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THE VELOCITY OF CIRCULATION OF MONEY: EMPIRICAL EVIDENCE FOR THE UNITED KINGDOM 1870-1991

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Abstract

The equation of exchange is not in itself a theory of the demand for money. It can be argued that it is no more than an identity which determines the value of velocity. Given certain assumptions it can be a theory of the aggregate price level. One such supposition is that velocity is a constant, or at least a stable function of a few variables. Velocity over time is far from being a constant. Friedman argues that this is mainly due to errors of measurement and deviations between actual and desired velocity. Keynes suggests that there is no reason to believe that velocity is stable, and that in periods of underemployment equilibrium it may be quite volatile. He also proposes that velocity will depend on the structure of the economy, including the state of technology and institutional arrangements. The main aim of this thesis is to employ long time series data and up to date econometric techniques to produce evidence that relate to these two opposing views. The models employed use both income and transactions velocity measures.

Transactions velocity has been much neglected in the twentieth century, on the grounds that a direct statistical measure is not available. This thesis attempts to resolve this problem by using archive material, sixty variables and seven thousand observations to construct an original transactions series for the period 1870-1991.

The thesis traces the historical origins of the concept of velocity, provides a comprehensive and critical review of earlier work on the subject and produces a considerable amount of empirical work based on long term United Kingdom series of observations. The reported evidence using Johansen cointegration techniques, suggests that there is a long run vector between velocity and a few economic variables. However, the dynamic relationships are both unstable and volatile over the full sample period. Only in using sub-samples can satisfactory statistical results be achieved.

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Thanks is also due to the library staff at the London School of Economics, University of London, whose collection of Parliamentary Papers and other data sources were most useful in constructing the time series variables prior to 1935. The part-time research student lives for the most part a lonely and nomadic existence, often moving from library to library. Accordingly, I would like to thank all the staff at the West Sussex County Council Library at Crawley, where I seem to have spent much of the last three years reading journal articles and preparing chapter drafts. Thanks especially to Helen, Karen, and Charles.

On a personal level I would also like to thank Ashley Parrott for her encouragement, emotional support, and spiritual guidance. Francis Bacon (1626) in his essay "Of travel" said that "Travel, ... is a part of education". Therefore I would like to thank Laurence Genet for organizing all my foreign travel arrangements, and her happy countenance, which brightened the days when the econometric and statistical results were disappointing.

A special word of thanks is due to my mother who often found TSP and MICROFIT printouts, discs, photocopies, and CSO data in the most inappropriate places of her home. She will be much relieved that this project has now been completed.

Unfortunately my father, David Riley, died suddenly on 24th January 1994. So, finally I would like to thank him posthumously, for his encouragement, guidance, and a very happy early childhood. In consequence I would like to dedicate this thesis to his memory.

Jonathan D.C. Riley
27th May 1995.

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Chapter 1

Introduction

There is a long history to the equation of exchange. In its most famous form, following Newcombe (1885), and popularised by Fisher (1911), it is written as:

$$MV^T \equiv PT$$

where M is the quantity of money, V^T is transactions velocity of circulation, P is the price level and T the volume of transactions. This equation is not in itself a theory of the demand for money. It is no more than an identity which determines the value of velocity. However, if one assumes that M is exogenous, V is a constant, or a stable function of a few variables and T is determined by the full employment output of the economy, then it becomes a theory of the price level.

Even a cursory look at empirical velocity data denies constancy. Friedman and Schwartz (1982) argue that this is due to errors of measurement and deviations between actual and desired velocity. Keynes suggests that there is no reason to suggest that velocity is a constant, and in periods of underemployment equilibrium it may be volatile. He further argues that velocity will depend on the structure of banking and industry, social habits, the distribution of income, and the effective cost of holding idle balances. Only if none of these factors are changing, can velocity be thought of as being constant. It is these two opposing hypotheses that will be the main theme of the thesis.

The fact that measured velocity appears to be volatile raises a number of questions regarding the operation of the equation of exchange and the effective conduct of monetary policy. In particular there is Keynes's liquidity trap, a case where the volatility of the velocity of circulation of money may frustrate the goals of monetary policy. Indeed, Keynes argued that velocity is very unstable, and will, for the most part, adapt to whatever changes independently occur in nominal income or the stock of money. Furthermore, if monetary policy is to be operated correctly, it is necessary for the monetary authorities to ascertain whether a shift in velocity is temporary or permanent. What emerges is the importance of forecasting future velocity movements. One approach to this problem is the construction of an econometric causal model to explain past movements and forecast future values of velocity. This is the approach adopted in this thesis. In undertaking this task, an attempt has been made to answer the fundamental question of whether velocity is a stable function of just a few variables or unstable, continuously adapting to structural developments taking place in the economy.

The layout of the thesis is as follows: Chapter two reviews the origins of the concept of velocity in the context of the quantity theory of money. Chapter three conducts a critical and extensive survey of empirical work and ascertains the causal factors that influence velocity behaviour. Chapter four criticises the methodology of earlier empirical literature, considers the development of cointegration analysis, and develops an estimation strategy to test the hypotheses. Chapter five is concerned with the definition, measurement, behaviour, and properties of velocity itself, as well as consideration of divisia monetary indices. Chapter six looks in more detail at the construction of a transactions variable for the United Kingdom, the data of which is used to construct a transactions velocity variable. Chapter seven builds a theoretical long term model, and proceeds to test it using Johansen cointegration estimation techniques. Chapter eight constructs a theoretical short run dynamic model. Chapter nine tests the model constructed in chapter eight, and brings together the long and short term models, and compares them with earlier empirical work. The final chapter provides a summary of and reports on the overall conclusions.

Chapter 2

The origins of the concept of velocity in the context of the quantity theory of money

2.1 Introduction

A simple definition of the velocity of circulation is the number of times a unit of money is transferred between economic agents in a given period of time. The evolution of transactions between individuals in the civilised world can be divided into four stages. First, we have simple barter, where any commodity is exchanged against any other. Second, trade with a recognized medium, fish, oxen, or utensils. Third the use of ingots made of precious metal, stamped with a mark guaranteeing weight. The first use of this can be traced to the Lydians, Greek inhabitants of modern western Turkey in the late seventh century before Christ. Fourth, the replacement of all coins of precious metal by token or symbolic money. In particular the use of paper notes, cheques, credit cards, and electronic transfers.

While much is made by economic historians of the role of the velocity of circulation in the rapid price inflation of the sixteenth century, following the inflow of precious metals from the New World, [see Rich and Wilson, 1967, pp.442-450], the concept of velocity did not emerge until the mid seventeenth century. It is William Petty (1664) with his book "Verbum Sapienti" that marks the origins of modern analysis of the velocity of circulation. He poses the important question of whether there is enough money in circulation for the needs of trade. It is discernible from early work that there was a divergence of the economic literature into two schools of thought. On the one hand are the "motion" theorists who consider the purely mechanical notion of velocity of circulation. On the other, the "cash balance" theorists, who consider money at rest and who argue that the size of the cash balances held is not dependent on the properties of coins but on individuals' actions governed by economic motives. These motives lead to the velocity of circulation being inversely proportional to the demand for money balances. In modern economic literature on velocity the views of the "cash balance" theorists have become dominant while the ideas put forward by the motion theorists have been conveniently neglected. It is, however, appropriate here that we should begin with further consideration of both schools.

2.2 Motion Theory

Motion theory is concerned with the circular course that coins have to follow in the pursuit of trade. This idea suggests a purely mechanical notion of velocity. That is the time and distance between transactions of a given coinage. According to Petty (1664), the larger the number of transactions in a given time, and the closer together, from a geographical perspective, that they take place, the greater is the velocity of circulation and the smaller the amount of money needed in circulation. It must be remembered, that the monetary system was not fully developed at this stage. As Cantillon (1732) points out, in country areas, money was only needed to pay the landlords' rent, and for transactions concerning commodities which must of necessity be purchased in a town. Cantillon is the first to recognise the significance of banks in stimulating the velocity of circulation. When a landlord in London receives his rent, he proceeds to deposit it with a banker, who subsequently lends it as money so that it continues in circulation. This, and the issue of notes by banks, he views not as an augmentation of the money supply but as the acceleration of its velocity of circulation.

To the "motion" theorists the velocity of circulation is a property of money, a kind of energy which results from coins being exchanged hand to hand. Money is seen as a durable material in contrast to other goods which are continually deteriorating to be replaced by others. In periods in which only metallic currency exists this view does not lead to any difficulties. However, with the advent of non-durable means of circulation this view is less straightforward.

Cantillon's paper "Essai sur la nature du commerce en general" contributes three further points of importance: first, an increase in the quantity of money increases consumption and prices throughout a country. Second, an acceleration in the speed of the velocity of circulation increases economic activity to a certain extent. Third, an excess of money in the economy leads to price inflation, and in order to control rising prices it is necessary for the state to withdraw money and constrain the rate of velocity of circulation.

In his critique of "motion theory" Cantillon developed a good understanding of the relationship between the stock of money and the circular flow of income and he is among the first economists to have contributed to our understanding of the equation of exchange. He defined explicitly the concept of velocity of circulation, viewing it not as a constant but as a variable influenced by both technological and economic variables.

2.3 Cash Balance Theory

The cash balance theorists consider money when it is at rest, in the hands of the landlord, the tenant, and the banker. They argue that the size of cash balances held is not dependent on the properties of coins but on the need for money at a given time. In consequence the velocity of circulation is inversely proportional to the demand for money balances. Early cash balance theory is epitomised by Locke's essay entitled "Some considerations of the consequences of lowering the Interest and raising the Value of Money". Locke (1623) considers that a certain amount of money is required for a country to carry out its transactions, although the value of this money stock is difficult to ascertain:

" ... what proportion that is, is hard to determine, because it depends not barely on the quantity of money, but the quickness of its circulation."

(Locke (1623) p.23)

He is not interested in the physical exchange of coins, but the need of an individual for a cash balance:

"Every man must have at least so much money, or so timely recruits, as may in hand, or in short distance of time, satisfy his creditor who supplies him with the necessaries of life, or his trade."

(Locke (1623) p.23)

Locke explicitly points out that it is important to consider average cash balances over a period in time, rather than balances at a particular moment:

" .... we are not to consider here how much money is in any one man's, or in any one sort of man's hands, at one time; .... but how much money is necessary to be in each man's hands all the year round taking one time with another ......"

(Locke (1623) p.26)

He also argues that average cash balances will vary for different types of people, labourers, landlords, tenants, and brokers. The volume of such cash balances is determined by the way in which receipts and disimbursements are linked together.

Locke is also among the first to recognise the influence of interest rates on the value of money:

" ... so far the change of interest, as all other things that promote or hinder trade, may alter the value of money, in reference to commodities."

(Locke (1623) p.32)

In mentioning velocity he explicitly looks upon it as a phenomenon which may promote or hinder trade:

" ... that it were better for trade ... for more money would be stirring, and less would do the business, if rents were paid by shorter intervals than six months"

(Locke (1623) p.27)

Locke also notes:

" ... that the multiplying of brokers hinders the trade of any country, by making the circuit, which the money goes, larger, and in that circuit more stops ... "

(Locke (1623) p.28)

In defining money the cash balance theorists regard both durable and non-durable currency as acceptable. Consequently, this theory is especially adaptable to the concept of credit money. Locke had a clear view of a naive quantity theory where he assumed both the velocity of circulation and the number of transactions as constants. Hume (1752) followed Locke but made a clear distinction between long-run statics and short-run dynamics. In the long run the price level would be proportional to the money stock, but in the short run, or transition period, changes in the money supply would produce changes in the number of transactions. It is at this juncture that the beginnings of the influence of the business cycle upon the behaviour of velocity of circulation can be seen. Thornton (1802) in his book "An Enquiry into the Nature and Effects of Paper Credit of Great Britain" considers the cause of the differences in the velocity of circulation of the same kinds of money at different times. Thornton like Locke believed that the velocity of circulation is determined by the inclination of merchants to hold money in cash. Nevertheless the propensity to do so will be affected by general levels of confidence:

"When ... a season of distrust arises, prudence suggests, that the loss of interest arising from a detention of notes for a few additional days should not be regarded."

(Thornton (1802) p.48)

He further suggests that in times of uncertainty guineas are hoarded, and even private individuals keep money in times of distrust, and this leads to a slower velocity of circulation. Thornton, a century before Keynes's idea of the speculative demand for money, perceives the damage caused to the economy by these fluctuations in velocity and uses this as an argument for the use of paper money as against gold:

"In a commercial country, subjected to that moderate degree of occasional alarm and danger which we have experienced, gold is by no means that kind of circulating medium which is the most desirable ... It is apt to circulate with very different degrees of rapidity, and also to be suddenly withdrawn, in consequence of its being an article intrinsically valuable, and capable of being easily concealed"

(Thornton (1802) p.319)

The importance of Thornton's contribution is that he perceives the fluctuations in the velocity of circulation which occur in the alternating periods of confidence and distrust. Thus he introduces the significance of the velocity of circulation for the problem of the business cycle. It is from this foundation that he states the first clear formulation of the modern quantity theory:

"It is on the degree of the rapidity of circulation of each (money and goods), combined with the consideration of quantity, and not on the quantity alone, that the value of the circulating medium of any country depends."

(Thornton (1802) p.307)

Tooke (1838) extends Thornton's statement by pointing out the contrast between times of speculation and times of dullness:

"The same sum, circulating in times of confidence and speculation with rapidity from hand to hand, will perform a great many more exchanges, and act upon prices with much greater effect than a larger sum in periods of dullness and absence of grounds for speculation; or at times when alarm and that of confidence induce the bankers and possessors generally of monied capitals to increase their reserves and withhold their usual balances"

(Tooke (1838) p.156)

Tooke, thereby, explicitly states the connection between the modern business cycle and changes in velocity of circulation.

2.4 Early Algebraic Versions of the Equation of Exchange

So far in this chapter we have considered the historical roots of the velocity of circulation of money. However, in order to proceed with our analysis in this thesis it is useful to state these arguments in algebraic form. Algebraic versions of the equation of exchange can be traced back to the seventeenth century - a comprehensive history of their development can be found in Marget (1942) and Humphrey (1984). A rudimentary version of the equation of exchange was given by Briscoe (1694) and Lloyd (1771), although, unfortunately, they omitted any discussion of the term velocity of exchange. One of the first comprehensive statements of the equation of exchange was by Lubbock (1840), who included all the terms in the equation and preceded Fisher in distinguishing between the quantities and velocities of hard currency, bank notes and bills of exchange. The nineteenth century saw a proliferation of papers throughout Europe on the algebraic components of the equation of exchange: in Germany, Lang (1811), Rau (1841), in Italy Pantaleoni (1889), in France Levasseur (1858), Walras (1874), de Foville (1907), and in America, Newcomb (1885), Hadley (1896), Norton (1902), and Kemmerer (1907). Of this group Newcomb perhaps gives the clearest statement. He started with consideration of the concept of exchange as involving the transfer of money for wealth. By adding all exchanges that take place in the economy he arrived at what he called his "equation of societary circulation", that is:

$$VR = KP \qquad (2.1)$$

where V is the total value of currency, R is the rapidity (velocity) of circulation, K is the volume of transactions, and P is a price index. While Fisher is usually given credit for the equation of exchange, Newcomb actually preceded him by over twenty five years. However Fisher (1909) acknowledged this to some extent when writing Newcomb's obituary, where he stated that his most important contribution to economics was:

"the distinction he applied in particular to what he called "societary circulation", or the equation of exchange between money and goods. So far as I am aware, he was the first definitely to enunciate this equation, expressing the fact that the quantity of money multiplied by its velocity of circulation is equal to the price level multiplied by the volume of business transactions. This equation with due amplification, represents the so called "quantity theory of money" in its highest form."

(Fisher (1909) p.642)

2.5 Irving Fisher's Contribution

While Newcomb can be credited with the formulation of the transactions form of the quantity equation, it is Fisher (1911) in his book "The Purchasing Power of Money" who popularized it. Fisher followed the "motion theory" tradition, suggesting that velocity is determined primarily by technological and institutional factors. Following Newcomb he defined the equation of exchange as:

"a statement, in mathematical form, of total transactions effected in a certain period in a given community ... In the grand total of all exchanges for a year, the total money paid is equal to the total value of goods bought. This equation thus has a money side and a goods side. The money side is the total money paid, and may be considered as the product of the quantity of money multiplied by its rapidity of circulation. The goods side is made up of the products of quantities of goods exchanged multiplied by their respective prices."

(Fisher (1911) pp.15-17)

In formulating the algebraic equation of exchange Fisher derived two forms: the first, where the left hand side concerning monetary transactions is aggregated, and the second, where payments are divided into: (i) those effected by the transfer of hand to hand currency, including coin, and (ii) those effected by the transfer of deposits. Therefore we have:

$$MV + M'V' = PT \qquad (2.2)$$

where M is the currency in circulation, V is the transactions velocity of circulation, P is the general price level, T an index of the volume of trade, M' is bank deposits, V' is bank deposits velocity. The equation of exchange represents the transfer of goods, services and securities from one economic agent to another, and where the initial agent receives a transfer of money in return. The right hand side of the equation represents the transfer of goods, services, or securities. This is a continuous process, a physical flow of goods, services and securities which once transferred, disappear from economic circulation. The left hand side of the equation is the matching transfer of money. This money once transferred, is treated as retaining its identity and accounted for, regardless of whether it is used or not during the accounting period. Thus, money is treated as a stock, not a flow.

Fisher realised that the equation of exchange was an identity. But he proceeded to suggest that variations in M and M' produce no changes in T. He did not claim a constancy of V and V', but rather that they are independent of M and M', and by implication of P or T. Similarly T is assumed to be independent of M, M', V, V' and P. Thus, Fisher viewed the components of the equation of exchange in the following way:

"The volume of trade, like the velocity of circulation of money, is independent of the quantity of money. An inflation of the currency cannot increase the product of farms and factories, nor the speed of freight trains or ships. The stream of business depends on natural resources and technical conditions, not on the quantity of money."

(Fisher (1911) p.155)

He also proceeds to state his hypothesis of how the quantity theory of money operates:

"Since then, a doubling in the quantity of money: (1) will normally double deposits subject to check in the same ratio and (2) will not appreciably affect either the velocity of circulation of money or deposits or the volume of trade, it follows necessarily and mathematically that the level of prices must double. While therefore, the equation of exchange, of itself, asserts no causal relation between the quantity of money and price level, any more than it asserts a causal relationship between any other two factors, yet when we take into account conditions known quite apart from that equation, viz, that a change in M produces a proportional change in M', and no changes in V, V', or the Q's *[the T's in our terminology]* there is no possible escape from the conclusion that a change in the quantity of Money (M) must normally cause a proportional change in the price level (the P's) ... We may now restate then in what causal sense the quantity theory is true. It is true in the sense that one of the normal effects of an increase in the quantity of money is an exact proportional increase in the general level of prices."

(Fisher (1911) pp. 156-7)

Despite the large amount of empirical work carried out by Fisher (1919) and Snyder (1934) the transactions version of the equation of exchange has fallen out of use. The main reason for this seems to have been the problems in measuring the various components in particular transactions. Fisher included in his definition of transactions, purchase or sale of wealth (real estate, commodities), property (bonds, mortgages, private notes, bills of exchange) and services (of rented real estate, of rented commodities, of hired workers). These various terms aggregated to $\Sigma P_i Q_i$ where P_i are prices, and Q_i are "quantities". To reduce this sum to a manageable size, Fisher introduced the idea of a general price level, defining a base year price weighted sum of quantities as a single variable called transactions, which gives the following:

$$(\Sigma P_i Q_i)_t = P_t T_t$$

where P_t is a price index using current quantities as weights, such that $P_t = \Sigma(P_i Q_i)_t / \Sigma(P_{io} Q_{it})$ and T is a quantity index of current quantities weighted by base year prices so that $T = \Sigma_i P_{io} Q_{it}$. The difficulties in measuring transactions, obtaining a general price level and overcoming the ambiguities arising from the mixture of current and capital transactions have never been satisfactorily resolved. Indeed the more recent comprehensive estimate of transactions was given by Cramer (1981a), who following Keynes (1930) distinguished between goods transactions and financial transactions. He suggests two reasons for treating these as a separate category. First, there is some doubt as to whether these financial transactions constitute demand for money or the placement of idle balances. Second, they constitute a large turnover on what are quite small balances, so that velocity is artificially larger than should be the case. Even with the more commonly quoted income velocity form of the quantity equation, there is still a number of statistical measures which could be thought of as constituting income. Indeed as Friedman and Schwartz (1982) point out, the emphasis on transactions reflected in the Fisher version of the quantity equation, suggests dividing total transactions into categories of payments for which the payment period or practices differ, for example capital transactions, purchases of final goods and services, purchases of intermediate goods, payments for the use of resources/services, wages and salaries, and other payments.

An excellent review of how neoclassical monetary economics evolved from the classical orthodoxy of the nineteenth century can be found in Laidler (1993). This study considers the theoretical developments in the context of contemporary policy and historical events. Laidler argues that the quantity theory of money played a central role in laying the foundations of modern monetary analysis which emerged after the First World War.

2.6 The Renaissance of the Cash Balance Approach

It is with Pigou that we see the renaissance of the cash balance approach of Locke and Hume. Pigou (1917) and later Marshall (1923) express the equation of exchange as:

$$1/P = KR/M \qquad (2.3)$$

where R is total resources of the community, K is the proportion of resources the community chooses to keep in the form of titles to legal tender, M is the number of units of legal tender, and P is a price index. To Pigou (1917) the main difference between Fisher and himself was that by focusing:

"attention on the proportion of their resources that people choose to keep in the form of titles to legal tender instead of focusing on the "velocity of circulation" it brings us into relation with volition - the ultimate cause of demand instead of something that seems at first sight accidental and arbitrary."

(Pigou (1917) p.174)

By the time that Pigou's book, "Industrial Fluctuations" was published in 1927, the empirical difficulties in measuring an index of transactions, and the price index associated with it, together with the development of national income accounting, led to the formulation of the income version of the equation of exchange:

$$MV = PY \tag{2.4}$$

where Y represents real national income, P the implicit price deflator, M the stock of money, and V the income velocity of the circulation of money. It is of critical importance to realise that the V in equation (2.2) and the V in equation (2.4) are not the same, as transactions velocity includes intermediate goods and the exchange of existing assets, in addition to payment for final goods and services. The transactions velocity will be affected by vertical integration of firms, which will reduce the number of transactions involved in a single income circuit. Furthermore, technological changes that lengthen or shorten the production process from raw materials to final product will also affect the number of transactions undertaken. This will not affect income velocity. The transactions version includes the purchase of an existing asset e.g. land, a house, equity, while the income version disregards these completely. The income approach measures transactions in terms of the value-added by each sector of the economy.

