^2 unknown. Base on above definition and considering should be minimised among all the possible linear hypothesis, $R\alpha = [0(K_2 \times K_1), I_{K2}]\alpha = 0$ Akaike information criteria is as follows:

$$A/C_{(R\alpha=0)} = \ln \frac{Y'mY}{T} + \frac{2K_1}{T}$$

Schwarz criterion (SC) is based on Bayesian arguments (see Judge *et al.*, 1988:122, 281, 284). "Assuming *a priori* probability of the true model being K_1 and a prior conditional distribution of the parameters given that K_1 is the true model", according to Schwarz the *a posteriori* most probable model which he suggests the following to the criterion minimise.

$$SC = \ln(Y'm_1 Y/T) + \frac{K_1 \ln T}{T}$$

APPENDIX 11: PERRON'S (1988) SEQUENTIAL TESTING PROCEDURE FOR UNIT ROOTS

Model	Null Hypothesis	Test Statistic	5% Critical Values
$\Delta S_{tt} = \gamma S_{t-1} + \mu + \delta t + \mu_t$	$\gamma = 0$	τ_τ	-3.45
$\Delta S_{tt} = \gamma S_{t-1} + \mu + \delta t + \mu_t$	$\gamma = \mu = 0$	Φ_1	6.49
$\Delta S_{tt} = \gamma S_{t-1} + \mu + \delta t + \mu_t$	$\gamma = 0$	Standard normal	1.96
$\Delta S_{tt} = \gamma S_{t-1} + \mu + \mu_t$	$\gamma = 0$	τ_μ	-2.89
$\Delta S_{tt} = \gamma S_{t-1} + \mu + \mu_t$	$\gamma = \mu = 0$	Φ_1	4.71
$\Delta S_{tt} = \gamma S_{t-1} + \mu + \mu_t$	$\gamma = 0$	Standard normal	-1.96
$\Delta S_{tt} = \gamma S_{t-1} + \mu_t$	$\gamma = 0$	τ	-1.95

5% critical values for the tests are based on a sample size of 100 observations.

APPENDIX 12: RATS COMPUTER PROGRAMME FOR "HANDYSIZE" AND "PANAMAX" MODELS

```
END 0;

DIS '********************************************************************************'
DIS '********************************************************************************'
*
*
cal 1970
all 1998:1
open data a:\final2\data36.rat
data(format=rats)

TABLE
SOURCE(NOECHO) C:\WINRATS\DIAG.SRC

********NAME THE VARIABLES***
* NAME THE VARIABLES

SET LGTH = LOG(GTH); SET LHGF = LOG(HGF); SET LPSET = LOG(PSET); SET LWGP = LOG(WGP);
SET D1LWGP = LWGP - LWGP{1}; SET LHFC = LOG(HFC); SET D1LHFC = LHFC - LHFC{1};
SET LBP = LOG(BP); SET D1LBP = LBP - LBP{1}; SET LGTP = LOG(GTP); SET LPGF = LOG(PGF);
SET LCST = LOG(CST); SET LRGS = LOG(RGS); SET D1LRGS = LRGS - LRGS{1};
SET LPFC = LOG(PFC); SET D1LPFC = LPFC - LPFC{1}; SET D1LGTH = LGTH - LGTH{1};
```

```
SET D1LHGF = LHGF - LHGF{1};SET D1LPSET = LPSET - LPSET{1};SET D1LRGS = LRGS - LRGS{1};
SET D1LCST = LCST - LCST{1}; SET D1LBP = LBP - LBP{1};SET D1LGTP = LGTP - LGTP{1};


COMPUTE BEGOBS=1970:1, ENDOBS=1998:1
COMPUTE LAGS=2
COMPUTE STEP=7


* SET THE ERROR CORRECTION TERMS
*********************************************
* model2 unrestricted
set ecm1 = LGTH - 1.0684*LHGF - 15.4

display '**********************************************************************'
display '*********     UNRESTRICTED VAR MODEL FOR HANDYSIZE ******'
display '*********                                                        ******'
display '**********************************************************************'

EQUATION 1 LGTH
# constant LPSET LPSET{1} D1LWGP D1LHFC D1LBP LRGS LHGF{1} LGTH{1}
```

```
EQUATION 2 LHGF
# constant LPSET LPSET{1} D1LWGP D1LHFC D1LBP LRGS LGTH{1} LHGF{1}

SYSTEM 1 2
END(SYSTEM)
SUR 2 begobs endobs
# 1 R1STORE: # 2 R2STORE;



/*
source(noecho) d:\winrats\source\var.src
@var(exog) begobs endobs
# lgth lhgf
# LPSET{1} D1LWGP D1LHFC D1LBP LRGS LPSET
*/



COMPUTE LOGDET = %LOGDET
COMPUTE NREG = %NREG
WRITE LOGDET

        COMPUTE logl = -.5*%nobs*3*(1+log(2*%PI)) - $
```

```
.5*%nobs*%logdet
COMPUTE logdet = logdet
COMPUTE aicv  = logdet + 2.*%nreg/%nobs
COMPUTE hqv  =  logdet + 2.*log(log(%nobs))*%nreg/%nobs
COMPUTE sicv  = logdet + %nreg*log(%nobs)/%nobs
  DISPLAY @4 'AKAIKE'  @20  'SCHWARZ'  @40 'HANAN QUINN'  @60 'log-likelihood'
  DISPLAY @5  ####.#### aicv  @20 ####.#### sicv @40 ####.#### hqv @60 logl
DISPLAY ''; DISPLAY ''



display '****************************************************************'
display '*********    RESTRICTED VAR MODEL FOR HANDYSIZE *********'
display '*********              SURE ESTIMATION                          *********'
display '*********                                                       *********'
display '****************************************************************'


EQUATION 1 LGTH
# constant lgth{1} lhgf{1} LPSET{1} LRGS LPSET
EQUATION 2 LHGF
# constant lgth{1} D1LWGP D1LBP LRGS LPSET
SYSTEM 1 2
```

```
END(SYSTEM)
SUR 2 begobs endobs
# 1 R1STORE; # 2 R2STORE;



COMPUTE LOGDET1 = %LOGDET
COMPUTE NREG1 = %NREG
CDF CHISQR (%NOBS-NREG)*(LOGDET1-LOGDET) NREG-NREG1

    COMPUTE logl = -.5*%nobs*3*(1+log(2*%PI)) - $
    .5*%nobs*%logdet
    COMPUTE logdet = logdet1
    COMPUTE aicv  = logdet + 2.*%nreg/%nobs
    COMPUTE hqv  =  logdet + 2.*log(log(%nobs))*%nreg/%nobs
    COMPUTE sicv  = logdet + %nreg*log(%nobs)/%nobs
      DISPLAY @4 'AKAIKE'  @20  'SCHWARZ'  @40 'HANAN QUINN'  @60 'log-likelihood'
      DISPLAY @5  ####.#### aicv  @20 ####.#### sicv @40 ####.#### hqv @60 logl
    DISPLAY ''; DISPLAY ''

@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LGTH R1STORE BEGOBS ENDOBS
          # CONSTANT LPSET LPSET{1} D1LWGP D1LHFC D1LBP LRGS LHGF{1} LGTH{1}

@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LHGF R2STORE BEGOBS ENDOBS
```

```
# CONSTANT LPSET LPSET{1} D1LWGP D1LHFC D1LBP LRGS LGTH{1} LHGF{1}

display '*************************************************************'
display '*********    RESTRICTED VAR MODEL FOR HANDYSIZE    ***********'
display '*********              SURE ESTIMATION              ***********'
disply  '*********                                          ***********'
display '*************************************************************'

EQUATION 1 D1LGTH
# constant D1LPSET D1LHGF D1LRGS
EQUATION 2 D1LHGF
# constant D1LWGP D1LBP D1LRGS D1LPSET D1LGTH
SYSTEM 1 2
END(SYSTEM)
SUR 2 BEGOBS=1971 ENDOBS=1998
# 1 R1STORE; # 2 R2STORE;

COMPUTE LOGDET1 = %LOGDET
```

```
COMPUTE NREG1 = %NREG
CDF CHISQR (%NOBS-NREG)*(LOGDET1-LOGDET) NREG-NREG1

        COMPUTE logl = -.5*%nobs*3*(1+log(2*%PI)) - $
        .5*%nobs*%logdet
        COMPUTE logdet = logdet1
        COMPUTE aicv  = logdet + 2.*%nreg/%nobs
        COMPUTE hqv  =  logdet + 2.*log(log(%nobs))*%nreg/%nobs
        COMPUTE sicv  = logdet + %nreg*log(%nobs)/%nobs
         DISPLAY @4 'AKAIKE'  @20  'SCHWARZ'  @40 'HANAN QUINN'  @60 'log-likelihood'
         DISPLAY @5  ####.#### aicv  @20 ####.#### sicv @40 ####.#### hqv @60 logl
        DISPLAY ''; DISPLAY ''

@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) D1LGTH R1STORE BEGOBS ENDOBS