The development of the income version of the equation of exchange is an important milestone in the theoretical development of the velocity of circulation of money. Transactions velocity is put to one side and the income velocity forms the foundation for the major developments in analysis which were about to take place. It is to these developments which we now turn.

2.7 The Cambridge Cash Balance Approach

The Cambridge Cash Balance approach associated with Pigou (1917), Marshall (1923), and Keynes (1923) considers a new algebraic equation:

$$M = KPY \qquad (2.5)$$

where $K = 1/V$ and is the time duration of the flow of goods and services money could purchase, that is the fraction of income held in the form of money balances. Arithmetically $MV=PY$ and $M=KPY$ are equivalent. However they are based on opposing views of the role of money in the economy. $MV=PY$ sees money as primarily a medium of exchange, and in line with the "motion" theorists money is continually moving around the economy changing hands. Whereas $M=KPY$ follows the "cash balance" approach where money is a temporary abode of purchasing power, that is a cash balance at rest. In consequence the Cambridge Cash Balance Approach view of the money stock, differs from the "motion" theory idea. The "motion" theorists view money as currency and checkable deposits, assets used primarily in the process of exchange. While the Cambridge approach includes, in addition to these, non-checkable deposits and other liquid assets.

Pigou and his contemporaries view the quantity theory based on M=KPY as both a theory of money supply and money demand. The money supply is determined by the monetary and banking authorities, while the money demanded is proportional to nominal income, with K the factor of proportionality, or the desired holding of real cash balances by economic agents. K, in addition to those factors outlined by Fisher, is determined by the rate of interest. As Bain (1980) points out, this could have been shown explicitly by writing:

$$M = K(r)PY \qquad (2.6)$$

where r is the rate of interest. He further states:

" ... the omission of r from the formal equation made it all too easy to argue as if K were a constant."

(Bain (1980) p.81)

2.8 Keynes and the Reinterpretation of the Cash Balance Approach

Keynes (1936) in his "General Theory of Employment, Interest and Money", offered an alternative approach to the interpretation of changes in money income and investment, rather than the relationship between money income and the stock of money. Keynes developed the concept of why people hold money. He emphasized the view that the aggregate level of transactions, bears a stable relationship to the level of income. He suggested three motives for holding money: the "transaction motive", that is the planned regular payments; the "precautionary motive", that is the holding of money for unexpected transactions, a level of liquid funds for times of emergency or uncertainty; and the "speculative motive", that is money holdings for speculation in financial markets in order to obtain monetary or other gain. Having done this, Keynes argued that the quantity of money demanded could be treated as if it were divided into two parts, one part, M1, "held to satisfy the transactions and precautionary motives", the other part, M2, "held to satisfy the speculative motive". Keynes suggested that M1 was roughly a constant fraction of income, and M2 as arising from "uncertainty as to the future course of interest rates."

In terms of defining the velocity of circulation, Keynes was unclear whether it should be seen as the ratio of Y to M, or as the ratio of Y to M1. He chose the latter view, and further assumed that transactions and precautionary velocity (V1) while not necessary constant in the long-run, could be thought of as being so in the short term. As Keynes (1936) states:

"There is, of course no reason for supposing V is constant. Its value will depend on the character of banking and industrial organization on social habits, on the distribution of income between different classes and on the effective cost of holding idle cash. Nevertheless, if we have a short period of time in view and can safely assume no material change in any of these factors, we can treat V as nearly enough constant."

(Keynes (1936) p.201)

However, Keynes argued that under conditions of underemployment equilibrium the V in equation (2.4) and the K in equation (2.5) were in fact very unstable and would for the most part adapt to whatever changes independently occurred in money income or the stocks of money. In order to understand this phenomenon we need to consider the other component of Keynes's definition of money, that is M2, held to satisfy speculative motives.

In analysing the speculative demand for money, Keynes concentrated on two alternative ways of holding financial assets, money and long-term bonds. The nominal value of money is seen as fixed, but that of bonds will change when the rate of interest is altered. An increase in the market rate of interest will lead to a fall in the price of bonds which offer a fixed rate of interest. Investors, in deciding whether to hold money or bonds, will also take into account possible gains and losses from holding bonds as well as the interest income. The important factor in the Keynesian theory is not the absolute level of the rate of interest (r), but the extent of the divergence from what can be considered a relatively safe (expected/"natural") rate of interest. Investors' views about the rate of interest are distributed about some expected rate of interest (ρ), which will vary between individuals, except at low levels. The larger the current rate of interest in relation to the expected level, the more investors will expect it to fall and thus choose to hold bonds. When the rate of interest is lower than the expected rate of interest asset holders in the main will expect interest rates to rise and choose to hold money. This relationship showing the demand for real speculative balances M2 is known as the liquidity preference curve, as shown by figure 2.1.

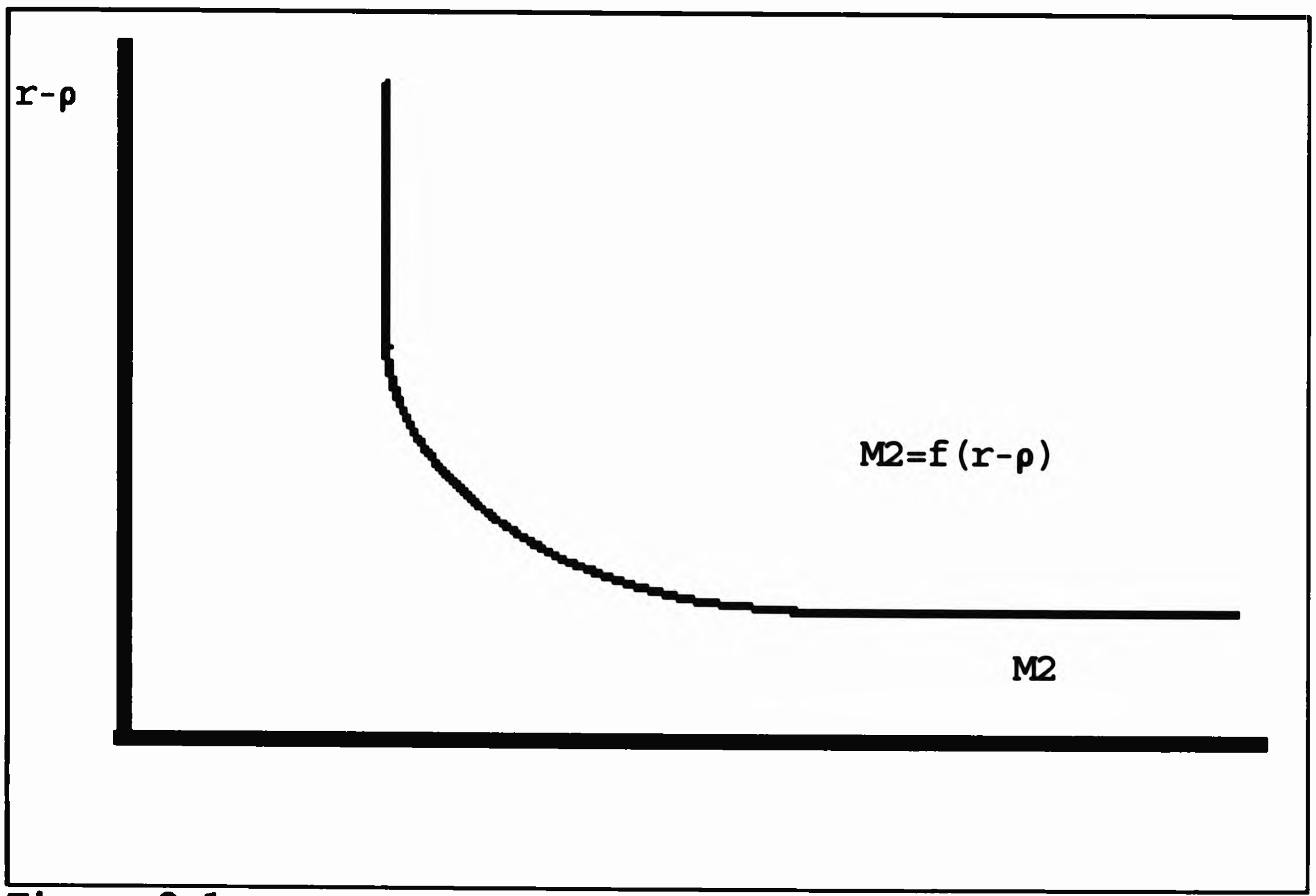

Figure 2.1

where r = the nominal interest rate, ρ = the expected interest rate, and $(r-\rho)$ = the differential between nominal interest rate and the expected interest rate. It follows that the speculative demand for money is a declining function of $(r-\rho)$. Thus;

$$M2 = f[(r-\rho)] \tag{2.7}$$

where $f'[(r-\rho)] < 0$. Keynes argued that at some low positive rate of interest the elasticity of the liquidity preference curve would become infinite. At this point investors do not believe interest rates will fall any lower and the expectation is for them to rise. Given the small yield, they would not be compensated for the risk of capital loss. Therefore, rather than hold bonds at a lower yield they convert their assets into money.

It is also important to note that Keynesians believe that in a situation of underemployment equilibrium, the demand for money equation will be unstable. Consequently, accurate prediction using the demand for money function may not be possible in these circumstances. A full discussion of the liquidity trap can be found in Johnson (1967, 1972). Nevertheless, there is little evidence to support the liquidity trap hypothesis. One of the most notable studies using both short and long term interest rates and a variety of money definitions was conducted by Laidler (1966). He found that there was no tendency for interest rate elasticities to be higher at low rates of interest.

The importance of this analysis to our understanding of the equation of exchange is that it is possible for there to be offsetting movements in velocity which directly cancel out any monetary policy undertaken. To understand the liquidity trap in the context of velocity behaviour, it is necessary to use the IS/LM framework. On the whole Keynesians see monetary policy as unimportant compared with the role played by fiscal policy. This suggests that the IS curve is steep and the LM curve flat. By considering two extreme cases of either a horizontal LM curve or a vertical IS curve, it can be seen that any change in the rate of growth of money is completely offset by an opposite change in velocity, so that monetary policy has no effect at all.

In the first example of the liquidity trap, the LM curve is horizontal, that is the demand for money is perfectly elastic with respect to the rate of interest. In consequence any additional money is absorbed into idle/speculative balances. In this situation an expansionary monetary policy would be incapable of reducing the rate of interest below r^*, and the level of income velocity would fall. This is shown in figure 2.2.

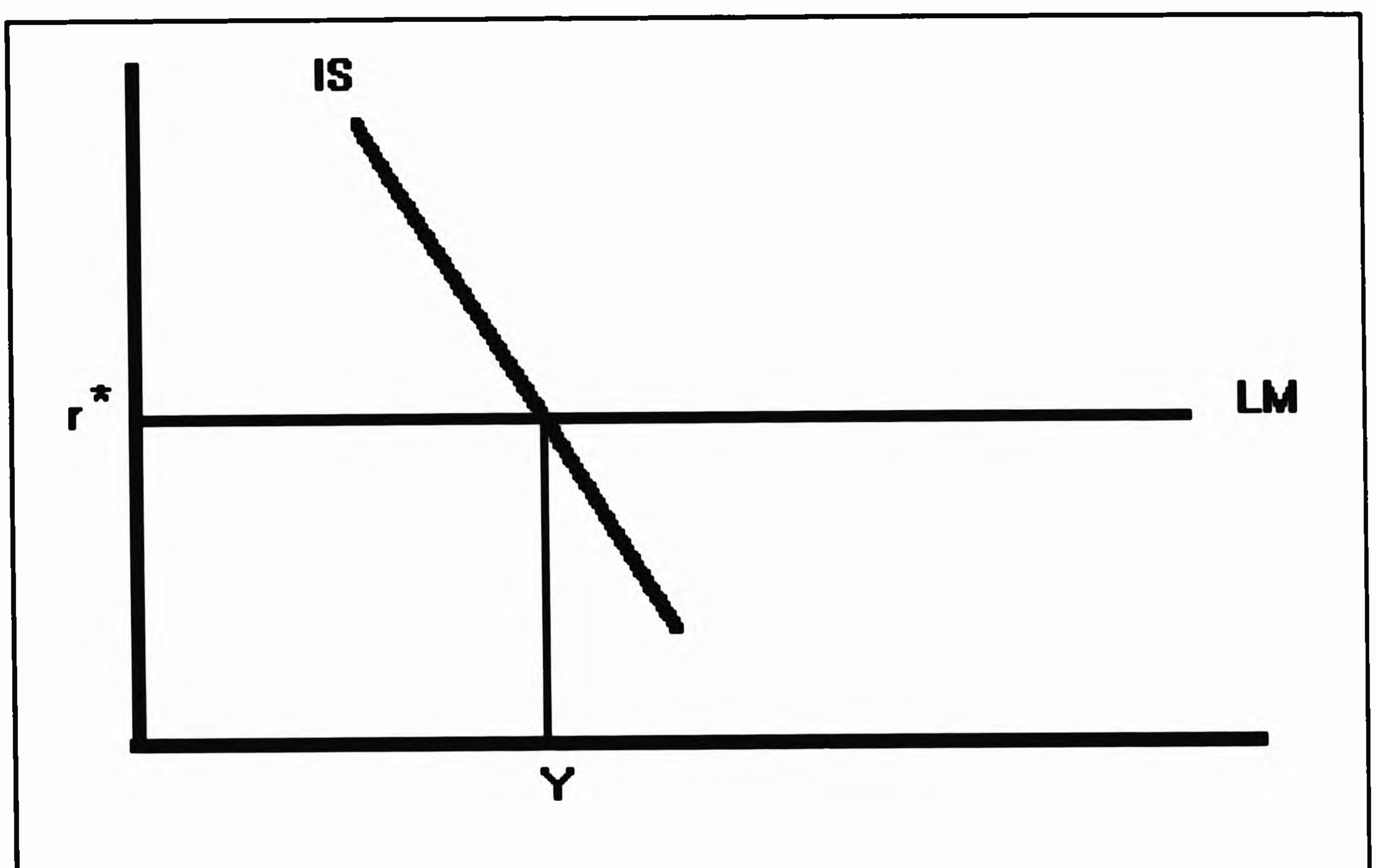

Figure 2.2 Source: Vane and Thompson (1979)

In the second example, consumption and investment are completely interest inelastic, again monetary changes have no effect on real output. As the stock of money grows, interest falls to maintain equilibrium in the money market, and velocity falls as the demand for money rises relative to the unchanged level of output. In this case the diagrammatic representation shows a vertical IS curve, an initial LM curve, and a second LM curve with the lower interest rate, as shown in figure 2.3.

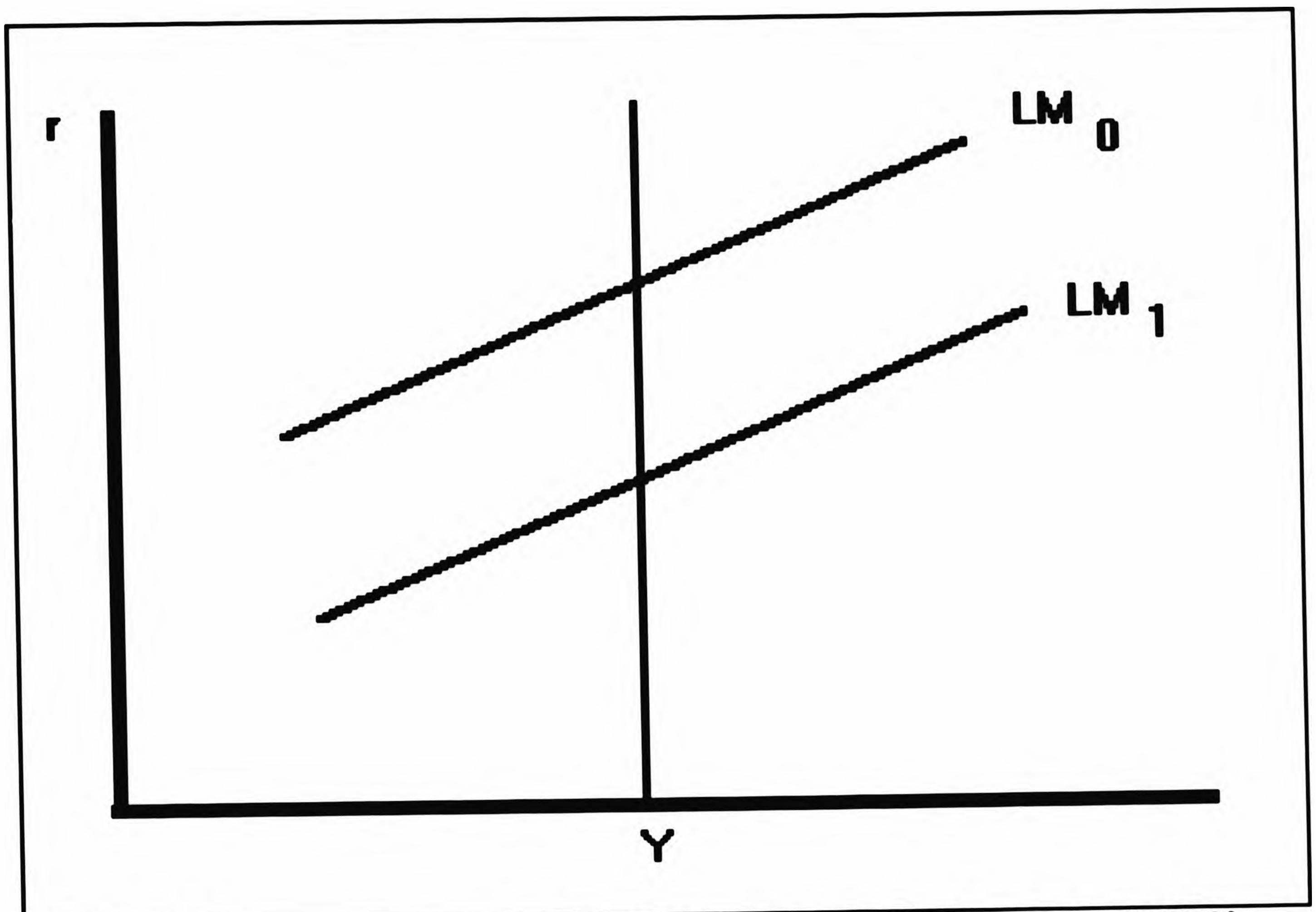

Figure 2.3 **Source: Vane and Thompson (1979)**

The liquidity trap hypothesis states that the demand for money becomes perfectly elastic at low levels of interest rates. This further suggests that the relationship between the demand for money and the rate of interest will be unstable over time.

We can now formalise Keynes' analysis algebraically as

$$M = M1 + M2 = k_1 y + f(r-\rho) \qquad (2.8)$$

where M = real money balances, M1 = real money balances held to satisfy transactions and precautionary motives, M2 = real money balances held to satisfy the speculative motive, P = the price deflator, r = the current rate of interest, ρ = the rate of interest expected to prevail, k_1 = the analogue to the inverse of the velocity of circulation of money, y = real income. This is treated as being determined by payment practices and hence is constant in the short run. However, later Keynesians, Baumol (1952) and Tobin (1956) argue that k_1 should be regarded as a function of interest rates.

2.9 Milton Friedman and the Modern Quantity Theory

Friedman (1956) re-examines the quantity theory of money in the light of Keynes' analysis, making the demand for money the explicit starting point. He draws attention away from the motives that prompt people to hold money, and towards the question of how much money individuals want to hold under various circumstances. The demand for money is treated in the same way as the demand for any other financial or physical asset. Thus the demand for any particular asset is determined by the characteristics including yield in relation to that of other assets, the individual's choice being subject to a wealth constraint. The budget constraint determines a maximum amount of goods or assets which can be held at any given time. Wealth can be considered to be the sum of an individual's assets, durable goods, bonds etc. However, if there is no restriction on what can be bought or sold there will be in fact no maximum limit on the amount of money an individual can hold. For if he has labour income there is no reason why he cannot trade his labour for money as well. With this kind of framework bonds can be considered a claim on future interest payments, and stocks a claim on future income from capital equipment. Therefore, it is difficult to distinguish between trade in these assets and trade in future income. This wealth can be split into two distinct elements, human wealth, and non-human wealth. The distinction between the two is that capital or non-human wealth is tangible, while human wealth is intangible. Human wealth is also assumed to be less liquid than non-human wealth.

Friedman also argues that the rate of return on holding money is not a constant. If the price level rises, the real value of money holdings falls and vice versa. The expected rate of growth of price inflation can thus be interpreted as an expected rate of return on money holdings, and other things being equal, the higher the expected rate of return on money balances the more will be held. Thus, the expected rate of change of price inflation becomes an important variable in the demand for money function. The price level, too, has to be mentioned, as money is held for the service it provides to its owners, that is the source of purchasing power.

Thus Friedman's model of the demand for money can be written as;

$$M_d = f\ [W, r - \frac{1}{r}\ \frac{dr}{dt}, \frac{1}{P}\frac{dP}{dt}, h]\, P \qquad (2.9)$$

where M_d = the demand for money in nominal terms, W = wealth, r = the rate of interest, P = the price level, h = the ratio of human to non-human wealth. In the period since the "Restatement" many refinements have taken place. In particular the problems of measuring wealth have been by-passed by the introduction of permanent income (see Friedman (1957)). This is the maximum amount of income that the individual could spend on consumption each year, without accumulating debts for the next generation.

Klein (1974a and 1974b) suggests that studies in the demand for money that ignore the own rate of return on money, for instance seven day deposit accounts, underestimate the sensitivity of the demand for money to the opportunity cost of holding it. When market interest rates rise, so does the own rate of return on money. In consequence the interest differential between money and alternative assets alters less than the value of market interest rates. Thus Friedman's (1970) demand for money function can be written as;

$$M_d/P = f(\ \underbrace{yp}_{a};\ \underbrace{rm;\ rb;\ re;\ 1/P\ dP/dt}_{b};\ \underbrace{u}_{c}) \tag{2.10}$$

where M_d/P = the demand for real money balances, yp = permanent income, rm = the rate of return on money, rb = the rate of return on bonds, re = the rate of return on equities, u = individual preferences, a = budget constraint, b = the return on money and competing assets, c = individual preferences. As the income velocity of circulation is simply the reciprocal of the number of weeks of income held as money, we can see why an analysis of velocity is equivalent to an analysis of the demand for money, and how the arguments outlined above are of use to the aims of this thesis.