        # CONSTANT D1LPSET D1LWGP D1LHFC D1LBP D1LRGS D1LHGF{1} LGTH{1}

@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) D1LHGF R2STORE BEGOBS ENDOBS
        # CONSTANT D1LPSET D1LWGP D1LHFC D1LBP D1LRGS D1LGTH{1} D1LHGF{1}

display '**********************************************************'
display '****  SIMULATION OF RESTRICTED VAR MODEL FOR HANDYSIZE ***'
display '**********************************************************'

EQUATION 1 LGTH
```

```
# constant lgth{1} lhgf{1} LPSET{1} LRGS LPSET
EQUATION 2 LHGF
# constant lgth{1} D1LWGP D1LBP LRGS LPSET
SYSTEM 1 2
END(SYSTEM)
SUR 2 begobs endobs
# 1 R1STORE: # 2 R2STORE:



DIS '**************************************************************************'
DIS '*****                    FOR FORECASTING PERFORMANCE                  *****'
DIS '*****                 USING SUR ESTIMATION METHOD,                   *****'
DIS '**************************************************************************'
SET LPSET ENDOBS-STEP ENDOBS = 2.47
PRINT BEGOBS ENDOBS LPSET LGTH LHGF

EQUATION 1 LGTH
# constant lgth{1} lhgf{1} LPSET{1} D1LWGP D1LBP LRGS LPSET
EQUATION 2 LHGF
# constant lgth{1} lhgf{1} LPSET{1} D1LWGP D1LBP LRGS LPSET
SUR 2 BEGOBS ENDOBS-STEP
# EQ1
```

```
# EQ2



*==============================================================
DIS '*****   FOR SIMULATION RESTRICTED VAR USING SUR ESTIMATION METHOD  *****'
        THEIL(SETUP,estimate=1) 2 step+1 ENDOBS
        # EQ1 EQ2
                DO TIME= ENDOBS-STEP+1, ENDOBS
                        THEIL(PRINT) TIME
                        system EQ1 EQ2
                        end(system)
                END DO TIME
        THEIL
*==============================================================

display '***************************************************************'
display '*********    UNRESTRICTED VAR MODEL FOR PANAMAX  ******'
display '*********                                                     ******'
display '***************************************************************'

EQUATION 1 LGTH
# constant LPSET LPSET{1} LCST D1LRGS D1LWGP D1LPFC LBP
EQUATION 2 LHGF
```

```
# constant LPSET LPSET{1} LCST D1LRGS D1LWGP D1LPFC LBP
SYSTEM 1 2
END(SYSTEM)
SUR 2 begobs endobs
# 1 R1STORE; # 2 R2STORE;

/*
source(noecho) d:\winrats\source\var.src
@ var(exog) begobs endobs
# lgth lhgf
# LPSET{1} D1LWGP D1LHFC D1LBP LRGS LPSET
*/



COMPUTE LOGDET = %LOGDET
COMPUTE NREG = %NREG
WRITE LOGDET

    COMPUTE logl = -.5*%nobs*3*(1+log(2*%PI)) - $
    .5*%nobs*%logdet
    COMPUTE logdet = logdet
    COMPUTE aicv  = logdet + 2.*%nreg/%nobs
    COMPUTE hqv  =  logdet + 2.*log(log(%nobs))*%nreg/%nobs
```

```
COMPUTE sicv  = logdet + %nreg*log(%nobs)/%nobs
  DISPLAY @4 'AKAIKE'  @20  'SCHWARZ'  @40 'HANAN QUINN'  @60 'log-likelihood'
  DISPLAY @5  ####.#### aicv  @20 ####.#### sicv @40 ####.#### hqv @60 logl
DISPLAY ''; DISPLAY ''



display '*************************************************************************'
display '**********    RESTRICTED VAR MODEL FOR PANAMAX        ************'
display '**********                SURE ESTIMATION              ************'
display '**********                                              ************'
display '*************************************************************************'