To Friedman the concept of velocity can be explained in two ways. The simplest of these is that measured velocity is the ratio of two independent magnitudes, income and money, each determined by a separate set of forces. This explanation is consistent with the view that: (1) there does not exist a stable demand for money function containing a small number of variables; (2) there exists a stable function, but it has a special form so that velocity adapts passively to the separate movements in income and money; (3) the errors of measurement of numerator and denominator dominate the fluctuations of velocity. The other explanation is that velocity is a numerical constant, if averaged over individual cycles. According to this view deviations from constancy reflect either errors of observation or temporary differences between actual and desired velocity. However, Friedman and Schwartz (1982) accept that measured velocity is not a constant:

"Velocity , as measured, is clearly not a numerical constant. However, measured velocity differs from true "permanent" or desired velocity for two reasons: errors of measurement, and deviations between actual and desired velocity. May these deviations not explain the failure of measured velocity to be a numerical constant"

(Friedman and Schwartz (1982) p.208)

Nevertheless, while velocity is not a constant, Friedman and Schwartz (1982) suggest that one should not forget how far the idea of constancy explains variations in the data.

"Though a numerically constant velocity must be rejected as a full explanation of the relationship between money and income, it should not be dismissed without recording how far it takes us. For any lengthy period ... the simplest and most rigid form of the constant - velocity view - accounts for the great bulk in the variation in nominal income."

(Friedman and Schwartz (1982) p.210)

This statement, is an issue which will have to be examined once again later in the thesis, in the context of the empirical work.

2.10 Conclusion

The origins of modern analysis of the velocity of circulation can be traced to Petty (1664). The early economic literature can be divided into two schools of thought, the "motion" theorists, and the "cash balance" theorists. In modern economic literature the latter have become dominant. While Fisher (1911) is usually given credit for the equation of exchange, Newcomb (1885) actually preceded him by over two decades. The cash balance approach associated with Pigou (1917) laid the foundations for work by Keynes (1936), who developed the concept of why people hold money. He emphasizes the view that the aggregate level of transactions, bears a stable relationship to the level of income. Keynes also argues that velocity can be highly unstable and volatile. It will depend on economic and social structure, and speculative behaviour. Friedman (1956) moves away from the motives that prompt people to hold money towards the question of how much money individuals want to hold under different circumstances. The demand for money is treated like any other good or service, being determined by the characteristics of its yield in relation to other assets. Friedman believes that velocity is a stable function of just a small number of variables, and that measured velocity is volatile due to errors of measurement and deviations between actual and desired velocity.

This chapter has reviewed the origins of the concept of velocity in the context of the quantity theory of money. In so doing, the roots of many of the controversies which will have to be dealt with in this thesis have been identified. Our first task, in attempting to resolve these issues, is to conduct a critical survey of empirical work, to ascertain the evidence on the causal factors that influence velocity behaviour.

Chapter 3

A Critical Survey of Empirical Work

3.1 Early Work - Cash Balances, Liquidity Preferences, and the Interest Rate

Early empirical work on the velocity of circulation on the whole followed Keynes's views, rejected the idea that the velocity ratio was sufficiently stable in the short run to predict the level of income, and based analysis on the components of aggregate expenditure. Like Keynes, in order to predict the demand for money, researchers sought motives for holding money. One part of the demand for money was assumed to be a constant ratio of transaction balances to income, that is a constant transactions velocity, the remaining monetary demand being functionally dependent on interest rates. The Keynesian function being written as:

$$M = L(r,Y) \qquad L_r < 0 < L_Y \tag{3.1}$$

where M = real money balances, r = a rate of interest, Y = real income, L_r and L_Y are the derivatives of the L function with respect to the two arguments. Keynes did not specify a unique set of measurement procedures for the variables or properties of equation (3.1). However, given the assumptions made above, the demand function can be written as:

$$M = M^T + L = kY + L(r) \tag{3.2}$$

where M^T = demand for real transactions balances (active balances), L = demand for real speculative balances (idle balances), k = the inverse of transactions velocity. Tobin (1947) provided some empirical support for this hypothesis. He assumed that the average cash balance k could be computed from time series data by choosing the minimum ratio of M/Y, 1929 from his data, the year in which velocity reached a maximum, and he assumed that there were no "speculative" balances in that year. Tobin's specification of the Keynesian hypothesis is generally written as:

$$L = M - \min (M/Y)Y = L(r) \tag{3.3}$$

Following Eisner (1963), who allows a constant minimum component of idle balances, even in years of maximum velocity, Brunner and Meltzer (1963) add a constant term to the Tobin specification of the Keynesian model. Thus they obtain two alternative Keynesian type hypothesis:

$$\ln(L+1) = b_1 \ln r + a_1 + u_1 \tag{3.4}$$

$$L+1 = b_2 r + a_2 + u_2 \tag{3.5}$$

Brunner and Meltzer (1963) proceed to estimate equations (3.4) and (3.5) using annual U.S. data for the period 1910-1940 and 1951-1958. The predictions from the two hypotheses are extremely poor for the period as a whole and for each of the sub-periods, although the use of levels and a 1918 base improves the predictive performance somewhat.

These early empirical results depend on quite strict assumptions about the nature of the demand for money function. However, Khusro (1952) who updated Brown's (1939) work on Great Britain, suggested that the ratio of idle balances to liquid assets varies with the rate of interest, and that this ratio is the first indication, albeit very narrowly defined, that a wealth variable plays a role in the demand for money function. Khusro also used econometric techniques to estimate the value of k, the ratio of active balances to income, improving upon the method outlined above, and found that this enhanced the explanatory performance of the model, which showed a significant inverse relationship between idle money balances and the interest rate.

Other early post-war writers sought to isolate a stable velocity function dependent on interest rates and/or other variables, for example income (see Lathane, 1954, 1960). Lathane avoided the Tobin assumption that the general hypothesis (equation 3.1) could be tested by means of the equation:

$$L = L(r) \tag{3.6}$$

Instead he presents a variety of additional forms of the Keynesian money demand function. The importance of Lathane's work is that he establishes a linear relationship between income velocity (Y/M) and the long term rate of interest (r_L) as measured by corporate bond yields, that is:

$$\ln V = a + b \ln r_L + u \tag{3.7}$$

Using annual U.S. data for the period 1909 to 1958 he obtains the estimated equation:

$$\ln V = -0.5 + 1.3 \ln r_L \tag{3.8}$$

Lathane suggests that the theoretical foundation for the relationship between V and r_L, is that in many instances, bonds are excellent substitutes for money. Money is held mainly to carry out transactions. Its yield is the convenience and utility of holding cash balances. The yield from bonds is balanced at the margin with the yield from money. When interest rates are high, individuals economise on their cash balances. If bonds are a good substitute for money, while other assets are fairly poor substitutes, then a change in the money supply will tend to affect the bond market rather than expenditure on other assets. In these circumstances, the interest elasticity of demand for cash balances has considerable influence on the effectiveness of monetary policy. Ritter (1959) suggests that when interest rates are low and idle balances large, a small rise in rates is likely to result in a large transfer of funds from hoards to active circulation, thus increasing velocity substantially. However, as interest rates continue to rise, due to continued monetary restraint and persistent demand for funds, idle balances are likely to become exhausted. Correspondingly velocity is likely to encounter an upper limit. As it becomes more difficult to obtain the release of additional funds from the depleted idle balances, velocity will be subject to new constraints, economic activity will become increasingly sensitive to monetary policy and further expansion of GDP will be inhibited.

Meltzer (1963) is critical of both Lathane and Ritter. He reexamines Lathane's work and finds that the interest elasticity does not differ significantly from zero in the period 1900-1929. According to Meltzer, Lathane's result is spurious since it combines the significant results of the later period, with the non-significant results of the first two or three decades. Meltzer argues that the definition of M is important, and that a rise in interest rates will change the demand for money much more when time deposits are excluded from M than when they are included in it. He also finds that measures of income velocity that include a large proportion of money substitutes in the denominator are less sensitive to interest rate changes than those based on currency and demand deposits alone. Rather than the velocity function Meltzer uses its inverse, that is money per unit of income. Using U.S. data for the period 1900-1958 he obtained the following results:

$$\ln 1/V_1 = \underset{(30.4)}{2.21 - 1.78} \ln r + \underset{(0.61)}{0.02} \ln W/P + w_1 \qquad (3.9)$$

$R^2 = 0.98$

$$\ln 1/V_2 = \underset{(19.5)}{1.37 - 1.34} \ln r + \underset{(6.4)}{0.23} \ln W/P + w_2 \qquad (3.10)$$

$R^2 = 0.96$

(t-statistics in parentheses)

where V_1 = velocity (excluding time deposits), V_2 = velocity (including time deposits), r = an interest rate, W/P = wealth divided by prices. Note that V_1 depends only on the interest rate, the parameter on (W/P) not being significantly different from zero, while V_2 depends both on interest rates and wealth as the hypothesis suggests wealth in this context is a budget constraint on the total amount of assets which can be held.

According to Meltzer, Ritter's notion that there is an upper bound to velocity is denied by the data. Interest rates range from 2.35% to 5.31% and there is little evidence of a velocity ceiling. He suggests that if such a ceiling exists, it should take the form of large positive value for w_1 in equation (3.9), during periods of high interest rates, that is the measured value of $1/V_1$ should exceed the predicted value by a large amount. However, this is not borne out by the findings.

The liquidity trap hypothesis is closely related to the proposition that the relationship between the demand for money and the rate of interest can be expected to be unstable over time. In order to asses this hypothesis, Meltzer employs two tests, (1) comparison of the estimates for sub periods - cycles or decades, with those for the entire period, (2) comparison of related cross section studies. The results he obtained for the first of these tests are shown in table 3.1.

Table 3.1
Elasticity of V1 with respect to Interest Rates

Period	Interest Elasticity
1900-1958	1.78
1900-1909	2.37
1910-1919	1.10
1920-1929	1.21
1930-1939	1.66
1940-1949	2.14
1950-1958	1.02

Source: Meltzer (1963)

These results suggest that income elasticity is fairly constant over time. This is supported by later evidence by Laidler (1971) for the United Kingdom over the period 1900-1964, which shows little variation between sub periods, and Friedman and Schwartz (1982) who for both the United States and United Kingdom over the period 1867-1975 and various sub periods, found very little variation in interest elasticities.

3.2 Milton Friedman & the Permanent Income Hypothesis

The drawback to all the empirical work outlined above, is that the authors assume that the demand for money is proportional to the level of income. This hypothesis would be challenged by those who regard wealth as a more appropriate variable to include in the velocity function. To Friedman (1959), expectations play an important role in the demand for money, for example expected capital gains, expected income yield, expected price inflation. He concludes from his empirical work that the main determinant of demand for money is permanent income, that is an average expected future income. This contradicts the view stated above that wealth is more appropriate than income. However, as Friedman (1959) points out:

"What comes out as income originally entered as wealth ... the "income" relevant to this equation is not income as measured in the national accounts but income conceived of as the net return on a stock of wealth, or wealth measured by the income it yields ... Permanent income can be regarded as a concept closely allied to wealth and indeed as an index of wealth"

(Friedman (1959) p.137)

Friedman suggests that permanent income has greater stability than actual measured income because this is a weighted average. Therefore, actual income fluctuates more widely than permanent income. The empirical findings of Friedman and Schwartz (1963) suggest the services given by money balances are a luxury. So demand for money rises proportionately more than the rise in real income. In other words the real income elasticity of the demand for real money holdings is greater than unity. Accordingly, income velocity should be expected to fall as permanent income rises. Empirical evidence supports this view for the period 1870 - 1947. However, in the post Second World War period there has been a rise in velocity. Permanent income has been rising, but so has velocity. Movements in velocity have been the opposite of what the theory would have predicted. It has been suggested that the rise in interest rates, the growth of money substitutes, and inflationary psychology, explain these movements. Indeed Bordo and Jonung (1987) found that permanent income elasticity of velocity was positive, and significantly different from zero at the 95% significance level for three European countries. These results suggest that permanent income elasticities of the demand for money are considerably less than one. This is in agreement with other empirical work by Goldfeld (1973). It also implies that there are economies of scale in cash management as argued by Baumol (1952) and Tobin (1956). However, Friedman and Schwartz (1982) reject these explanations. They suggest "one possible common root" of the pre and post Second World War periods, that is the changing patterns of expectations about economic stability. In their view the instability and uncertainties of the period 1929-1942 led to a sharp increase in the demand for money. In the post war period, growing confidence in future economic stability, with high levels of employment and mild recessions, led to a decline in the demand for money.

While Friedman (1959) believes that interest rates have a systematic effect on the velocity function, with empirical evidence supportive of a positive relationship, he believes the effect to be small. As Friedman states, the observed cyclical changes in interest rates:

"seem most unlikely to account for the ... cyclical pattern in velocity"

(Friedman (1959) p.138)

Nevertheless, in later work (Friedman 1966, 1970) he denies that interest rates have no effect. It is simply that income or wealth are more important. However, there has been much criticism of Friedman's Permanent Income Hypothesis. Tobin (1965) asserts that:

" ... the annual percentage change in the money supply explains only 31 per cent of the variation in the annual percentage change in money income over the period 1869-1959. So the relationship between the quantity of money and income is not stable, and neither it appears has velocity been a stable function of permanent income"

3.3 Klein and the "Own" Rate of Interest on Money

Klein (1973) attempts to reconcile the differences between Friedman and Schwartz (1963) and Lathane (1954, 1960), concerning the significance of the rate of interest as a determinant of velocity. He attempts to explain these discrepancies by considering the simultaneous movements that occurred over this period in the inverse of the money multiplier, a variable which has been shown to be related to competitive interest payments on money, known more commonly in recent times as the "Own Return on Money". Once the additional variable is introduced, the major problems in the velocity interest rate relationship are eliminated, and the relationship remains intact over a longer time period.

Klein initially derives an estimate of the interest payments that would be made on money balances in a perfectly competitive banking system. The marginal return on money (r_M), is defined as a weighted average of marginal interest on currency (r_C), and marginal interest on deposits, (r_D).

$$r_M = (C/M)r_C + (D/M)r_D \tag{3.11}$$

where the money supply equals currency (C) plus commercial bank deposits (D).

$$M = C + D \tag{3.12}$$

The interest on currency is assumed to be zero $r_C = 0$. Interest on bank deposits can be estimated by measuring the marginal cost of producing the deposits, this for the most part, is interest foregone by commercial banks on the non-interest bearing reserves in their portfolio. The perfectly competitive interest payments on deposits are:

$$r_D = r_I \ (1-[R/D]) \qquad (3.13)$$

where r_I equals the marginal rate of return on bank loans and investments, (the marginal return on the interest bearing assets in bank portfolios), and [R/D] is the marginal reserve to deposit ratio. If this ratio is also equal to the average reserve to deposit ratio, and if commercial bank deposits are defined to include demand time deposits we obtain:

$$r_M = r_I \ (1-[H/M]) \qquad (3.14)$$

where H is high powered money which equals currency plus total commercial bank reserves held on deposit such that H = C + R. It is expected that (1-[H/M]) is positively related to the demand for real cash balances and is negatively related to movements in velocity. Klein proceeds to test this hypothesis, using annual U.S. data for the period 1880-1970. His first specification follows Lathane's log relationship stated earlier. (equations 3.7 and 3.8):

$$\ln V = 0.1436 + 0.4206 \ln r_L \qquad (3.15)$$

$$(2.88)$$

$$R^2 = 0.075 \quad D.W. = 0.058 \quad s.e. = 0.2997$$

Although the t-statistic would suggest that the coefficient on the long run rate of interest is statistically different from zero, the high autocorrelation, as indicated by the low Durbin Watson statistic, (the correlation between ln V and its lagged value is 0.97), suggested that Friedman and Schwartz were correct to reject this equation[1].

When Klein adds the high-powered to total money ratio to the regression the following results are obtained:

$$\ln V = -1.2581 + \underset{(8.79)}{0.9117} \ln r_L - \underset{(11.27)}{2.3071} \ln (1-[H/M]) \quad (3.16)$$

$R^2 = 0.617$ D.W. $= 0.271$ s.e. $= 0.1928$

With the addition of this variable, both the size, and the significance of the interest rate coefficient are increased, as is the predictive power of this equation. However, the Durbin-Watson statistic still indicates a problem with autocorrelation.

Klein moves on to consider the Permanent Income Hypothesis. It is pointed out that since Friedman (1959) argues that the velocity, the ratio of measured to permanent income and interest rates all move procyclically, the cyclical movement in velocity may be due to the measured rather than permanent income being used in the calculation of velocity, and this is what the interest rate is picking up. Therefore the ratio of measured to permanent income (Y/Y_p) is added as an additional variable to determine the purely secular relationship between velocity and interest. Furthermore, in order to eliminate the implicit constraint that the income elasticity of demand for money equals one, Klein, includes a real income variable in the relationship. In addition a short term interest rate is introduced, since both short and long rates may affect the demand for money.

$$\ln V = 1.8681 - \underset{(13.95)}{0.3353} \ln Y_p + \underset{(5.48)}{0.2765} \ln r_L + \underset{(11.02)}{0.1866} \ln r_S$$

$$- \underset{(13.11)}{1.2020} \ln (1-[H/M]) + \underset{(10.33)}{0.7345} \ln(Y/Y_p) \qquad (3.17)$$

$R^2 = 0.959$ D.W. = 0.687 s.e. = 0.0633

The parameter on the ratio of measured to permanent income is significantly different from zero. However, this variable was introduced purely because it is argued that the velocity measure contains the incorrect measurement. If this is the case, and the permanent income weights are correct, a coefficient of unity is expected. Klein argues that the fact that this coefficient is 0.7345 is because the measurement of the variable contains upward bias during the postwar period, due to the failure to take account of the positive trend in the price level when calculating the permanent price level. All other coefficients are of the correct sign, and are significantly different from zero. While the predictive performance of the equation would appear good, this is offset by the presence of autocorrelation, which appears to be a failing in all of Klein's equations. Nevertheless, given this evidence, it would appear that Friedman was wrong in maintaining that rates of interest are much less important determinants of measured velocity, than the ratio of measured to permanent income.

The significance of the inverse of the money multiplier variable is that it suggests that money makers must be aware of how a particular change in the money supply is brought about to fully understand its effects. An increase in the money supply by open market operations will generally have a greater expansionary effect than those brought about by lowering reserve requirements. Changes in reserve requirements offset by open market purchases, that is changes in the composition of money will have non neutral effects. A change in the banks' reserve ratio will affect interest payments on deposits, and consequently will influence both the desired currency to deposit ratio and the demand for real cash balances.

3.4 Transitory Income, Monetary Shocks, and the Business Cycle

While the ratio of measured to permanent income is introduced in Klein's work because of Friedman's view that the dependent variable is measured incorrectly, this variable can also be used to represent a second argument. The above discussion of permanent income suggests that both measured income and measured consumption contain a permanent and a transitory element. The permanent part is the anticipated and planned element of income and consumption, while the transitory elements are the windfall gains and losses of income and unanticipated changes in consumption. The transitory income will have an effect on money demanded and hence velocity. The ratio of measured to permanent income should have a coefficient of one. A positive coefficient less than one would be in line with Friedman's (1957) permanent income hypothesis, suggesting that velocity moves procyclically. During the business cycle transitory income increases the demand for money, as cash balances serve as a buffer stock. (see Carr and Darby (1981) and Laidler (1984)). However, in the long-run these transitory balances are worked off, returning the coefficient to unity. These observations that can be said to constitute the pointers to a buffer stock theory of money demand are to be found in Darby (1972). He proposed that money balances serve as a shock absorber or buffer stock which temporarily absorbs unexpected variations in income (transitory income), until the portfolio of securities and consumer durable goods can be adjusted. Another shock may come from unexpected changes in the nominal money supply. If the Bank of England increases the money supply by open market operations, the first effect will be on the price of Treasury Bills. This impact will quickly move to the price of other securities. As this process takes place, investors will find that they cannot obtain their expected yield from their original portfolio, some will choose to hold larger cash balances, others will sell assets. Credit will be easily available, and the application for loans approved more quickly. The inverse of this process would be an unexpected decline in the money supply, unexpected low asset prices, slow sales, restricted credit availability, which in turn could lead to individuals calling upon their cash reserves. The role of money supply shocks can be best summed up by Carr and Darby (1981):

"... money supply shocks will affect the synchronization of purchases and sales of assets and so engender a temporary desire to hold more or less money than would have otherwise be the case."

(Carr and Darby (1981) p.187)

In order to translate this theoretical model into an empirical one the basic starting point is Chow (1966). Carr and Darby's discussion suggests using two modifications to the basic Chow mechanism: (1) addition of a transitory income term, (2) addition of a money supply shock term. The shock absorber version of the Chow mechanism is thus:

$$m_t = \lambda m_t^d + (1-\lambda) m_{t-1} + B y_t^T + \phi \hat{M}_t \qquad (3.18)$$

where $y^T_t = y_t - y^P_t$, y = logarithm of real income, y^P_t = logarithm of real permanent income, $m_t = M_t - P_t$, M = logarithm of the nominal money supply, P = logarithm of the price level, M^* = the logarithm of the expected money supply, (generated using an univariant ARIMA process), $\hat{M}_t = M_t - M_t^*$ = the money supply shock.

Carr and Darby's preferred long-run money demand function is;

$$m_t^d = \gamma_0 + \gamma_1 y_t^P + \gamma_2 R_t \qquad (3.19)$$

where R = the nominal rate of interest. Combining (3.18) and (3.19) we get the estimating equation:

$$m_t = \lambda\gamma_0 + \lambda\gamma_1 y_t^P + \lambda\gamma_2 R_t + (1-\lambda) m_{t-1} + B y_t^T + \phi \hat{M}_t \qquad (3.20)$$

Simultaneity bias arises because y^P_t, R, y^T, M, are all determined simultaneously with m_t and so are likely to be correlated with the stochastic disturbance in (3.20). Also, using ordinary least squares would induce a positive bias in the coefficient of M_t. Carr and Darby's results using United Kingdom quarterly data 1957I to 1976IV are as follows:

$$m_t=0.0353+0.0148y_t^P-0.4232R_t+0.9713m_{t-1}+0.0929y_t^T+0.8541\hat{M}_t \quad (3.21)$$

(0.298) (0.730) (3.363) (19.316) (0.746) (7.848)

s.e.= 0.0148 R^2=0.9502 h = 0.280; t statistics in parenthesis.

The policy implication of the shock absorber model is that money supply shocks will induce smaller interest fluctuations than a conventional model.

The question of velocity and the variability of unanticipated and anticipated monetary growth has returned to the forefront of literature in mid 1980s following a uniform decline in velocity after 1980 in the United Kingdom, reversing the steady increase during the post war period. Friedman (1983, 1984) argues that this is due to a more volatile money supply growth, and looks upon money as a shock absorber which smooths temporarily the economy's response to unanticipated changes in the money supply. However, Goodhart (1986, 1989) argues that the behavioural change is due to the impact of "financial innovation" on money demand. Indeed a whole sub-group of literature testing the relationship between velocity and the variability of unanticipated and anticipated monetary growth has developed using tests for causality developed by Granger (1980). The main arguments can be found in Thornton (1991) based on earlier work by Serletis (1990). He finds evidence that money growth and its variability have had a "causal" impact on velocity growth, and that one should not attribute any greater importance to unanticipated over anticipated variables in their influence. However, there are some doubts about the methodological robustness of the arguments presented. The first problem concerns unit roots. Sims, Stock, and Watson (1986) point out that the asymptotic distributions of causality tests are sensitive to the presence of unit roots and time trends in the series. However, this is not the universal picture, for Christiano and Ljungqvist (1987) argue that the distortions introduced by unit roots being present may not be large enough to affect the results, and that differencing, may lead to causality tests lacking power. In light of this alternative view, it is important to test for the presence of unit roots in the velocity series and the volatility variables. As Mehra (1989) points out:

"At the minimum, the causality test results should be checked for their robustness to differencing and the treatment of trend."

(Mehra (1989) p.263)

The second problem concerns the selection of lag lengths. In estimating the Granger causality tests most authors choose "arbitrarily" lag lengths. It is well known that the results from such tests are sensitive to the selection of lag length. If the lags are too short, biased estimates result which will give misleading results. If the lags are too long, the estimates will be unbiased, but inefficient. Thornton and Batten (1985) have looked at this problem in great detail, and conclude that the Final Prediction Error Test (FPE) suggested by Hsiao (1981) is the best criterion for choosing lag lengths. A third problem concerns the Granger two step procedure itself. This produces biased estimates of the standard errors, as it treats the anticipated and unanticipated monetary variables as known data rather than statistical estimates. (see Pagan, (1984)). An alternative would have been to use a one step procedure and treat the two equations as a system. Given the problems outlined above there remains some controversy concerning velocity and the variability of unanticipated and anticipated monetary growth in the United Kingdom.

3.5 Inflation Influences on Velocity

Another causal factor which we have already mentioned in passing is the expected rate of inflation. This represents the opportunity cost of holding money. The demand for money is inversely related to the expected rate of inflation. The main cost of holding transaction balances is the rate of depreciation of the value of money, that is the rate of growth of prices. Therefore, when inflation expectations are falling, the demand for money should rise, and the velocity of money should fall. The significance of the expected rate of inflation is well established in empirical work. Cagan (1956) used an error learning process to measure expected inflation, which he assumed was a good simulation of rational behaviour. However, Jacobs (1975) criticised Cagan's statistical methods, which he suggested exaggerated the strength of correlation between variables. Early studies using United States data by Selden (1956) and Friedman (1959) did not find any systematic relationship between the demand for money and the rate of inflation. In an earlier paper, however, Brown (1939) found that variations in the inflation rate influenced the demand for idle balances. However, work carried out two decades later on a more comprehensive set of post Second World War data by Shapiro (1973), who measured the expected inflation rate using weighted average of past actual rates, and

Goldfeld (1973) where expectations were based on opinion from survey data, found that a relationship did exist. While the expected rate of growth of prices has a direct influence on the demand for money and in consequence the velocity of circulation, it should be remembered that there is a secondary effect on nominal interest rates, which should vary systematically with the expected rate of inflation. Parkin and Laidler (1975) confirm this argument, but point out that variations in nominal interest rates do not fully reflect changes in the expected inflation rate. They suggest that there is a direct role for the expected inflation ratio. Indeed, Baba, Hendry, and Starr (1992) argue that the inflation rate and interest rate are not highly correlated and that both should be included in the demand for money function. This issue also is discussed by Brown (1939), Melitz (1976), Shapiro (1973), and Goldfeld (1973) whose empirical work contains both an expected inflation rate, and nominal interest rate. An attempt to measure the influence of the real rate of interest directly is given by Hamburger (1966,1977) who uses the dividend. This is an area since developed by Friedman (1988), and is an issue that will be considered again under financial innovations later in this thesis.

3.6 The Influence of Foreign Interest Rates

The work which has been reviewed so far has been concerned only with the domestic influences upon the velocity of circulation. However, over the last decade empirical work has looked at the demand for money in open economies. These studies have included as explanatory variables measures of the rate of return on foreign currencies and foreign securities. The most prominent pieces of work in this area have been Arango and Nadiri (1981), Bordo and Choudhri (1982), Brittain (1981), Cuddington (1983), McKinnon (1982) and Miles (1978). Nonetheless, their success in introducing non domestic causal factors has been mixed. However, for the purposes of this study Brittain is of the most interest. Brittain (1981) introduces a model of the following form:

$$Y/M_d = a + b(Y/M_d)_{t-1} + c\ r_d + d\ (r_f - r_d) + u \qquad (3.22)$$

where r_d = a domestic rate of interest, r_f = a foreign rate of interest, and $(r_f - r_d)$ is the foreign portfolio variable. Since a rise in domestic interest rates (r_d) increases the opportunity cost of holding domestic currency, there should be a decline in M_d and a rise in domestic velocity (Y/M_d). By contrast a rise in foreign interest rates (r_f) increases the opportunity cost of holding foreign currency, and should lead to an increase in the demand for domestic currency (M_d) and a reduction in domestic velocity. These arguments suggest a negative coefficient on the portfolio variable. Brittain (1981) estimated the theoretical equation for the United Kingdom using quarterly data for the period 1963I to 1979II where the rate of return on 90 day German Treasury bills was used for the foreign rate of interest. Of the countries examined by Brittain the United Kingdom provided the least support for the foreign portfolio hypothesis. While a variety of money measures using both quarterly and annual data produced coefficients on the foreign portfolio measure of the correct sign, half of these were insignificantly different from zero and the residuals showed a high degree of serial correlation. The reason put forward for this poor performance has been the existence of British exchange controls until the early 1980s.

3.7 The Value of Time and the Velocity of Circulation

With the rise of Friedman's Permanent Income Hypothesis the Keynesian tradition of breaking the demand for money into separate components, of transactions, precautionary and speculative balances was for the most part neglected. However Karni (1974) suggested that the distribution of money between its component parts still plays an important role. He suggests that *ceteris paribus* the demand for real money holdings is positively related to the real value of time. This is due to the fact that individuals and firms wish to save time when conducting their exchange activities. Karni's hypothesis is stated in the form of an inventory model of the demand for money, by assuming that cash withdrawal involves a cost in terms of goods and time, that is forgone earnings. He suggests that the elasticity of the demand for money with respect to real hourly earnings is larger than the elasticity of the demand for money with respect to property income or per capita hours worked. In consequence as the real value of time increases economic agents will spend less time carrying out their transactions and demand larger money balances which in turn will lower the velocity of circulation.

3.8 Exogenous short term shocks to nominal income

So far consideration has been made of those factors which determine the numerator of the velocity ratio, that is the demand for money. Just as important are those factors which have short run shocks on the numerator, that is nominal income. Tatom (1983) has suggested a number of causal components in this area. First he suggests that high employment expenditures by governments in the form of fiscal spending are likely to affect nominal income at least temporarily. It is expected that in a dynamic specification government expenditure is positively related to velocity. Another factor is labour strikes which lower both production and spending. Tatom measures this as the ratio of working days lost by strikes to labour force employed. Here a negative relationship is expected. The third influence concerns inventories and imports. In the last phase of the business cycle sales fall. If this is not anticipated production schedules may not be altered quickly and inventories rise more than planned. As inventory investment is included in the calculation of expenditure based GDP, this can lead to output being stronger than desired expenditure. A positive relationship between inventories and velocity is expected. Furthermore, if money demanded is to be used in the purchase of imports, this can cause the velocity ratio to fall as the denominator rises and the numerator remains constant, given the fact that imports are not included in GDP. In consequence a negative relationship between imports and velocity of circulation is anticipated. Another exogenous shock to the numerator are foreign energy and raw material prices. Beckerman (1985) and Beckerman and Jenkinson

(1986) claim that unemployment has no stable impact on inflation, which is in fact determined in the main by import prices. Tatom (1983) proceeds to estimate a model using explanations stressing the exogenous short term shocks which have an impact on nominal income for the United States, using quarterly data for the period 1948III to 1981III. The results were as follows.

$$\begin{aligned} V_t = {} & \underset{(9.49)}{3.825} - \underset{(11.10)}{0.801}\,\Delta M_t - \underset{(6.44)}{0.555}\,\Delta M_{t-1} - \underset{(3.80)}{0.371}\,\Delta M_{t-2} - \underset{(2.79)}{0.248}\,\Delta M_{t-3} \\ & - \underset{(2.22)}{0.188}\,\Delta M_{t-4} + \underset{(2.74)}{0.032}\,E_t - \underset{(0.41)}{0.005}\,E_{t-1} - \underset{(2.46)}{0.029}\,E_{t-2} - \underset{(3.85)}{0.004}\,E_{t-3} \\ & - \underset{(15.88)}{0.855}\,\Delta G_t + \underset{(1.16)}{0.015}r_t + \underset{(6.96)}{0.443}\,\Delta P_t - \underset{(4.13)}{0.248}\,\Delta S_t - \underset{(2.08)}{0.040}p^e_t \\ & - \underset{(1.39)}{0.030}\,p^e_{t-1} + \underset{(3.40)}{0.077}\,p^e_{t-2} \qquad (3.23) \end{aligned}$$

$R^2 = 0.80$ s.e. $= 1.94$ D.W. $= 2.01$ $\rho = \underset{(5.81)}{0.45}$

where M = the money stock, E = high employment expenditures, the difference between trend and actual government expenditure, G = the GDP gap, the difference between trend GDP and actual GDP), r = short term interest rate (Aaa bond yield), P = GDP price deflator, S = strikes, measured by days lost due to strikes relative to the size of the civilian labour force, p^e_t = relative price of energy, measured by the producer price of fuel and related products and power, deflated by the business sector implicit price deflator. While the equation performs well, it has been corrected for autocorrelation. The correction, and the manner in which it is corrected, will be one of the major issues which will be considered in more detail later in this chapter.

Later literature considers further factors which are assumed to have an impact on nominal income. McGibany and Nourzad (1985) argue that there is a direct relationship between income tax rates and the velocity of money. The authors base their arguments on Holmes and Smyth (1972) who claim that:

"Given the importance of tax deductions at source, the flow of receipts relevant to households' money holdings decision is surely income after taxes, (personal disposable income) rather than national income."

(Holmes and Smyth (1972) p.179

It follows that for a given national income, a reduction in taxes increases personal disposable income. This, Ricardian equivalence apart, leads to an increase in consumption, which in turn leads to a rise in the demand for transaction balances. Accordingly in the short run a reduction in taxes results in a decline in the velocity of money. Hence a positive parameter on the standard rate of tax is expected. It must be remembered that while the decrease in the tax rate increases the demand for money balances in the velocity ratio, the numerator for the most part does not change, unless disposable income is used to measure transactions so that taxation is taken into account. McGibany and Nourzad test their hypothesis using quarterly data for the period 1948I to

1981III.

3.9 Long Run Behaviour of the Velocity of Circulation

The majority of the work reviewed so far, has concerned itself with the velocity of circulation, in the short run. However, over the last decade new work has considered the long run behaviour of the velocity of circulation, that is the secular behaviour of velocity. Figure 3.1 shows the stylized facts of velocity M3 for the United Kingdom using annual data for the period 1870-1988, and this exhibits a U-shaped pattern. Bordo and Jonung (1987) suggest that technical progress in the financial sector during the process of industrialization of a particular country accounts for this initial downward trend in velocity.

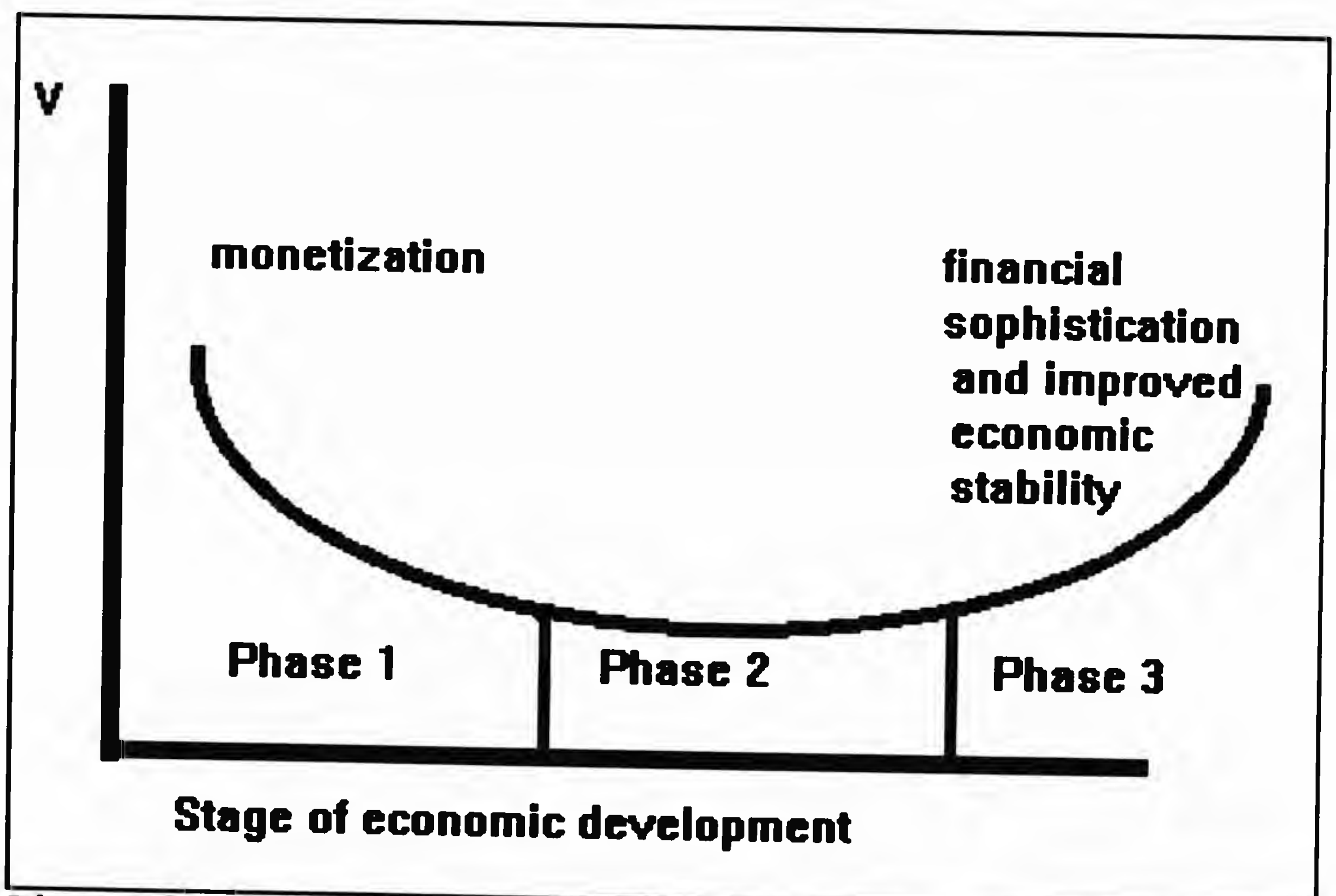

Figure 3.1

During the 19th century, cash and demand deposits came into use as a means of settling transactions, replacing barter, and payments in kind. As monetization took place, demand for transactions balances grew more rapidly than income, and velocity declined. A corresponding influence on this fall in velocity was the rise of the commercial banking system which gave the general public deposit facilities. However, with growing financial sophistication velocity began to exhibit an upward trend by the middle of this century. It is often suggested that this was due to the development of a large number of close substitutes for money, such as stocks, bonds, and other fairly liquid assets, together with the advent of forms of payment not requiring money balances, such as credit cards, electronic transfers and cash management techniques. As Clower (1969) points out, the more advanced the market economy becomes, the method of payment chosen will be that with the lowest transaction costs. These changes tend to reduce the transactions demand for measured money. Furthermore, with growing economic security and stability brought about by the modern welfare state and policies which were aimed at maintaining full employment and providing free health care, individuals felt it less necessary to hold money balances as a contingency reserve against the unexpected. This upward trend in velocity continued until 1980 when a sharp decline took place, and the subsequent downturn has continued to the present day. It has been suggested that there are two reasons for this fall in velocity. First, Bordo and Jonung (1990) argue that it is due to the deregulation of the banking system, which in turn led to financial innovation. Banks, by paying interest on deposits and expanding the number of banking services available, made the holding of money more attractive. This tended to raise the demand for money and thus lower velocity. Second, Friedman (1987) and Rasche (1989) suggest that the fall in velocity is due to disinflation.

In view of the fact that direct measures of long run institutional factors are unavailable, Bordo and Jonung (1987) developed a number of proxy variables. The first of these is the ratio of the number of people working in nonagricultural pursuits (LNA) to the total number of people employed (L) used as a proxy for monetization. This ratio will tend towards one as increased monetization takes place. Therefore, we expect a negative relationship with velocity. As the primary sector declines in importance the demand for money will rise. Capie and Wood (1986) suggest urbanization as an alternative measure to the share of the labour in non-agricultural production. That is the share of the population in major towns (POMPT). They argue that it is possible that industries in rural areas were slow to monetize, so that the Bordo and Jonung measure may be misleading.

The second proxy employed is for the spread of commercial banking which is measured as the currency-money ratio (CM), that is the currency notes and coins in circulation outside the Bank of England (C), divided by the total stock of money as measured by M3. It is expected that the currency money ratio (CM) will be negatively correlated with the monetization of the economy, and thus be positively correlated with velocity. Capie and Wood

(1986) suggest that the currency deposit ratio is a better measure than the currency/money ratio because it is sharper moving. They also introduce three additional monetization variables: the number of bank branches, which will encourage monetization, bank deposits per head, and the number of cheque clearings per head.

The third proxy is the ratio of total non bank financial assets to total financial assets (TNBFA/TFA), a measure for financial development, which is expected to be related positively to velocity. Nevertheless, Capie and Wood (1986) have criticised this measure of financial evolution. They argue that the growth of non bank financial assets has been dominated by those assets which are not necessarily close substitutes for money. The authors suggest that this variable be disaggregated. In the personal sector they suggest the use of the growth of building society deposits, life assurance premiums, and pension funds. Another area for consideration as a replacement for the original variable is the growth of government securities, together with the increase of credit finance companies.

The final proxy is for economic stability, which should be negatively correlated with velocity. Following Bordo and Jonung (1987) this is measured as a six year moving standard deviation of the annual percentage change in real income per capita. In addition Capie and Wood (1986) use the percentage of GDP spent on social services, defined as education, health, social security, and unemployment benefits.

Bordo and Jonung (1987) proceed to estimate two equations for the United Kingdom using annual data: The first is the benchmark equation which is similar to the conventional equations discussed above:

$$\ln v_t = B_0 + B_1 \ln y^P{}_t + B_2\, i_t + B_3 \ln(\text{cycle})_t + e_t \qquad (3.24)$$

where $B_1,\ B_2,\ B_3 > 0$

and where permanent income (y^P) and an interest rate (i) jointly determine the time path of velocity (v). The cycle variable which is measured as the ratio of real per capita income to real per capita permanent income reflects the short run effects of business cycles. The authors build upon the benchmark equation to attempt to capture the role of institutional factors outlined above. The second equation is a revised specification which takes the form:

$$\ln v_t = B_0 + B_1 \ln y^P{}_t + B_2\, i_t + B_3 \ln(\text{cycle})_t + B_4(\text{LNA/L})_t$$
$$+ B_5 \ln(\text{C/M})_t + B_6 \ln(\text{TNBFA/TFA})_t + B_7 \ln \text{YSD} + e'_t \qquad (3.25)$$

where $B_1,\ B_2,\ B_3,\ B_5,\ B_6 > 0,\ B_4,\ B_7 < 0$

and where LNA/L = the share of the labour force in non agricultural pursuits, C/M = the currency-money ratio, TNBFA/TFA = the ratio of total non-bank financial assets to total financial assets, YSD = a six year moving standard deviation of the annual percentage change in real per capita income.

In estimating the benchmark equation using annual United Kingdom data for the period 1876-1974 and correcting for autocorrelation using the Cochrane-Orcutt method AR(2), Bordo and Jonung obtained the following results:

$$\ln v_t = 0.094 + 0.0651 \ln y^P_t + 1.651\, i_t + 0.650 \ln(\text{cycle})_t \quad (3.26)$$
$$\quad (0.095) \quad (0.419) \qquad (3.352) \qquad (3.287)$$

$R^2 = 0.907$ s.e. = 0.05 D.W.=1.790 ρ=0.939

(t statistics in parenthesis)

All parameters are of the correct sign, but while the parameters on the short term interest rate and the log of cycle are significantly different from zero at the 95% significance level, the parameter on the log of permanent income (and the constant) is not significantly different from zero. An R^2 of 0.907 suggests quite a good fit, but it is a relationship where just two regressors play a significant part. The Durbin-Watson statistic suggests that the autocorrelation has been corrected. Some more general criticisms of Bordo and Jonung's work will be considered in a moment, but first let us consider their expanded equation. Once again it is based on annual data for the United Kingdom for the period 1876-1974 and has been corrected for autocorrelation. The results were as follows:

$$\ln v_t = \underset{(0.344)}{-0.3950} + \underset{(1.240)}{0.1971} \ln y^P_t + \underset{(5.014)}{2.497}\, i_t + \underset{(4.588)}{0.7970} \ln(\text{cycle})_t$$
$$- \underset{(2.313)}{6.271} \ln (LNA/L)_t + \underset{(2.167)}{0.211} \ln (C/M)_t + \underset{(3.107)}{0.746} \ln(TNBFA/TFA)_t$$
$$- \underset{(2.059)}{0.0341} \ln YSD_t \qquad (3.27)$$

$R^2 = 0.931$ n = 98 s.e. = 0.043 D.W. = 2.081 ρ=0.925

All parameters are of the correct sign. Nevertheless, the constant and the coefficient on permanent income fail to be significantly different from zero. The adjusted R^2 is fairly good, and the serial correlation has been corrected. However, a lack of statistical tests makes full analysis of their results, without re-estimating the model, impossible. We now turn to a general criticism of Bordo and Jonung's empirical work. Given recent advances in econometric methodology we can raise a number of econometric objections to the manner in which the authors proceed with their estimation. The first problem was the severe positive serial autocorrelation in the residuals of the ordinary least squares estimation, which they chose to correct using the Cochrane-Orcutt technique.