EQUATION 1 LGTP
# constant LPSET D1LWGP D1LPFC LBP
EQUATION 2 LPGF
# constant LPSET LCST D1LRGS D1LWGP LBP
SYSTEM 1 2
END(SYSTEM)
SUR 2 begobs endobs
# 1 R1STORE; # 2 R2STORE;
```

```
COMPUTE LOGDET1 = %LOGDET
COMPUTE NREG1 = %NREG
CDF CHISQR (%NOBS-NREG)*(LOGDET1-LOGDET) NREG-NREG1

    COMPUTE logl = -.5*%nobs*3*(1+log(2*%PI)) - $
    .5*%nobs*%logdet
    COMPUTE logdet = logdet1
    COMPUTE aicv  = logdet + 2.*%nreg/%nobs
    COMPUTE hqv  =  logdet + 2.*log(log(%nobs))*%nreg/%nobs
    COMPUTE sicv  = logdet + %nreg*log(%nobs)/%nobs
      DISPLAY @4 'AKAIKE'  @20  'SCHWARZ'  @40 'HANAN QUINN'  @60 'log-likelihood'
      DISPLAY @5  ####.#### aicv  @20 ####.#### sicv @40 ####.#### hqv @60 logl
    DISPLAY ''; DISPLAY ''


@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LGTP R1STORE BEGOBS ENDOBS
        # CONSTANT LPSET LPSET{1} D1LWGP D1LHFC D1LBP LRGS LHGF{1} LGTH{1}

@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LPGF R2STORE BEGOBS ENDOBS
        # CONSTANT LPSET LPSET{1} D1LWGP D1LHFC D1LBP LRGS LGTH{1} LHGF{1}
```

```
display '************************************************************'
display '*********   RESTRICTED VAR MODEL FOR PANAMAX     ***********'
display '*********           SURE ESTIMATION              ***********'
display '*********                                        ***********'
display '************************************************************'


EQUATION 1 D1LGTP
# constant D1LPSET D1LCST DLRGS D1LWGP D1LPFC D1LBP
EQUATION 2 D1LPGF
# constant D1LPSET D1LCST DLRGS D1LWGP D1LPFC D1LBP
SYSTEM 1 2
END(SYSTEM)
SUR 2 begobs endobs
# 1 R1STORE; # 2 R2STORE;

COMPUTE LOGDET1 = %LOGDET
COMPUTE NREG1 = %NREG
CDF CHISQR (%NOBS-NREG)*(LOGDET1-LOGDET) NREG-NREG1
```

```
COMPUTE logl = -.5*%nobs*3*(1+log(2*%PI)) - $
        .5*%nobs*%logdet
        COMPUTE logdet = logdet1
        COMPUTE aicv  = logdet + 2.*%nreg/%nobs
        COMPUTE hqv  =  logdet + 2.*log(log(%nobs))*%nreg/%nobs
        COMPUTE sicv  = logdet + %nreg*log(%nobs)/%nobs
          DISPLAY @4 'AKAIKE'  @20  'SCHWARZ'  @40 'HANAN QUINN'  @60 'log-likelihood'
          DISPLAY @5  ####.#### aicv  @20 ####.#### sicv @40 ####.#### hqv @60 logl
        DISPLAY ''; DISPLAY ''


@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) D1LGTP R1STORE BEGOBS ENDOBS
                # CONSTANT D1LPSET D1LCST DLRGS D1LWGP D1LPFC D1LBP

@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) D1LPGF R2STORE BEGOBS ENDOBS
                # CONSTANT D1LPSET D1LCST DLRGS D1LWGP D1LPFC D1LBP



display '****************************************************************'
display '**** SIMULATION OF RESTRICTED VAR MODEL FOR PANAMX ******'
```

```
display '************************************************************'

EQUATION 1 LPTH
# constant LPSET LPSET(-1) LCST DLRGS D1LWGP D1LPFC LBP
EQUATION 2 LPGF
# constant LPSET LPSET(-1) LCST DLRGS D1LWGP D1LPFC LBP
SYSTEM 1 2
END(SYSTEM)
SUR 2 begobs endobs
# 1 R1STORE; # 2 R2STORE;



DIS '**********************************************************************'
DIS '*****                    FORECASTING PERFORMANCE                  *****'
DIS '*****                    USING SUR ESTIMATION METHOD,             *****'
DIS '**********************************************************************'