Hendry and Mizon (1978) suggest that serial correlation in this context may be evidence of model mis-specification. The second problem is that it is now clear that many economic time series contain a unit root (see Nelson and Plosser (1982)), which, according to certain authors, include the income velocity series. (see Gould and Nelson (1974) and Gould et al. (1978)). As a result of these and similar observations, it is argued that time series with a unit root are best analyzed in first differences or rates of growth, rather than levels. Raj and Siklos (1988) re-estimated Bordo and Jonung's equations in first differences and found evidence unfavourable for the institutional hypothesis. However, attempting to model the dynamics at this stage may merely serve to obscure the set of explanatory variables which is sufficient or necessary to adequately model the series. If a valid dynamic model of the velocity of circulation is to exist it must contain a set of variables which satisfies the tests of cointegration which are applied at the initial part of the estimation procedure. Indeed, even Raj and Siklos (1988) neglect to add the conditions outlined above and this may lead to spurious regression problems and to equations which may not be structurally stable, as suggested by Granger and Newbold (1974). This leads us to the general criticism that previous literature fails to take account of the developments in cointegration and error correction models, the two exceptions being an unpublished working paper by Siklos (1989), and Siklos (1993). These arguments are considered more fully in chapter five.

3.10 Financial Innovation

As discussed earlier, one possible reason for the downturn in velocity since 1980 has been financial innovation, following deregulation of the banking system. A full review of issues concerning financial innovation is given in Podolski (1986), and more recently by Arestis et al. (1992). According to Johnston (1984) there are two approaches in dealing with financial innovation in empirical work. The first is to redefine the dependent variable by including new money substitutes in the definition of money. This will be dealt with comprehensively in chapter four when the different definitions of velocity are considered. The second approach is to introduce new "innovative variables" among the regressors. These innovation variables are designed to convey developments in the payments and transaction system. It is this issue which is of concern here.

The first financial innovation variable to be considered is the number of automatic teller machines or cash dispensers. These increase personal accessibility to money when banks are closed, or crowded, and in locations away from bank branches such as shopping malls and superstores. Johnston (1984) is uncertain what the implications have been on personal sector cash holdings. In some instances they encourage greater use of cash in making transactions. However, equally valid is the view that individuals may reduce the average inventory of cash which they hold. So the expected sign on this parameter is unclear.

The second financial innovation variable is the number of credit cards. These have risen rapidly since their introduction, apart from a slight decline in the early 1990s following the introduction of an annual charge. A credit card concentrates a number of transactions into one single monthly payment, which is usually settled by a transfer and not cash. Therefore individuals tend to economise on cheques, and thus average holdings in cheque accounts and cash holdings. In consequence this leads to a reduction in the demand for money, and an increase in the velocity of money. Thus a positive relationship is to be expected.

The third innovation variable concerns the growth in the number of Bank current accounts and Building Society share accounts since the Second World War. One reason for this has been the move away from wage and salary payment by cash towards cheque and electronic transfers. According to Johnston (1984) cash payments accounted for 75% of wage payments in 1960. However, by 1981 this had fallen to 44%, whereas credit transfer of wage payments rose from 15% to 38% during the same period. Furthermore, a cheque can be seen as a close substitute for payments in cash particularly where large amounts are concerned. The Bank of England (1982) has attempted to measure the influence of unemployment on the volume of wages paid in cash. As unemployment rises the demand for cash balances to pay employees falls. All the above arguments decrease the need for cash balances, and thus a positive relationship with velocity is to be expected.

The fourth new variable is the interest rate ratchet, defined as the previous peak level of interest rates. Goldfeld (1973) suggests that there are fixed costs with altering cash management techniques. Economic agents will only change to more efficient cash management techniques when it is worthwhile, for instance when interest rates rise to new high levels. However, these new techniques may not be abandoned when interest rates subsequently fall. Goldfeld (1973) thus suggests that there is a ratchet effect in the demand for money, and argues that a simple way to measure this phenomenon is to use the previous peak level of interest rates. Here, a positive relationship is to be expected.

The final area concerning the financial innovations which have been taking place, is the rapid growth of the stock market, and in particular the growth of electronic trading. This has made the role of the Stock Market more important in recent years. According to Friedman (1988) the role of the stock market in affecting velocity has to be taken into account in two ways: (a) treating the volume of financial transactions created by the market as an argument in the demand for money function, on the principle that these transactions will "absorb" money, and hence reduce income velocity and (b) by following Hamburger (1966,

1977) and taking the earnings or dividend yield on securities as an alternative measure of return to money in the individual's portfolio.

Friedman (1988) also argues that there is an inverse relationship between stock market prices and monetary velocity. He suggests that this can be rationalised in three ways: (a) A rise in stock market prices means an increase in nominal wealth and given that there is usually a wider fluctuation in stock market prices than in income, also in the ratio of wealth to income. The higher wealth to income ratio will be reflected in a higher money to income ratio and thus a lower velocity, (b) a rise in stock market prices reflects an increase in the expected return on risky assets relative to safe assets. Such a change in relative valuation may not be accompanied by a lower degree of risk aversion or greater risk preference. Indeed the resulting increase in risk could be offset by increasing the weight of relative safe assets in an aggregate portfolio, (c) a rise in stock market prices may imply a rise in nominal volume in value terms of financial transactions, increasing the demand for money to undertake such transactions.

In order to measure the influence of stock market behaviour on the velocity of circulation a number of independent variables have been suggested by empirical work. These include real stock market price, Financial Times earnings yield, and the ratio of Treasury Bonds Long to Short rates. All three variables will be considered in subsequent chapters.

3.11 Conclusion

This chapter has revealed that the velocity of circulation of money - at least in the short run - can be sensitive to a large number of factors. Given that velocity is measured as a ratio of two important macroeconomic variables this is not entirely surprising. However, it makes any attempt at modelling velocity a very difficult task. On the one hand there are those structural variables which determine the long run behaviour of velocity. These can be divided into three types. The use of monetization variables, epitomizes the period when the demand for transaction balances grew more rapidly than income. The financial sophistication variables representing the development of a large number of close substitutes for money such as stocks and bonds, and payment methods not requiring currency. The latter are being further represented by the financial innovation variables. Finally, there are those variables associated with the short run dynamic behaviour of velocity. These can be further divided into demand for money variables - interest rates, wealth, and price expectations - and those affecting nominal income - fiscal policy, labour strikes, and foreign energy and raw material prices.

However, before we can construct an econometric model of velocity behaviour, we need to address the definition of those variables outlined in this chapter. In particular we need to examine the measurement problems in relation to the velocity variable, what constitutes money and what is the most appropriate measure of transactions. First we consider the advances which have taken place in econometrics during the last decade, which bring into doubt the validity of earlier empirical work.

Chapter 4

Criticism of the Methodology used in Earlier Literature and the Advent of Cointegration

4.1 Introduction

As discussed earlier, the most comprehensive empirical work on income velocity is Bordo and Jonung (1987,1990). Yet given recent developments in econometric methodology, in particular cointegration, their results are open to question. This chapter charts the advent of cointegration, and introduces the estimation strategy to be used in this thesis.

4.2 Background to Cointegration

There have been perhaps three major developing themes in econometric analysis in the last decade, which led ultimately to the advent of cointegration analysis; spurious correlation; stationarity; and error correction models. Consequently the reliability of much of the earlier empirical work on the velocity of circulation may be in doubt. It is the consideration of this possibility, that is one of the main themes of this thesis. Let us consider briefly each of the areas outlined above.

The fact that there is a high correlation between two variables, does not necessarily mean that there exists a causal relationship between them. There needs to be some economic meaning to the relationship. For example Hendry (1980), found that there was a statistical relationship between rainfall and inflation. There is of course no theoretical reason for this being the case, and such relationships, lead to what is known as spurious correlation. One reason for two variables being highly correlated in this way, is when they both share a common trend. Another, suggested by Granger and Newbold (1974) is the presence of autocorrelated disturbances, which leads to i) inefficient estimates of the regression coefficients, ii) sub-optimal forecasts and iii) invalid standard statistical significance tests.

The second development is derived from the time series literature, and concerns the concept of stationarity. A stochastic process is said to be stationary, if the joint and conditional probability distributions of the process are unchanged through the passage of time. In practice, according to Spanos (1986, pp.137-140), a stochastic process is said to be stationary if its means and variances are constant over time, and the covariances between subsequent time periods, depends only on the gap between these periods. In reality very few time series are stationary, and many have trends, leading to the problem of spurious correlation discussed above. However, a nonstationary series can be transformed into a stationary one by differencing d times, and when stationarity is achieved the variable in question is said to be integrated of order d. A series is said to be integrated of order one, I(1), if it has to be differenced once before stationarity is obtained, or order two, I(2), if it has to be differenced twice before stationarity is achieved.

The last development concerns the concept of error correction models. Here econometric modellers are concerned not only with the dynamics of the short run, but also in the long run steady state relationship. Hence, while the short run dynamic model may have rates of growth, and a generous lag structure, in the long run the rates of growth are zero or non-zero constants, the lag structures disappear, and the model is solved in levels. Thus the long run model introduces a theoretical foundation to the short run dynamic model.

4.3 Cointegration

The idea of cointegration was first introduced by Granger and Weiss (1983), and development continued in Engle and Granger (1987). If two series are cointegrated there exists an error correction model which can potentially improve short run forecasts, but which particularly affects the quality of long run forecasts. The general approach to cointegration followed in this thesis is the Engle and Granger (1987) two-step-method, together with subsequent developments by Johansen (1988), as discussed later. The initial step is the estimation of the long run equilibrium relationship, the second step the estimation of the dynamic short run relationship. In order to carry out the two-step-method, we first consider the degree of integration of individual variables which are proposed for the cointegrating or long run equation. It is possible that two variables x_1 and x_2 which are both integrated of the same order, give rise to a linear combination with stationary residuals

$$e = x_1 - \lambda x_2 \qquad (4.1)$$

that is integrated of degree zero, in other words e is I(0). In such a case we say that x_1 and x_2 are cointegrated. This concept can be extended to a multivariable model.

If there are only two variables in the long run equation, that is the dependent variable and one independent variable, both must have the same order of integration. However, if we have more than one independent variable the order of integration of the dependent variable cannot be higher than the order of integration of any one of the explanatory variables.

The next task is to derive and estimate the long run equation, and test for stationarity of the residuals which is necessary if the variables in question are to be cointegrated. Finally, we estimate a short-run dynamic equation, using the lagged residuals of the long run equation as an error correction term.

One major problem with the multivariable Engle and Granger two-step-method is that of uniqueness. To avoid this identification problem, a test is required to determine how many cointegrating vectors there are for a set of variables. The test usually used in general modelling strategy is that given by Johansen (1988) which is used to (i) determine the maximum number of cointegrating vectors for the variables of interest, and (ii) to obtain the maximum likelihood estimates of the cointegrating vector and adjustment parameters. Johansen (1988) achieves this by using canonical correcting methods and utilising the eigen-values and eigen-vectors given by the matrix of correlation coefficients. It is this approach which is used in this thesis.

A full review of cointegration for applied economics can be found in Rao (1994).

4.4 Estimation Strategy

The overall conceptual approach to econometric modelling follows the L.S.E. tradition, using the general to specific methodology (see Hendry, Pagan and Sargan, 1984). At the heart of this approach is the idea of the data generation process, which is a general statement of the joint probability distribution of all possible variables. However, the data generation process contains far too many variables than can be dealt with efficiently or are of interest theoretically. Therefore a selection process is undertaken to produce a subset of variables of interest. Some variables are disregarded given the problem being considered. In consequence a simplified theoretical model is derived for estimation purposes, and the proposed functional form is chosen.

The next step is to consider the time series properties of the proposed variables, and check their order of integration. According to Holden and Thompson (1992) tests for stationarity fall into three categories; i) informal examination of correlograms; ii) Durbin-Watson statistical tests; iii) regression based t-tests, usually given the name of Dickey-Fuller tests.

The first category of tests is derived from the time series literature, and uses a correlogram graph. If the autocorrelations die away rapidly as time increases, then it is likely that the series is stationary. However, if the autocorrelations are non zero after a number of lags, then the series is probably not stationary. If this is the case, the series is differenced, and the graph is examined for a second time, and so on, until stationarity is achieved. The major problem is that of subjectivity, and for this reason the correlogram test will not be used in this thesis.

The earliest type of second category tests was suggested by Sargan and Bhargava (1983). They propose that the variable concerned is regressed on a constant, such that:

$$Y_t = a_0 \tag{4.2}$$

and then examining the cointegrating regression Durbin-Watson statistic (CRDW), which is given by:

$$CRDW = \Sigma(e_t - e_{t-1})^2 / \Sigma(e_t^2) \tag{4.3}$$

where e_t is the residual. If the CRDW is close to zero, then Y is not stationary. Sargan and Bhargava (1983) produce tables of the relevant critical values, (see appendix B). If the calculated CRDW is greater than the tabulated critical value, then we conclude that Y is stationary.

An alternative literature provided more sophisticated tests, and these are commonly known as Dickey-Fuller statistics. These tests are conducted within the context of three types of generating process of a univariate series. First the mean of the series is zero, so

$$Y_t = \alpha_1 Y_{t-1} + u_t \tag{4.4}$$

Second the mean of the series is non-zero

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + u_t \qquad (4.5)$$

Third the mean of the series is non-zero and there is a time trend

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \gamma T + u_t \qquad (4.6)$$

The tests are designed to ascertain whether the value of α_1 is equal to 1, in which case Y is not stationary, or less than 1, in which case the Y series is stationary. An alternative way of expressing (4.4) is the following:

$$Y_t - Y_{t-1} = (\alpha_1 - 1)\ Y_{t-1} + u_t \qquad (4.7)$$

which can be rewritten as:

$$\Delta Y_t = \beta Y_{t-1} + u_t \qquad (4.8)$$

where $\beta = (\alpha_1-1)$, and test of whether $\alpha_1=1$ becomes a test of whether $\beta = 0$. Unfortunately the ordinary least squares estimate of β may be substantially biased in an autoregressive equation, and according to Charemza and Deadman (1992) little is known about the distribution of the Student t-test where the variable Y_t is nonstationary. Therefore it is necessary to use special modified t statistic tables produced by Fuller (1976). The null hypothesis is that Y_t is I(1), and this hypothesis is rejected if the computed t value is larger in absolute terms than the critical value for statistic Γ (Γ representing the modified t statistic). Rejection of the null hypothesis implies that Y_t is I(0). Acceptance of the null hypothesis implies that Y is a random walk without drift.

A similar test can be performed on a variable where the mean of the series is non-zero. (4.5) is rewritten as:

$$\Delta Y_t = \alpha_0 + \beta Y_{t-1} + u_t \qquad (4.9)$$

Comparison is made between the t value for β and the critical value for Γ in tables 8.5.1 and 8.5.2 in Fuller (1976, pp. 371 and 373). The null hypothesis is that the series is I(1) and this is rejected if the value of the t statistic is a larger negative value than the tabulated one. If we cannot reject the null hypothesis, this implies Y_t is a random walk with drift. We can check the presence of drift by estimating ΔY on a constant and performing a standard t test on the constant. Furthermore it should be noted that according to Dolado and Jenkinson (1987), when drift is present the normal distribution rather than the special Dickey-Fuller statistics should be used.

Similarly the same test can be performed where the mean of the time series is non-zero and has a time trend. (4.6) is rewritten as:

$$\Delta Y_t = \alpha_0 + \beta Y_{t-1} + \gamma T + u_t \qquad (4.10)$$

Once again we compare the t value for β with the tabulated values given in Fuller (1976). As in the previous examples, the null hypothesis is that Y_t is I(1) and this is rejected if the t statistic computed has a larger negative value than the critical value. This test requires γ, the coefficient on T, to be zero. We test for this using a standard F test that both β and γ are zero. The estimated value of F is then compared with the critical value for Φ_3 contained in Dickey and Fuller (1981, pp.1062-1063).

Unfortunately there is a problem with the basic Dickey-Fuller (DF) tests. The estimated residuals are not free from autocorrelation, and this invalidates the tests. Consequently they are not used in this thesis. However, this problem is overcome by introducing the lagged dependent variable into the equation, and this approach is called the Augmented Dickey-Fuller Test (ADF). This gives the equation:

$$\Delta Y_t = \alpha_0 + \beta Y_{t-1} + \gamma T + \delta_1 \Delta Y_{t-1} + \delta_2 \Delta Y_{t-2} + \ldots + \delta_n \Delta Y_{t-n} + u_t \quad (4.11)$$

The number of lags is equal to that which eliminates autocorrelation from the residuals, which can be tested using the standard Lagrange-Multiplier (LM) test. One problem with the Augmented Dickey-Fuller (ADF) statistic is that the inclusion of the lagged values of ΔY results in a loss of degrees of freedom, but with over one hundred and twenty annual observations this is not a major problem in our case. The Augmented Dickey Fuller regression is estimated for each variable and the corresponding statistics computed. These are used to established the type of series using the excellent sequential method suggested by Holden and Perman (1994).

According to Perron (1989), unit roots which do not take into account the possibility of structural breaks may have low power. Therefore, the procedure developed by Perron (1989, 1994) to test for unit roots in the presence of possible structural breaks is used for each variable. The detailed exposition of this procedure is left until chapter seven.

As Holden and Thompson (1992) point out in reviewing a general modelling strategy for the Johansen procedure for determining the number of cointegrating vectors:

"Usually only I(1) variables will occur in any long-run relationship"

(Holden and Thompson, 1992, p.35)

As Engle and Granger (1991) further observe:

"Often researchers would like to include in the cointegrating relationship variables which are not I(1). In principle, inclusion of a stationary variable is prohibited"

(Engle and Granger, 1991, p.14)

In consequence, those variables which are not I(1) are rejected, and the model(s) for estimation further simplified.

Before applying Johansen's estimation procedure, it is necessary to determine the lag length k of the VAR (vector autoregressive model). According to Sedgley and Smith (1994):

"this should be high enough to ensure that errors are approximately white noise, but small enough to enable estimation"

(Sedgley and Smith, 1994, p.141)

According to Perron (1994) there is evidence to suggest that data dependent techniques to select the lag parameter k gives test statistics which have better properties, that is stable size and higher power, than a fixed k a priori. There are three methods of choosing lag length. The first is the Akaike Information Criteria (AIC), where k is chosen by selecting the lag length which minimises the value of the test. However, Perron (1994) criticises this method:

"Data-dependent methods based on information criteria, such as the A.I.C., tend to select very parsimonious models leading to tests with sometimes serious size distortions. This finite sample performance is consistent with our findings that the use of an information criterion leads to a selected value of k that increases to infinity, as T [the sample size] increases, only at rate log(T), a very slow rate. These theoretical results are in accord with the empirical results ..... based on the A.I.C. lead to very small values of k being selected (typically 0 or 1). This suspicion about the performance of data based methods used by the A.I.C. is reinforced by the fact that often the estimated residuals exhibit serial correlation."

(Perron, 1994, page 139)

An alternative is to use sequential F tests. Initially a large value of k is selected and the following equation is estimated:

$$Y_t = E + \Pi_1 Y_{t-1} + \ldots + \Pi_{k-1} Y_{t-k+1} + \Pi_k Y_{t-k} + \epsilon_t \qquad (4.12)$$

This specification is reestimated for ever smaller values of k. The likelihood ratio tests are then used to ascertain the smallest lag length which is acceptable. Finally there is Perron's (1989) recursive t-statistic procedure. This:

" ... uses a general to specific recursive procedure based on the value of the t-statistic on the coefficient associated with the last lag in the estimated autoregression. More specifically, the procedure selects that value of k, say k^*, such that the coefficient on the last lag in an autoregression of order k^* is significant and that the coefficient on the last lag in an autoregressive of order greater than k^* is insignificant, up to some maximum order kmax selected a priori."

(Perron, 1994, page 138)

This is the procedure adopted by this thesis. To confirm residual whiteness, standard serial correlation tests and A.D.F. tests are carried out.

It should also be noted, that the smaller the sample size and the higher the number of independent variables, the smaller will be the degrees of freedom, and the power of the Johansen tests will be reduced.

Once the lag length is determined, the next step is to use the Johansen cointegration LR tests based on the maximum eigenvalue of the stochastic matrix, and on the trace of the stochastic matrix, to determine the number of cointegrating vectors. However the two Johansen test statistics may give conflicting results. According to Johansen (1991) this disagreement is due to the complication the test statistics face when the cointegration relationship is quite close to the nonstationary boundary. He further suggests, that the ambiguity of the test statistics in empirical work is due to the slow speed of adjustment to the hypothetical equilibrium state. This may be due to high adjustment costs, regulations, or short run effects which keep the process away from the equilibrium path. Johansen and Juselius (1992), argue that the final number of cointegrating vectors which are accepted is determined by three factors, the formal test results outlined above, the estimated coefficients obtained, and the graphs of the long-run relationships.