SET LPSET ENDOBS-STEP ENDOBS = 2.47
PRINT BEGOBS ENDOBS LPSET LGTH LHGF

EQUATION 1 LGTP
# constant LPSET LPSET(-1) LCST DLRGS D1LWGP D1LPFC LBP
EQUATION 2 LPGF
```

```
# constant LPSET LPSET(-1) LCST DLRGS D1LWGP D1LPFC LBP
SUR 2 BEGOBS ENDOBS-STEP
# EQ1
# EQ2
```

```
*==========================================================
DIS '*****  FOR SIMULATION RESTRICTED VAR USING SUR ESTIMATION METHOD  *****'
        THEIL(SETUP,estimate=1) 2 step+1 ENDOBS
        # EQ1 EQ2
                DO TIME= ENDOBS-STEP+1, ENDOBS
                        THEIL(PRINT) TIME
                        system EQ1 EQ2
                        end(system)
                END DO TIME
        THEIL
*==========================================================
```

APPENDIX 13: RATS COMPUTER PROGRAMME FOR "CAPESIZE" MODEL

```
end 0;

DIS '*************************************************************'
DIS '*************************************************************'
*
*
cal 1970
all 1998:1
open data  C:\WINRATS\data15.rat

data(format=rats)

table
SOURCE(NOECHO) C:\WINRATS\DIAG.SRC


set trend = t
COMPUTE PSE(4)  = 1
SET LBP = LOG(BP); SET LGTC = LOG(GTC); SET LNGT = LOG(NGT); SET LCGF = LOG(CGF);
SET LNST = LOG(NST); SET LEGP = LOG(EGP); SET LEGC = LOG(EGC); SET LPSE = LOG(PSE);
SET LESP = LOG(ESP); SET LESC = LOG(ESC); SET LCCBC = LOG(CC/TBC); SET NGS = NST+NGT
```

```
SET LEBF = LOG(EBF); SET LPSET = LOG(PSET); SET DLCGF = LCGF - LCGF{1}; SET DLBP = LBP - LBP{1}
SET LCF = LOG(CF); SET DLCF = LCF - LCF{1}; SET LCIR = LOG(CIR); SET LIST = LOG(IST)
SET LCIT = LOG(CIT); SET LCBF =LOG(CBF); SET LNGS = LOG(NGS); SET LGDP = LOG(GDP)
SET DLEGC = LEGC - LEGC{1} ; SET DLESP = LESP - LESP{1}; SET DLESC = LESC - LESC{1};
SET DLPSET = LPSET - LPSET{1}; SET DLIST = LIST - LIST{1}; SET DLCBF = LCBF - LCBF{1};
SET DLBP = LBP - LBP{1}; SET DLGDP = LGDP - LGDP{1}; SET DLCIR = LCIR - LCIR{1}
SET DLGTC = LGTC - LGTC{1};SET DLNGT = LNGT - LNGT{1};SET DLNST = LNST - LNST{1};SET DLCGF = LCGF - LCGF{1}; SET
DLCGF = LCGF - LCGF{1}; SET DLBP = LBP - LBP{1}
SET LCF = LOG(CF); SET DLCF = LCF - LCF{1};


tabel

STATISTICS LGTC


STATISTICS LNGT

STATISTICS LCGF

STATISTICS LNST

STATISTICS LPSET
```

```
STATISTICS LEGC

STATISTICS LESP

STATISTICS LESC

STATISTICS LIST

STATISTICS LCIR

****************************************************************************************************************

************************************************************************************
********************        HAUSMAN SPECIFICATION TEST       *************************
************************************************************************************

****** STEP 1- EQUATION 1 T 4

LINREG LGTC / RES1
# CONSTANT LEGC LESP LESC LPSET LIST LGTC{1} LNGT{1} LCGF{1} LNST{1}

SET LGTCFIT = LGTC - RES1
GRAPH 2; # LGTC ; # LGTCFIT
```

```
LINREG LNGT / RES2
# CONSTANT LEGC LESP LESC LPSET LIST LGTC{1} LNGT{1} LCGF{1} LNST{1}

SET LNGTFIT = LNGT - RES2
GRAPH 2; # LNGT ; # LNGTFIT

LINREG LCGF / RES3
# CONSTANT LEGC LESP LESC LPSET LIST LGTC{1} LNGT{1} LCGF{1} LNST{1}

SET LCGFFIT = LCGF - RES3
GRAPH 2; # LCGF ; # LCGFFIT

LINREG LNST / RES4
# CONSTANT LEGC LESP LESC LPSET LIST LGTC{1} LNGT{1} LCGF{1} LNST{1}

SET LNSTFIT = LNST - RES4
GRAPH 2; # LNST ; # LNSTFIT

LINREG LGTC / RES21
# CONSTANT LNGTFIT LCGFFIT  LNSTFIT
EXCLUDE
# LNGTFIT LCGFFIT LNSTFIT

    *@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LGTC R1 1970:1 1997:1
```

```
        *# CONSTANT LNGTFIT LCGFFIT LNSTFIT RES2 RES3 RES4

LINREG LNGT / RES22
# CONSTANT LEGC LCGFFIT LPSET LNSTFIT LGTCFIT
EXCLUDE
# LCGFFIT LNSTFIT LGTCFIT

        *@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LNGT R2 1970:1 1997:1
        *# CONSTANT LGTCFIT LCGFFIT LNSTFIT RES1 RES3 RES4

LINREG LCGF / RES23
# CONSTANT LIST LCGF{1} LGTCFIT  LNGTFIT LNSTFIT
EXCLUDE
# LNGTFIT LGTCFIT LNSTFIT

        *@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LCGF R3 1970:1 1997:1
        *# CONSTANT LGTCFIT LNGTFIT LNSTFIT RES1 RES2 RES4


LINREG LNST / RES24
# CONSTANT LESP LESC LPSET LGTCFIT LNGTFIT LCGFFIT
EXCLUDE
# LNGTFIT LGTCFIT LCGFFIT
```

```
*@diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LNST R4 1970:1 1997:1
*# CONSTANT LGTCFIT LNGTFIT LCGFFIT RES1 RES2 RES3

**********************************************************************
*********************** F TEST FOR VARIABLES EXOGENITY ***************
**********************************************************************

LINREG LGTC / RSE1
# CONSTANT LEGC LESP LESC LPSET LIST LBP LCIR
SET LGTCFIT = LGTC - RSE1

LINREG LNGT / RSE2
# CONSTANT LEGC LESP LESC LPSET LIST LBP LCIR
SET LNGTFIT = LNGT - RSE2

LINREG LCGF / RSE3
# CONSTANT LEGC LESP LESC LPSET LIST LBP LCIR
SET LCGFFIT = LCGF - RSE3

LINREG LNST / RSE4
# CONSTANT LEGC LESP LESC LPSET LIST LBP LCIR
```

```
SET LNSTFIT = LNST - RSE4

****************************************

LINREG LGTC / RES21
# CONSTANT LNGTFIT LCGFFIT  LNSTFIT
EXCLUDE
# LNGTFIT LCGFFIT LNSTFIT

LINREG LNGT / RES22
# CONSTANT LEGC LCGFFIT LPSET LNSTFIT LGTCFIT
EXCLUDE
# LCGFFIT LNSTFIT LGTCFIT

LINREG LCGF / RES23
# CONSTANT LIST LCGF{1} LGTCFIT  LNGTFIT LNSTFIT
EXCLUDE
# LNGTFIT LGTCFIT LNSTFIT

LINREG LNST / RES24
# CONSTANT LESP LESC LPSET LGTCFIT LNGTFIT LCGFFIT
EXCLUDE
# LNGTFIT LGTCFIT LCGFFIT
```

```
*******************************************************************************

******************************** 2SLS PROGRAM *******************************

*******************************************************************************

INSTRUMENTS CONSTANT LEGC LESP LESC LPSET LPSET{1} LGTC{1} LNGT{1} LCGF{1} LNST{1}

LINREG(INST,ROBUSTERROR,LAGS=4,DAMP=1) LGTC 1970:1 1998:1 RES1
# CONSTANT LNGT LCGF LNST LGTC{1}

          @diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LGTC RES1 1970:1 1997:1
          # CONSTANT LNGT LCGF LNST LGTC{1}

LINREG(INST,ROBUSTERROR,LAGS=1,DAMP=1) LNGT 1970:1 1998:1 RES2
# CONSTANT LEGC LCGF LPSET LPSET{1} LNGT{1}

          @diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LNGT RES2 1970:1 1997:1
          # CONSTANT LEGC LCGF LPSET LPSET{1} LNGT{1}

LINREG(INST,ROBUSTERROR) LCGF 1970:1 1998:1 RES3
# CONSTANT LNGT LCGF{1} LIST

          @diag(print,lmlags=6,qlags=7,SPAN=1,archlags=6) LCGF RES3 1970:1 1997:1
```

```
    # CONSTANT LNGT LIST LCGF{1}

LINREG(INST) LNST 1970:1 1998:1 RES4
# CONSTANT LESP LESC LCGF LPSET LNST{1}

    @diag(print,lmlags=6,qlags=6,SPAN=1,archlags=6) LNST RES4 1970:1 1997:1
    # CONSTANT LESP LESC LCGF LPSET LNST{1}
```