The formal Johansen tests establish the possible number of cointegrating vectors. The next step is to estimate these vectors. The estimated normalized parameters of these vectors, their sign, size and relationship with economic theory are then explained. The vector must also satisfy the restrictions of economic theory. Using the likelihood ratio statistic suggested by Johansen (1988), it is possible to check that all parameters are significantly different from zero. The χ^2 statistic is compared with its 5% critical value. If a vector passes all of these tests, it is selected as a candidate for the long run cointegrating vector and its lagged residuals are used as an error correction term in the short run dynamic equation. If more than one vector is suitable, then it may be possible to solve this dilemma by considering the graphs produced by the residuals of these vectors. These are in two forms[1]. First $\beta'_i X_t$ describes the actual deviation from the equilibrium path as a function of short run effects. Second, the graph of the cointegrated relationship corrected for short-run dynamics, $\beta'_i R_{kt}$. According to Johansen and Juselius (1992) the latter are of more use, for they illustrate the ability of the model to move towards the equilibrium state space, although this may never occur given a variety of exogenous shocks. If graphical interpretation cannot resolve the dispute between vectors, experimentation with short run dynamic equations and consideration of their performance is another path to follow. If no vector passes the above tests, the basic model is simplified until either no or acceptable long run cointegrating vector is found.

Once the long run cointegrating vector has been established, one proceeds to estimate the short run dynamic model[2], using ordinary least squares, with the lagged values of the residuals for the appropriate vector, included as an error correction mechanism. This should appear with a negative sign on their coefficient. According to Holden and Thompson (1992):

"If economic theory suggests that any additional variables affect short-run behaviour, these can be added at this stage"

Holden and Thompson (1992, p.36)

Nevertheless, there are rules governing their order of integration, as Holden and Thompson further state:

"It is also permissible to incorporate lagged first differences of other I(1) variables suggested by economic theory. These variables will have a short-run impact on the relationship between X and Y but will not occur in the co-integration regression"

Holden and Thompson (1992, p.29)

In estimating the short run equations, the econometric methodology suggested by Hendry's work, (see Hendry, Pagan, and Sargan, 1984), will be used, that is from the general to the specific. In other words, a general model is adopted with a generous lag structure, which is simplified with the help of statistical tests, until an acceptable specific (parsimonious) model is derived. In estimating the relationship the procedure adopted in MICROFIT 3.0 will be used, (see Pesaran and Pesaran, 1987 and 1991). We therefore use in a consistent way the barrage of diagnostic tests available. These tests including the Durbin-Watson statistic and Durbin's h statistic for autocorrelation. Godfrey's test of residual serial correlation (F_1), (see Godfrey 1978a, 1978b). Ramsey's RESET test of functional form, (F_2), (see Ramsey 1969, 1970). Jarque-Bera's test of the normality of regression residuals, ($\chi^2(2)$), (see Jarque and Bera (1980); Bera and Jarque (1981)). Finally a test for heteroscedasticity, F_3. Where observations allow, two further tests are computed. The Predictive Failure Test (F_4), a test of adequacy of predictions. (see Chow(1960), Salkever (1976), Dufour (1980), Pesaran et al. (1985)). The Chow test of the regression coefficients (F_5). (Chow (1960), Pesaran et al (1985). In cases where the tests suggest the presence of a problem, the specification will be re-examined until an acceptable model is arrived at. In addition, a plot of actual and predicted values, together with a graphical representation of the residuals are examined, and the reason for any outliers considered. One of the main concerns of this thesis is parameter stability. An initial method is to use the techniques for testing the constancy of regression relationships over time suggested by Brown et al. (1975). These are usually shown in the form of two graphical representations. The first of these is a plot of cumulative sum of recursive residuals, with a pair of straight lines drawn at the 5% level of significance. If these are not crossed the null hypothesis that the regression model is correctly specified is accepted. This indicates that there are no systematic changes in the regression coefficients.

The second test is a plot of cumulative sum of squares of recursive residuals, together with a pair of straight lines representing the 5% critical values of this test. If neither line is violated, the null hypothesis is accepted that there is not a sudden departure from constancy of the estimated regression coefficients. If either CUSUM test suggests a problem it is possible to check each coefficient individually using plots of the recursive coefficients for the variables in the regression equation one at a time to see where the problem lies. In order to consider parameter stability still further, the complete estimation strategy is repeated for two sub periods 1870-1946 (falling income velocity) and 1950-1991 (rising income velocity). With the empirical work at hand an evaluation of hypotheses and theoretical model is undertaken.

4.5 Summary

Much of the econometric work in previous literature is now in doubt, given the advent of cointegration. This chapter has considered the concept and developed an estimation strategy to test the hypothesis stated earlier. Nevertheless, before empirical work can take place, it is necessary to define the concept of velocity more clearly.

Chapter 5

Measurement, Behaviour and Properties of Velocity

5.1 Introduction

The first task in analysing velocity behaviour is to find a suitable empirical measure for the variable to be explained. In theory this should be straightforward, velocity being the ratio of the value of goods and services to the stock of money. Unfortunately there are a variety of measures for both the numerator and denominator, and therefore a corresponding number of velocity measures. Even the Central Statistical Office definition is a compromise:

"The velocity of circulation ... is derived as the ratio of gross domestic product at current market prices ... to the money stock ... The use of GDP (Gross Domestic Product) - or any other national income or expenditure aggregate, eg. total domestic expenditure or total final expenditure - in this calculation must be regarded as a crude approximation of what is ideally wanted - namely the total value of transactions in the economy involving money. These aggregates are strictly unsuitable because they exclude the transfer between sectors and transactions within sectors (of which transactions in primary and intermediate output within the industrial and commercial sector are very important) and they include non-cash items such as imported income and income in kind. Use of GDP assumes a stable relationship over time between GDP and total transactions."

Central Statistical Office (1990, p.108)

5.2 Velocity - The Numerator

The empirical work reported in this thesis employs various forms of national income resulting in various measures of velocity. Indeed, following Rasche (1987), initially, Net National Product (NNP), Gross Domestic Product (Average Measure) (GDPA), Total Final Expenditure (TFE), and Personal Disposable Income (PDY) will be used. On the whole the adopted measure relies on the output approach, which measures transactions in terms of the value-added by each of the various sectors of the economy. In aggregating over the whole economy, each firm's value-added is being used - this being the value of its output minus the value of the inputs that it purchases from elsewhere. However, we will also be concerned with measuring transactions directly, that is adopting an approach which, because of the unavailability of official data, has been rather neglected. Nevertheless, as we saw in chapter two the concepts of transactions velocity and income velocity were at the heart of the argument between the "motion theorists" who suggest a purely mechanical notion of velocity, that is the relationship between distance and time, and the "cash balance theorists" who argue that the size of cash balances held is not dependent on the properties of coins, but on the need for money at any given time. In consequence, the velocity of circulation of money is inversely proportional to the demand for money balances.

It is also of interest to consider a broader measure of transactions, because it gives us the opportunity to distinguish between those transactions which are associated with final goods and services and, thus, closely related to the level of national income, and those which are just related to financial transactions. The latter often permit a huge turnover on quite small balances, so that the transactions velocity of circulation is very much larger than if these were excluded. Furthermore, the velocity of business deposits, and therefore aggregate velocity will be influenced by variations in the velocity of deposits used by business for financial transactions. Therefore fluctuations in financial transactions will cause changes in velocity independently of changes in the production of goods and services. In Keynes's (1930) view, income and transactions velocities will often deviate given a fixed money supply, because this may be used to facilitate financial transactions, which are highly volatile and speculative in nature. As Keynes (1930) states:

"the volume of trading in financial instruments ... is not only highly variable but has no close connection with the volume of output whether of capital goods or of consumption goods; for the current output of fixed capital is small compared with the existing stock of wealth, which in the present context we will call the volume of securities ... and the activity with which these securities are being passed around from hand to hand does not depend on the rate at which they are being added to."

(Keynes (1930) p.222)

Indeed Fisher (1911) distinguishes between the two types of transactions:

$$MV = PT_1 + PT_2 \qquad (5.1)$$

or

$$V = PT_1/M + PT_2/M \qquad (5.2)$$

or

$$V = V^T + V^F \qquad (5.3)$$

where M = the stock of money, P = the price level, T_1 = goods and services transactions, T_2 = financial transactions, V = total velocity of circulation, V^T = the velocity of circulation of goods and services, V^F = the velocity of financial transactions. However, the problem remains of how to measure transactions, when no official statistical data are available. Furthermore as Howells and Biefang-Frisancho Mariscal (1992) point out:

"A measure of total transactions has to incorporate all intermediate transactions (for raw materials, part finished goods); all transactions in second hand goods (including much spending on house purchase in the UK) and by far the greater part of financial and speculative transactions."

(Howells and Biefang-Frisancho Mariscal (1992) p.373)

There have been two approaches in the literature to measuring transactions. First, Cramer (1981a) provides a framework from which rough estimates of the total volume of transactions in the United Kingdom can be derived, by distinguishing between different types of transaction. Second, Keynes (1930) uses the total value of cheque clearings as an estimate of the number of total transactions incorporating all intermediate transactions.

This work was extended more recently by Howells and Biefang-Frisancho Mariscal (1992) who construct a transactions velocity series for the United Kingdom using bank clearing data. Below we consider both methods.

5.3 The Cramer Approach to the Measurement of Transactions

Cramer (1981a) estimates three components of PT without distinguishing between the price level and the volume of trade with all transactions being measured in current prices. The three categories are as follows: (i) current transactions, which include all transactions which are related to production, income, and expenditure, (ii) transfers, that is transfers of the private sector, public sector, and from Central Government to Local Government, and (iii) asset and portfolio adjustment. Total transactions is defined as follows:

$$TT = CT + TF + APA \tag{5.4}$$

where TT = total transactions, CT = current transactions, TF = transfer transactions, APA = asset and portfolio adjustment transactions. Let us consider each group individually. For full definitions, see appendix A. The full statistical data for the period can be found in the appendix C. This contains over sixty variables, more than seven thousand observations, and took nine months of work using the London School of Economics archives to complete. A full description of the methodology and techniques used to construct the transactions variable can be found in chapter six. We return to consider the data in detail later, but first let us consider an alternative method of measurement.

5.4 The Keynes, Howells & Biefang-Frisancho Mariscal Approach to the Measurement of Transactions

Howells and Biefang-Frisancho Mariscal (1992) follow Keynes (1930) and use bank clearings as a method of generating a variable for transactions. In the 1930s it was fairly straightforward to use bank clearings, as the only real alternative was the use of currency. However, today members of the Association of Payments Clearing Systems (APACS) use a variety of payment methods, both physical and electronic.

The value of interbank clearings can be divided into three main categories: (1) bulk paper clearings: (2) high-value clearings (Town and CHAPS): and (3) electronic clearing (BACS Banks Automated Clearing System), used for regular transfers, wages, mortgage payments, and local taxes. As Howells and Biefang-Frisancho Mariscal wish to find a measure of personal sector transactions, they exclude Town Clearing (TOWNCL) because this is dominated by same day settlement for financial transactions between financial institutions. They also exclude CHAPS (Clearing House Automated Payments System) because this involves large financial sums over one hundred thousand pounds, usually involving house purchase and other large financial transactions. Therefore their definition of transactions becomes:

HBCLEAR = TBCLEAR - TOWNCL - CHAPS + ELECLEAR (5.5)

where HBCLEAR = Howells and Biefang-Frisancho Mariscal definition of personal sector transactions, TBCLEAR = total bank clearings (excluding electronic clearing and credit clearing), TOWNCL = town clearing, CHAPS = Clearing House Automated Payments System transactions, ELECLEAR = BACS, Banks Automated Clearing System, clearings.

We modify Howells and Biefang-Frisancho Mariscal's definition of personal sector transactions by adding electronic clearing (ELECLEAR), so that:

$$CTBC = TBCLEAR - TOWNCL - CHAPS + ELECLEAR \tag{5.6}$$

where CTBC = current transactions (bank clearings).

In addition, we introduce financial sector transactions, measured as:

$$FTBC = TOWNCL + CHAPS \tag{5.7}$$

so that total transactions based on bank clearing data becomes:

$$TTBC = CTBC + FTBC \tag{5.8}$$

where TTBC = total transactions (bank clearings), FTBC = financial transactions (bank clearings). As Howells and Biefang-Frisancho Mariscal (1992) point out, bank clearings are not a perfect measure of transactions, because by definition they exclude all those transactions which are carried out with currency, which probably were still very important at the beginning of our sample period at the end of the nineteenth century. Therefore, the measure used is likely to be an understatement of the true value of transactions. However, if one assumes that since the Second World War the currency element has declined as individuals acquired clearing accounts, then the clearing bank transactions measure has become nearer to the true total of transactions in recent years.

5.5 Comparison of Numerator Measures - Income versus Transactions

In figure 5.1 we plot, using a log scale, the three definitions of the velocity numerator (total transactions) used in this thesis. These are Net National Product (NNP), Total Transactions (Cramer definition) (TT), and Total Transactions (TTBC).

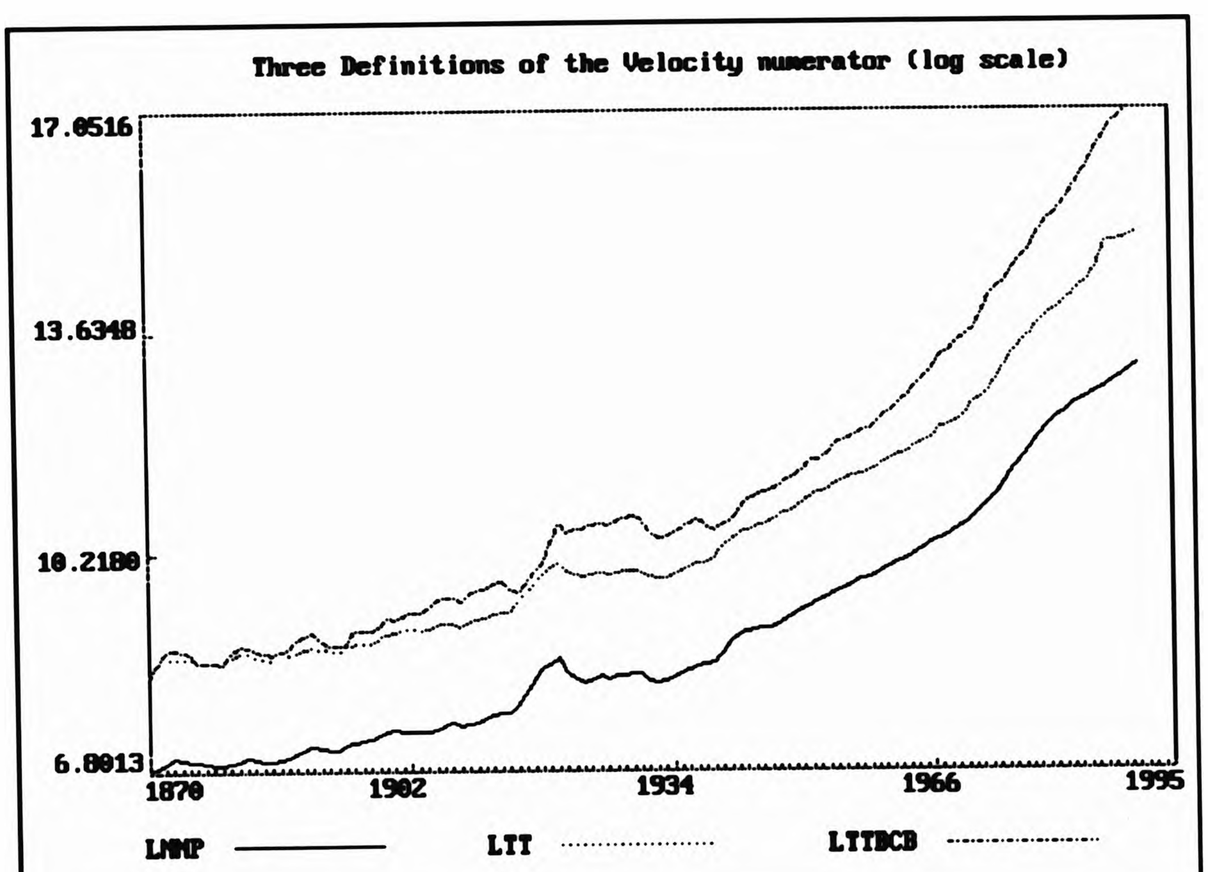

Figure 5.1

Both transactions measures are larger than Net National Product. This is to be expected, given that they measure total transactions between all sectors of the economy, whereas NNP measures only the value added by each economic agent. While the Cramer transactions definition follows the net national income measure in shape fairly closely until the 1980s, the Bank Clearing Transactions measure does not. It is due to the fact that TTBC measures not only transactions, but also the growth of bank clearing accounts of the personal sector during the century, and is the main contributing factor for its upward trend. Given this problem, the bank clearing definition will not be used in this thesis.

5.6 Velocity - The Denominator

In theory the denominator of the velocity of circulation is the money stock. However, an initial and key question, is what constitutes the money stock. There are perhaps four theoretical approaches to defining money. The conventional one, (Lathane, 1954), where money is defined as an asset that is generally acceptable as a means of exchange and a store of value. This view considers money to be the currency in circulation and demand deposits, that is current accounts. The Chicago approach, Friedman (1956), defines money more broadly as a temporary abode of purchasing power. This view also includes time deposits with a commercial bank which are interest bearing, as it is relatively easy to withdraw money from such accounts with few financial penalties. The third approach originates from Gurley and Shaw (1960), who argue that money can be seen to include a whole family of assets which are considered by the public as a liquid store of value. Finally, there is the central bank approach to the definition of money, where money is seen in the broadest possible terms, indeed a measure of total credit available.

The various approaches to the definition of money, are reflected in the various statistical money measures available in the United Kingdom, as shown in Table 5.1.

Table 5.1

Official Definitions of Money Stock in the United Kingdom

(1994 Definitions)

Definition of M0

Notes and coin in circulation outside the Bank of England and
Bankers' operational balances with the Bank of England

Definition of M2

Holdings of:

a. sterling notes and coin, and

b. "retail" sterling deposits with U.K. banks and building societies

by the M4 private sector, ie by the U.K. private sector other than banks and building societies

Definition of M4

M4 private sector holdings of:

a. sterling notes and coin, and

b. all types of sterling deposits with U.K. banks and building societies (including certificates of deposit etc)

Source: Financial Statistics Handbook (1994, p.54)

Given the proliferation of different aggregates, the concept of money becomes rather elusive. As Weintraub (1981) suggests: "Under the zeal for numerical magnitudes we have been bombarded with different aggregates, each containing a more inclusive assortment of liquid assets, such as M1, M2, M3, ..., Mn, in bewildering profusion ... The numbering spiel can under Socratic logic, ultimately prove that "money" is something in the eye of the beholder as an economic version of beauty."

(Weintraub (1981) p.469)

One consequence of this ongoing redefinition of money, is the lack of comprehensive data over long time periods. Indeed Pepper (1992a and 1992b) believes that much of the data we do have for the post war period is inaccurate and unreliable. He suggests that there has been a massive distortion to the financial system, in particular large volumes of artificial transactions to circumvent the control mechanisms of Competition and Credit Control[1]. Pepper (1992b) suggests that his work:

" ... provides a warning to time series analysts and econometricians who are attempting to analyse data with little or no knowledge of the special factors which may be present and who as a result, draw erroneous conclusions."

(Pepper (1992b) p.1)

However, while we take note of his argument, we have no alternative but to accept the available data, although we heed his words of warning.

Given the problems of measurement and the continuous redefinitions even within monetary groups (eg. M3), this study concentrates on the broad monetary aggregate M3 as defined by

Capie and Webber (1985), together with their narrow definition M1 where appropriate. Using Capie and Webber's work as a base, gives us what we believe is a fairly reliable measure of the money stock from 1870-1991. Therefore, our two main monetary aggregates are defined as follows:

Capie and Webber M1

$$CWM1 = PC + DD \tag{5.9}$$

Capie and Webber M3

$$CWM3 = PC + DD + TD + OD \tag{5.10}$$

where PC = currency in the hands of the public, DD = demand deposits net of 60% of items in transit, TD = time deposits net of interbank deposits, OD = other deposits at the Bank of England.

As a contrast to these long run series we will also use current Central Statistical Office (CSO) definitions of the money stock. These are available on an annual basis from 1963 onwards, apart from money stock sterling M3 which is not published after 1989. These are defined as follows:

CSO Money Stock M1

$$M1CSO = NCCWP + SDNI + SDIB \tag{5.11}$$

CSO Money Stock M3

$$M3CSO = M1CSO + PSSTD \tag{5.12}$$

CSO Money Stock M4

$$M4CSO = M3CSO + PSSDBS - BSHM3 \tag{5.13}$$

CSO Money Stock M5

$$M5CSO = M4CSO + OMIXBS + NSDS \tag{5.14}$$

where NCCWP = notes and coin in circulation with the public, SDNI

= U.K. private sector sterling sight deposits with monetary sector (non-interest bearing adjusted for transit items), SDIB = U.K. private sector sterling sight deposits with monetary sector (interest bearing), PSSTD = U.K. private sector time deposits, PSSDBS = private sector shares and deposits with building societies, BSHM3 = building societies holdings of M3, OMIXBS = other money market instruments excluding holdings by banks and building societies, NSDS = National Savings deposits and securities.

However, the official monetary aggregates have been criticised for the weighting scheme used to aggregate individual assets used to construct a money measure, and for the specific assets used to construct an aggregate (Barnett, 1980). This has become an ever more important issue with the rapid financial innovations which have been taking place during the last decade (Goodhart, 1986).

One way of deciding whether an asset should be included in a group for aggregation is to test for weak separability, this treats financial assets as commodities that are held for the services they provide. This approach suggests that individuals allocate assets according to their preferences for the characteristics of each asset and the relative return on each asset, which leads them to being part of a utility function. It is argued that aggregates based on weak separable groups should be more stable and should eliminate shifts in money demand functions which are a result of financial innovations. (Varian

1982, 1983, Barnett 1987, Ishida 1984, Serletis 1987, Fayyad 1986, Hancock 1987, and Belongia and Chalfant 1989).

Another criticism of the official monetary aggregates relates to potential errors associated with the simple sum weighting scheme used to derive them. This gives the same weight to currency, as money placed in deposit account where interest is received. In terms of opportunity cost these have completely different characteristics. To overcome this argument Barnett (1983, 1984) has constructed a series of divisia monetary aggregates. The advantage of this construction over simple sum aggregation, is that the measured value of the divisia index will not change, unless the utility or production functions forming the foundation of the index actually alter. These Divisia money indices are based on the difference between the rate of return on each component asset. This reflects the opportunity cost of holding a particular asset, that is the interest differential.

There is little work on Divisia monetary aggregates for the United Kingdom, the majority of the literature dealing with the United States. The most comprehensive papers for United Kingdom data are Mills (1983), Chrystal and MacDonald (1994), and Spencer (1992) upon which much of our work is based.

Following Barnett (1978) and Barnett et al. (1984), a Divisia monetary aggregate is constructed in the following manner. Let q_{it} and p_{it} represent the quantities and user costs of each asset to be included in the aggregate at time t. The expenditure share

(s_{it}) on the services of monetary asset i in the period t is:

$$s_{it} = p_{it}\, q_{it} \,/\, \Sigma\, p_{it}\, q_{it} \qquad i = 1, 2, .., .., n \qquad (5.15)$$

The user cost (p_{it}) of each asset is measured as:

$$p_{it} = p_t^*(R_t - r_{it})(1\text{-}M)/1+R_t(1\text{-}M) \qquad (5.16)$$

where p^* = the geometric mean of the GDP deflator, R_t is the maximum available expected holding period yield (RMAX), that is the maximum rate of return available across the monetary components included, r_{it} is the observed rate of return on asset i, M is the average marginal tax rate. However as Ishida (1984) points out, all terms other than (R_t - r_{it}) are common for all i and can be eliminated from the numerators and denominators which are used to compute the Divisia indices. Therefore in computing such indices, it is sufficient to use (R_t - r_{it}) as the user cost of the i-th component of money.

The growth rate of a Divisia index is constructed as the sum of the growth rate of each asset category weighted by the average share of the two periods. This can be written as;

$$\ln Q_t - \ln Q_{t-1} = \Sigma\, s^*_{it}(\ln q_{it} - \ln q_{it-1}) \qquad (5.17)$$

or

$$\Delta\, Q = \Sigma\, s^*_{it}\, \Delta q \qquad (5.18)$$

where s^*_{it} = 1/2 (s_{it} + s_{it-1}), Δq = the growth rate of the individual component. In order to calculate Divisia Monetary Aggregates for the United Kingdom our first task is to consider the monetary components of each proposed monetary divisia measure and their user costs. These are laid out in table 5.2

Table 5.2 Monetary Components and User Costs			
Variable Name	Component Description	Interest Rate on each asset	Variable Name
PC	Currency in hands of the public	None	n.a.
DD	Demand Deposits Net 60% of items in transit	None	n.a.
TD	Time Deposits Net of Interbank Deposits	Rate of Interest paid on Bank Deposits	RBDEP
OD	Other Deposits at the Bank of England	None	n.a.
NCCWP	Notes and coin in circulation with the public	None	n.a.
SDNI	U.K. private sector sterling sight deposits with monetary sector (non-interest bearing, adjusted for transit items)	None	n.a.
SDIB	U.K. private sector sterling sight deposits with monetary sector (interest bearing)	London interbank 7 day deposit rate	RINTB
PSSTD	U.K. private sector time deposits	Rate of Interest paid on Bank Deposits	RBDEP
PSSDBS	Private sector shares and deposits with building societies	Average Rate of Interest for building societies (RBSDEP+RBSSH) /2	RBSAV

Table 5.2 (continued)			
Variable Name	Component Description	Interest Rate on each asset	Variable Name
BSHM3	Building Societies holding of M3	London interbank 7 day deposit rate	RINTB
OMIXBS	Other money market instruments excluding holdings by banks and building societies (Bank Bills, Treasury Bills etc.	London interbank 7 day deposit rate	RINTB
NSDS	National Savings deposits and securities	Rate of Interest National Savings Investment Account	RNS
RMAX	The maximum available interest rate available at time t. (Maximum of above rates		RMAX

5.7 Velocity Measurement - Empirical Evidence

In figure 5.2 we plot the three varieties of M3 income velocity, for Total Final Expenditure (V8), Personal Disposable Income (V9), and Gross Domestic Product (Factor Cost) (Average Measure) (V10). All three velocity measures follow a similar pattern for annual data 1870-1991, their magnitudes reflecting the various definitions.

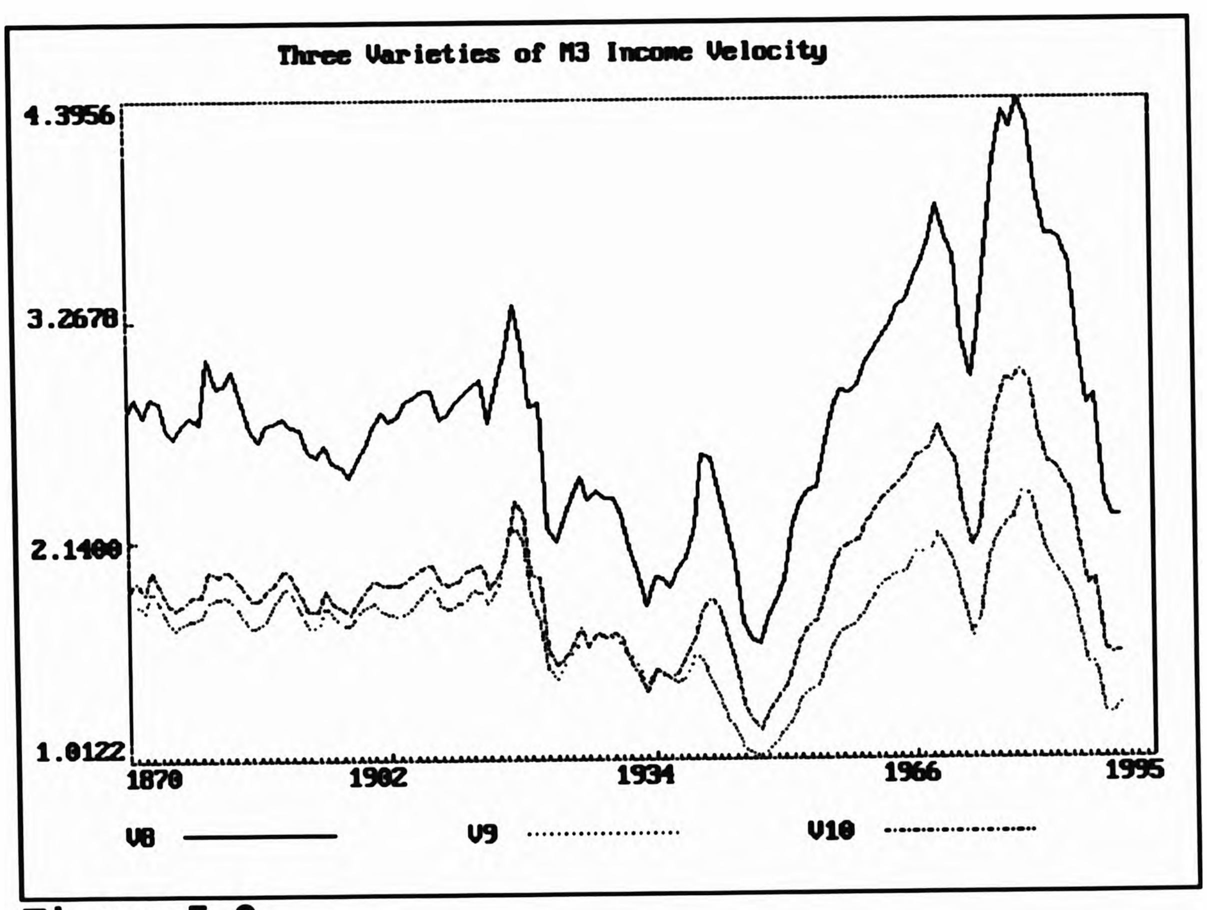

Figure 5.2

Given its widespread use in empirical work, we concentrate analysis on velocity as defined as Net National Product/Capie and Webber M3, (V1), as shown in figure 5.3.

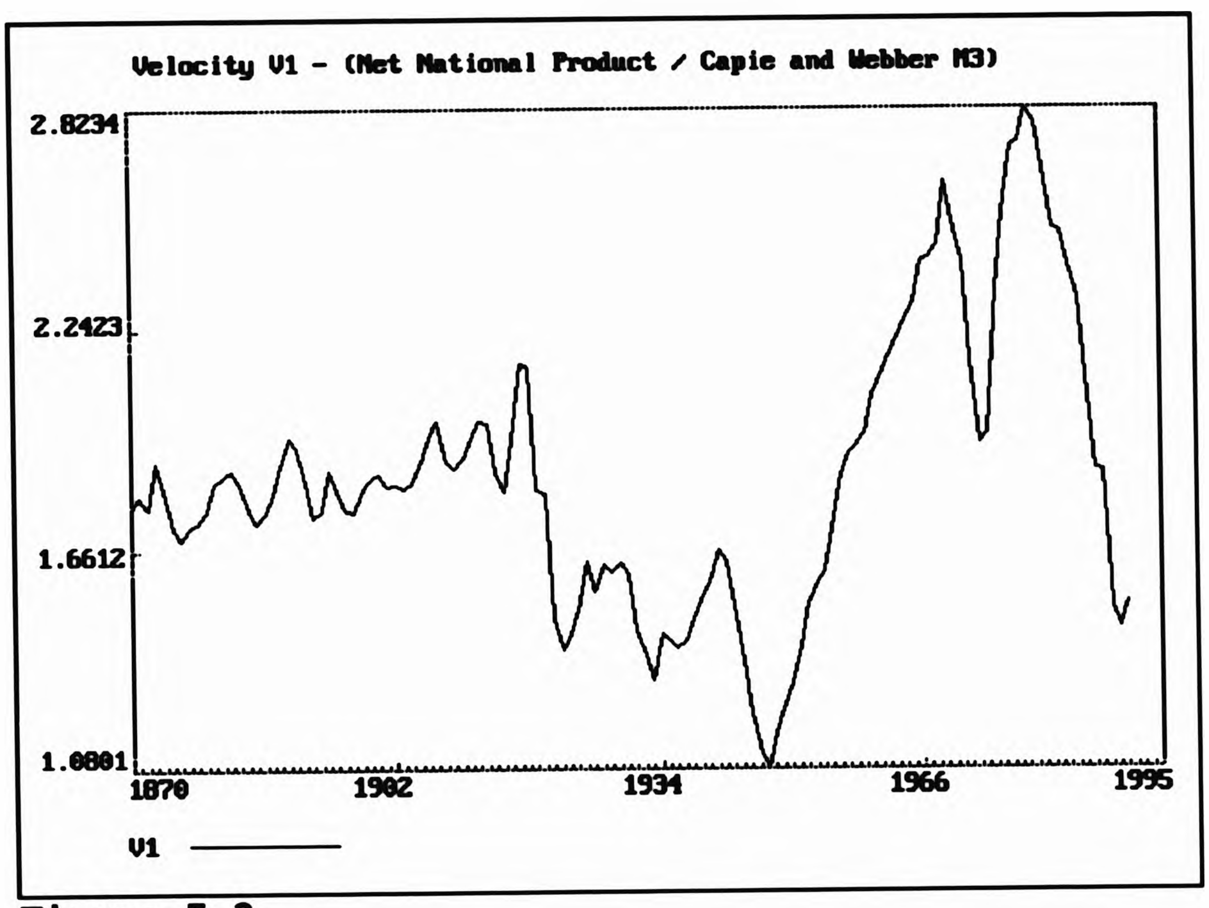

Figure 5.3

In the period 1870-1913 velocity (V1) is quite stable, with random fluctuations around a constant mean. It has been suggested by de Cecco (1974) and Brown (1940), that during this period Britain was an open economy at the apex of a world wide political empire. This meant that the Bank of England could manage the Gold Standard using small changes in interest rates to maintain monetary stability. After the First World War velocity growth fell in line with the sharp deflation. After a partial recovery during the 1920s, it fell again during the recession of the early 1930s. During the Second World War it fell to a new low, the war years being characterised by growing liquidity and various limits on private expenditure and other controls. There was a decline in the production of consumer goods during this period and a strong propensity to save in order to finance the war effort.

When the war ended in 1945 the high levels of liquidity were converted into consumer spending, and this probably contributed to a strong rise in the growth of velocity. To Morrell (1987) the stability of the money supply between 1946 and 1964 was due to the application of direct controls over banks. During this period the banks' loan portfolios were around 45% of their assets. Therefore to Morrell (1987):

"... since every advance creates its own deposit, the expansion of bank credit and the money supply was held at a relatively modest rate, averaging 4 per cent per annum between 1946 and 1964. With output (GDP) growing at around 2.5 per cent in real terms, price inflation would have averaged no more than 1.5% (the element of surplus money) but for the acceleration in the velocity of money, which contributed to an average inflation rate of 3%."

(Morrell (1987) p.30)

However, from the early 1970s direct controls over the banking system began to be dismantled. Within this more free market environment bank loans as a ratio of total money supply began to increase rapidly. Furthermore during Barber's 1972-1973 "dash for growth" monetary policy became very loose, and with increased consumer spending to beat the introduction of value-added tax in 1973, it led to the money supply rising rapidly, leading to a decline in income velocity growth measures using broad measures of money. After the world economic crisis in 1974/75, monetary policy was on the whole restrictive, interest rates rose, and velocity of circulation also rose to a peak in 1980. In the period 1980-1991, when for the most part inflation was falling, monetary policy was restrictive, and all measures of income velocity M3 fell uniformly.

As we discussed earlier, the Cramer transactions velocity M3 displays similar characteristics to the income velocity M3, albeit at a higher magnitude. The exception being the additional peak in 1988, and subsequent decline. Total Transactions Velocity (V2) is illustrated in figure 5.4.

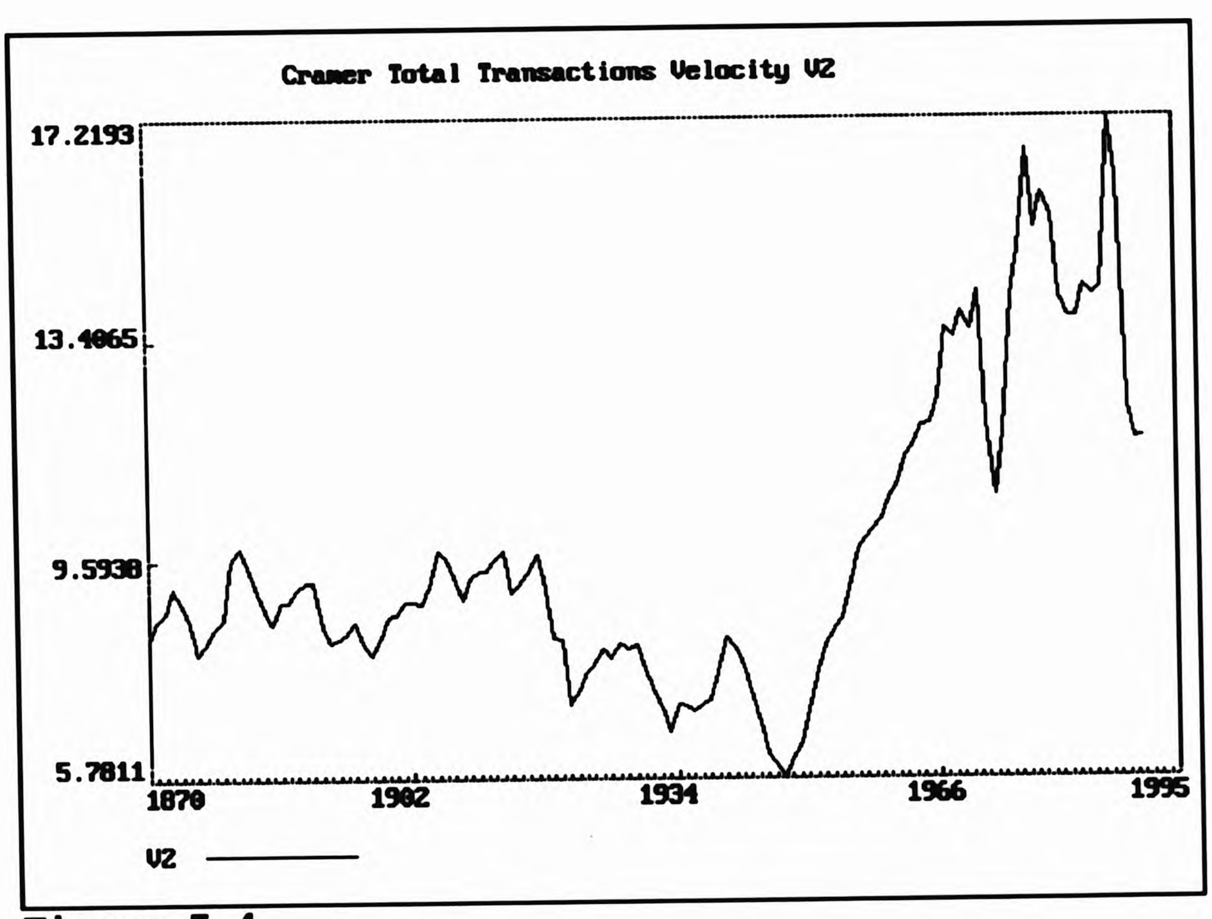

Figure 5.4

The interesting point about transactions velocity is that it can be split into its three component parts, current transactions velocity (V4), transfers transactions velocity (V5), and asset and portfolio transactions velocity (V26), as shown in figure 5.5. V4 shows similar characteristics to income velocity (V1). However, transfers transactions velocity (V5) displays different characteristics. It rises almost continuously from 0.19276 in

1875 to a peak of 2.6413 in 1979 before falling in line with most velocity measures. The exception is the notable trough in 1972, and relatively level periods between 1883 and 1902, together with 1918 and 1934. Asset and portfolio adjustment transactions (V26) also has unique characteristics, it moves around a fairly constant mean from 1870 to 1939. During the Second World War it falls to an all time low of 1.0707. In post war Britain, there is an upward trend, with notable peaks in 1971, 1976, and 1988, and troughs in 1973/4 and 1983.

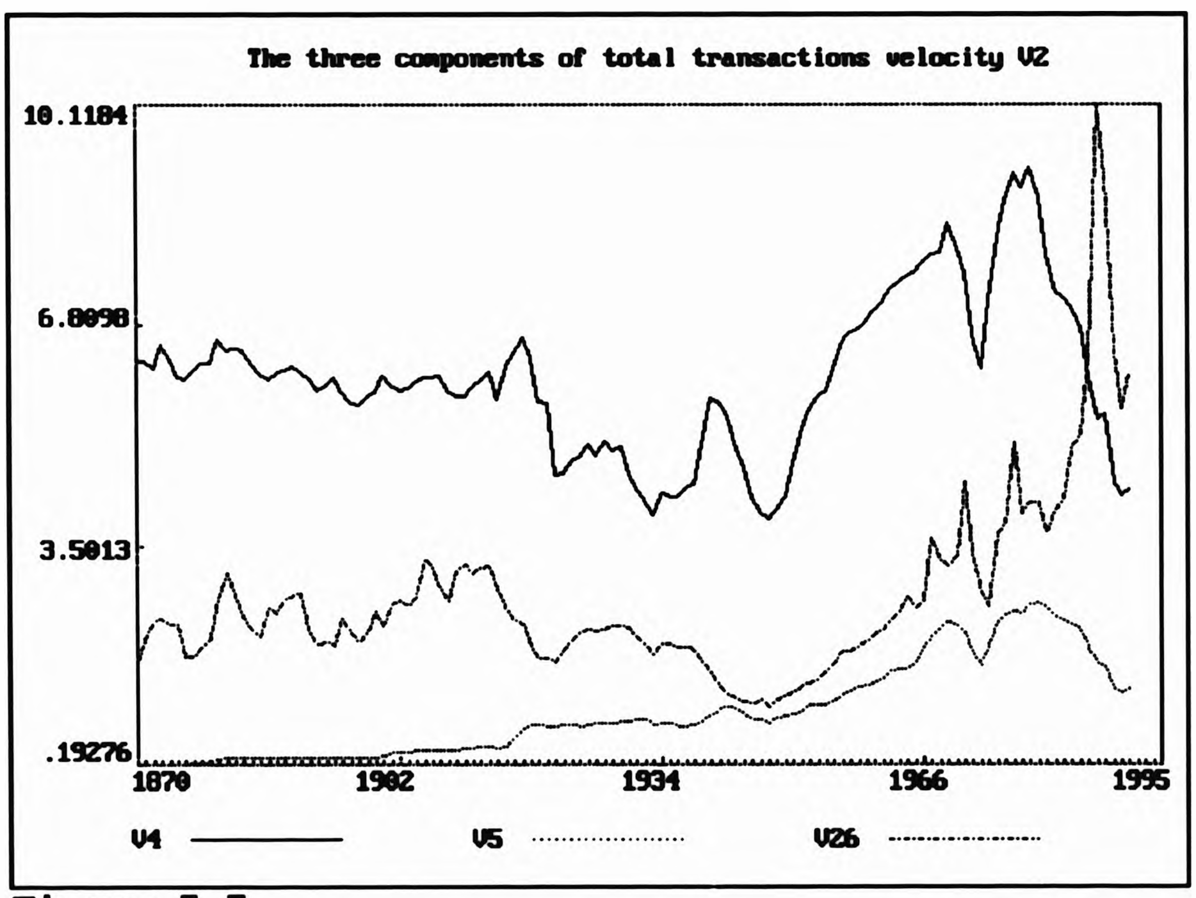

Figure 5.5

The velocity measures using Divisia M3 data are very similar to their simple sum M3 counterparts until the early 1970's. As an example figure 5.6 shows velocity V1, that is Net National Product (NNP) divided by Capie and Webber M3, together with V14, Net National Product (NNP) divided by Divisia Capie and Webber M3.

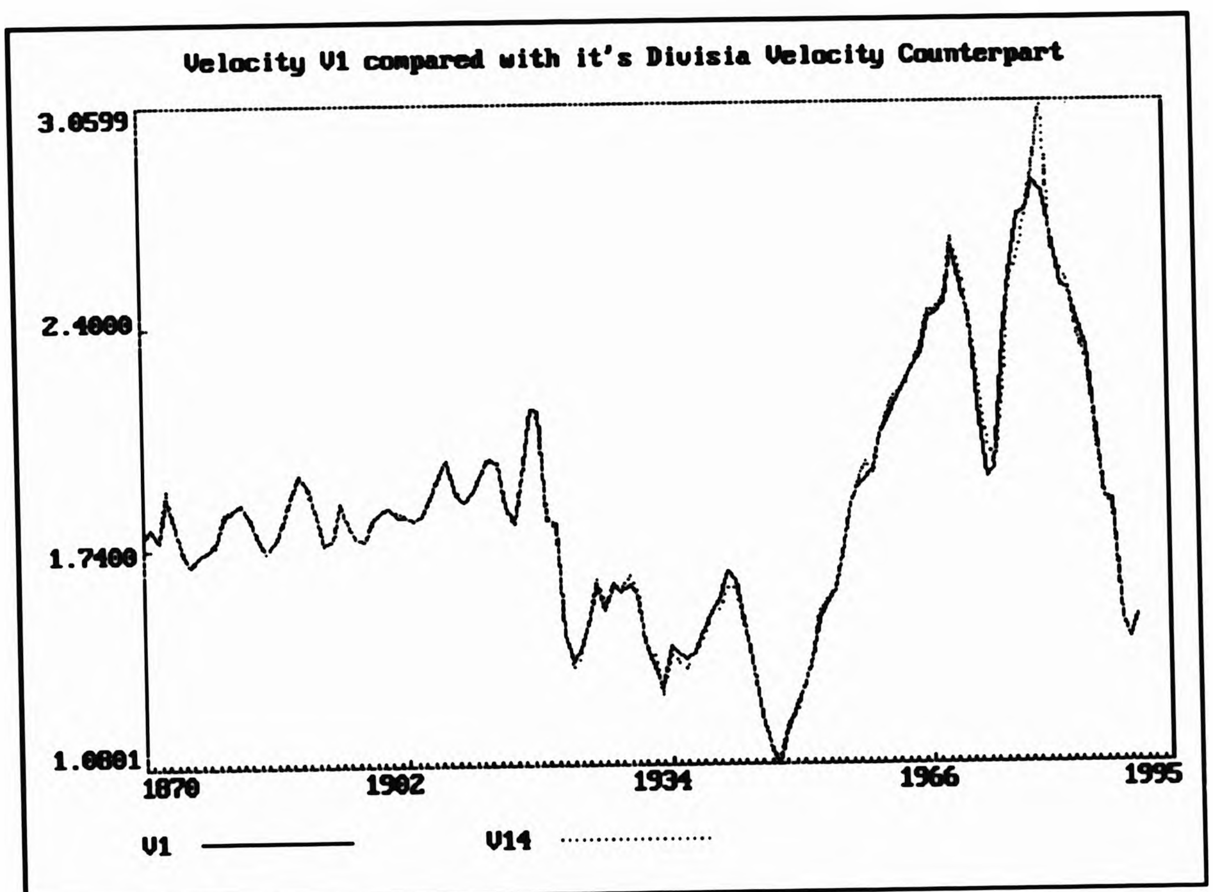

Figure 5.6

The most significant differences between the simple sum velocities and divisia velocities take place between 1963 and 1991. Figure 5.7 illustrates V1, its Divisia counterpart V14, and the equivalent velocity measure using Divisia M4, V18, for the period 1963 to 1991. Between 1963 and 1973 V14 is larger than V1. The years 1974 to 1978 are characterised by V14 being smaller than V1. Divisia M3 velocity peaks in 1980 unlike its simple sum counterpart. After 1980 V14 converges with V1. The Divisia M5 velocity measure, V18, declines until 1974, unlike V1 which peaks in 1969 and then declines. The shape of the V18 is then similar to V1, although its magnitude is smaller, which is to be expected, although the shape of the curve is less pronounced.

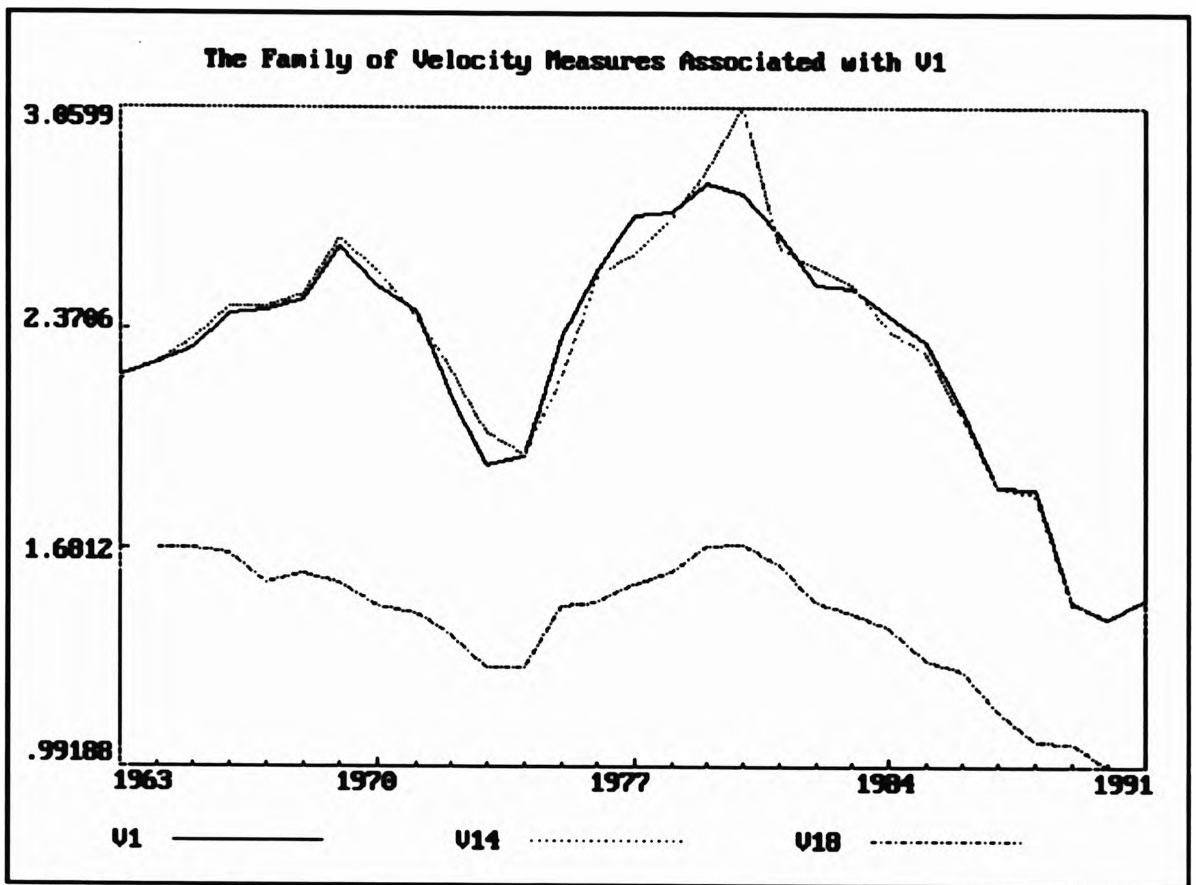

Figure 5.7

Total Transactions Velocity (Cramer Definition), V2, together with its Divisia Capie and Webber M3, V15, and Divisia M4, V21, counterparts are illustrated in figure 5.8. The first ten years finds V15 being larger than V2. However, after the trough of 1973, V2 becomes larger for the next four years. There is a common peak in 1977, but V15 peaks again in 1980. Between 1981 and 1986 both velocity measures are fairly constant, they both peak in 1987 before declining in the early 1990's. Apart from the declining in the 1960's, V21 follows a similar path to V2, albeit at a lower magnitude.

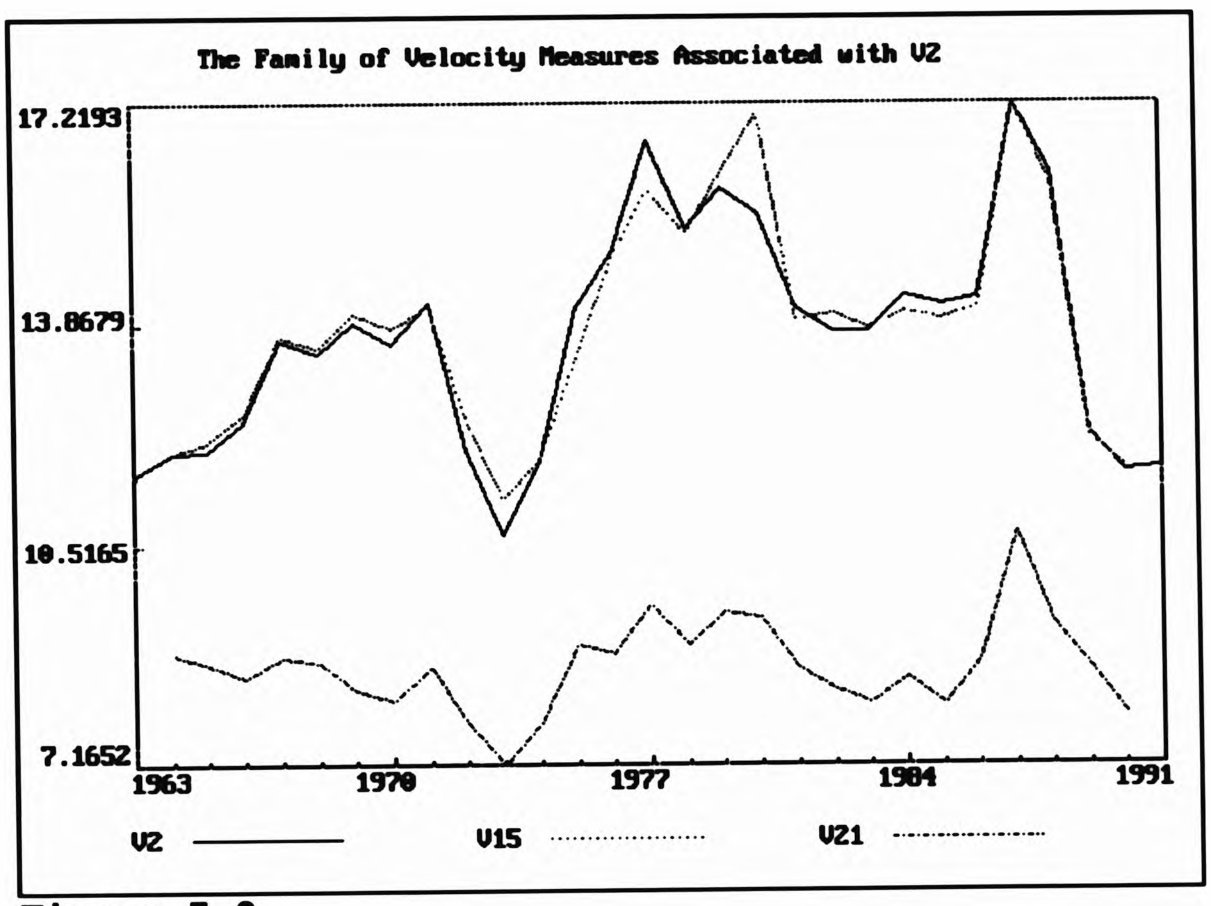

Figure 5.8

In this section we have discussed a number of ways that velocity of circulation of money can be measured. Nevertheless how well these statistical definitions capture true velocity is difficult to ascertain, especially as the evolution of money continues at a rapid pace, and the difficulties posed by accurately recording the number of transactions taking place in the economy. However, these are far too numerous to be of use in our empirical work. Given the small number of observations available for divisia velocity measures these were not considered further. The empirical work concentrates on income velocity (V1) and transactions velocity (V2). The development of the long term model being the first step.

Chapter 6

The Volume of Transactions in the United Kingdom

6.1 Introduction

Early literature concerning the velocity of circulation used the volume of transactions as the measurement of the value of goods and services. However, difficulties in measuring transactions and the advent of national income accounting led to the former being dismissed in favour of the latter, on grounds of lack of reliable statistical data. Nevertheless, this substitution can only be considered satisfactory if there is a strong correlation between the behaviour of the two series. The last chapter discussed a number of ways of measuring the volume of transactions. This established the Cramer (1981a) method as the favoured alternative. This chapter discusses in some detail the framework used to construct a volume of transactions variable for the United Kingdom covering the period 1870-1991. It also describes the problems associated with collecting transactions data. With the data at hand, the various components of transactions are considered. Finally, the relationship between income and transactions is examined.

6.2 Background

Before the advent of comprehensive national income accounting, there were a number of attempts at measuring the volume of transactions in the United Kingdom and elsewhere. An early study by des Essars (1895) attempted to construct transactions velocities for a number of countries. Fisher (1911, 1919) wrote comprehensively about the subject in the context of the United

States. This work was extended by Snyder (1934) and Angell (1936) who believed that transactions velocity was an important indicator of business conditions. Contemporaneously Edie and Weaver (1930) and Keynes (1930) estimated the number of transactions for England. The middle years of this century saw little interest in measuring transactions. The exceptions being Garvy and Blyn (1970), Turvey (1960) and Lieberman (1977). A revival took place in the early nineteen eighties with Cramer (1981a) who constructed the volume of transactions for the United Kingdom for the period 1968 to 1977. This was complemented by similar studies for the Netherlands 1950-1978, Cramer (1981b) and the United States 1950-1979, Cramer (1986). This framework of analysis being constructed by extending similar work by Jonker (1973). It is this methodology which is used here to build a volume of transactions variable for the United Kingdom 1870-1991.

6.3 Framework of Analysis

The initial starting point is a variation on the equation of exchange;

$$MV = \sum_j (PT)_j \tag{6.1}$$

where M = money, V = the velocity of circulation, P = the price level and T is the volume of transactions. Cramer (1981a) abandons the distinction between price and volume and estimates each P_jT_j as the money value at current prices of each category of transactions. The identity of the equation of exchange holds only if all payments on the left hand side are accounted for by transactions on the right hand side. The main aim of this work is the encapsulation of the latter.

It is important to note, that as with previous work in this area, all transactions data is rough and an approximation. As Cramer (1981a) points out, in view of the fact that government statistical data is not constructed for this purpose, at best it provides an estimate of the order of magnitude of the variables concerned. Indeed, Cramer (1981a) states;

"In the case of PT we have laboriously been trying to undo the work of the compilers of macro-economic statistics who net out opposing flows and reduce gross output or turnover to its value added component. Inevitably the precision of our procedures is no match for theirs. While it would be tedious to repeat these reservations throughout the text they should be borne in mind constantly."

Cramer (1981a, p.235-236)

Therefore where it is possible to measure a certain group of transactions, this often involves a great amount of extrapolation and interpolation. Thus estimates for successive years are not necessarily independent. Nevertheless, constructing transactions has the benefit of identifying different types of transactions, which do not necessarily move together.

In order to measure the volume of transactions in the United Kingdom, it is necessary to identify the different types of transaction and the different groups of economic agents who interact with each other. If we recall from chapter five, Cramer (1981a) separates PT into three components, current transactions (CT), transfer transactions (TF), and asset and portfolio adjustment transactions (APA). So that total transactions (TT) is defined as:

$$TT = CT + TF + APA \qquad (6.2)$$

It is also possible to group economic agents into six categories, Producing Firms (ie. firms involved in primary and secondary industries, together with agriculture), Wholesale, Retail and Service Firms, the Financial Sector, Government, Rest of the World, and Households. In order to understand these interactions and to justify why the data presented here represents a full account of transactions, each type of transaction will be dealt with in turn.

6.4 Current Transactions

First let us consider those current transactions in connection with production. Firms involved in the secondary sector purchase raw materials from the primary sector (or from overseas), input labour and capital to produce goods, pay wages, and profits to shareholders. That is income to households. The goods are sold to wholesalers and retailers, who add their margins and also pay wages and dividends. Finally, the retail sector sell the goods to households, and pay indirect taxes to the Government. A similar process takes place for the agricultural sector. In both cases some produce/goods are exported and others imported. The service sector also interacts with households and other firms. The Government is also a player, purchasing goods and services, and providing subsidies in certain cases. Consequently current transactions can be measured as:

$$CT = OP + AGOP + PCON + IN + PAPG \qquad (6.3)$$

where OP = industrial output , AGOP = agriculture output, PCON = expenditure on final goods and services (personal consumption), IN = incomes (from employment, self employment, profit, rent), PAPG = public sector payments for goods and services.

Industrial output includes exports but imports are not recorded. This would not be a problem if all exports were paid for in domestic currency and all imports in foreign currency. Unfortunately, Cramer (1981a) found that proportions vary, and was unable to take this into account. Ideally industrial output should be derived from input/output tables. However, the publication dates of these are not consistent and do not include the whole sample period. Observations of industrial output for the period 1870-1906 are taken from Hoffman (1955). Whereas Lomax (1959) is used for data collection in the middle part of this century. The post war period consults the Census of Production, with intervening years derived through interpolation. One problem with this method is ever changing industry definitions. Industrial output in constant prices is illustrated in figure 6.1. In 1850 the British Economy was very much reliant on agriculture and textiles. However, in the twenty years leading up to the start of the sample period, Britain became industrialised with major growth taking place in engineering, ship building, mines and quarries. The major source of this increase in demand was overseas purchases of ships and railways, which in turn led to a greater requirement for iron, steel and coal. However, towards the end of the nineteenth century there was increasing industrial competition from Germany, France and America. This meant that Britain lost much of its earlier supremacy. An additional problem was the adoption of trade barriers in Europe, which led not only to the loss of trade, but also allowed indigenous industries to build up behind their protection. At the turn of the century industry began to recover, but this was due to one industry, coal. However, this large increase masked the stagnation in the textile industry and the development of the American and German iron and steel industries which hit British exports. The industrial malaise which emerged after the end of the first world war had its roots before 1914, and it was not only a British problem. There were perhaps two main roots. First, the long term trend towards low prices of primary products, made it more difficult for nations producing these commodities to afford to import manufactured goods. Second, the war had caused major dislocation of characteristic nineteenth century trade patterns. There were also the new industrial powers of Japan and the United States, and the virtual withdrawal of Russia from world markets. It was with this already poor situation that the Great Depression shattered the world's economy between 1929 and 1932. Nevertheless by 1935 industrial recovery had started, mainly due to the growth of the new industries, including chemicals, rayon, cars and radio. However, the largest factor in this recovery was the building boom in both the private and industrial sectors. This situation came to an abrupt halt in September 1939 at the start of the second world war. There was a post war boom in industry and in building, caused by war time lags and shortages. This was also helped by the emerging new products such as man-made fibres and plastics which developed rapidly. Nevertheless, industrial output peaked in 1966 and has declined, for the most part, ever since. Nevertheless, the statistics are distorted by the discovery of North Sea oil in the mid 1970s. Furthermore, the fall in industrial output in the early 1980s can be attributed to the closure of much of the traditional primary industries such as coal and steel.

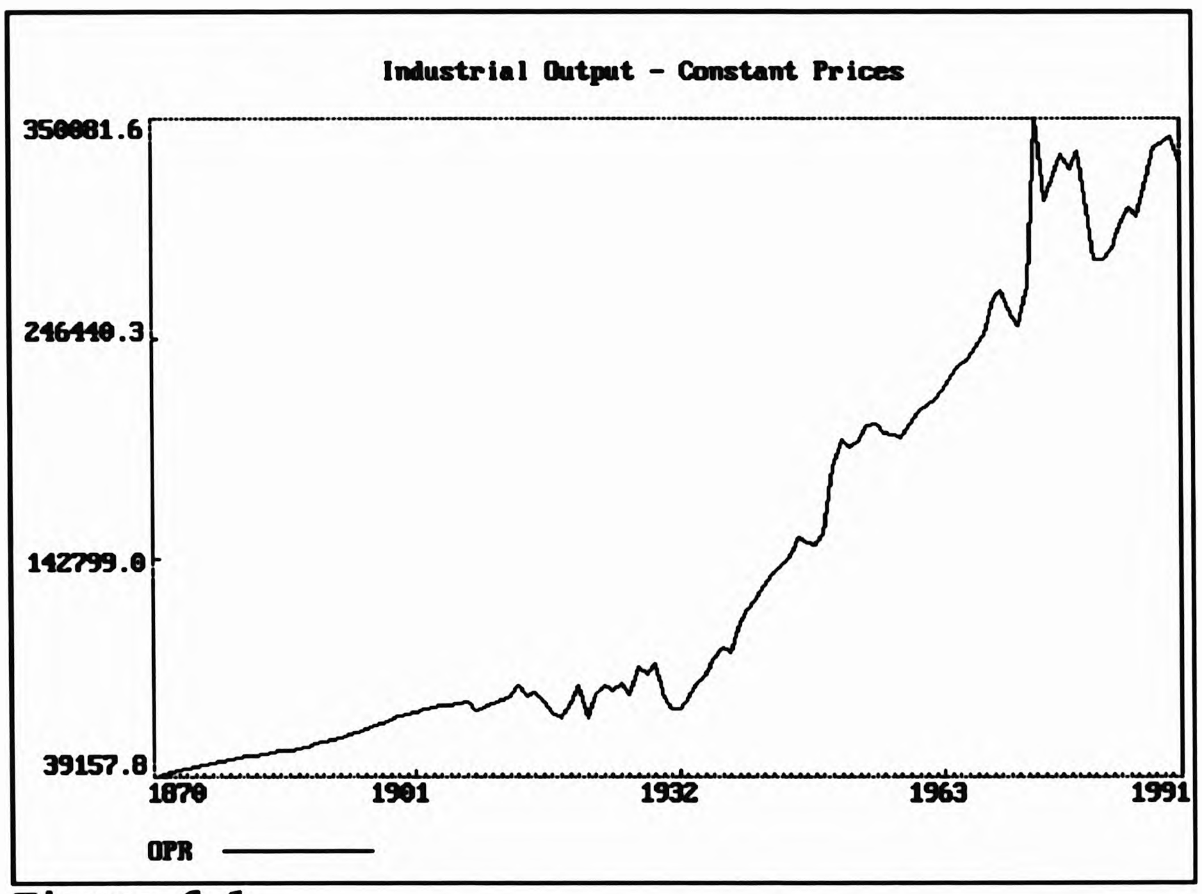

Figure 6.1

Agricultural output is taken from a variety of sources. Prior to the First World War data is recorded in Bellerby (1968), who writes comprehensively about agrarian history in the nineteenth century. Ojala (1952) provides a number of observations for the period 1915-1944, and interpolation is used to establish intervening years. Remaining values of AGOP are taken from various Annual Abstract of Statistics. Agricultural output, as illustrated in figure 6.2, declined at the end of the nineteenth century. There were bad harvests in the late 1870s and a greater reliance on imported food supplies. Furthermore, competition in wheat production from overseas, especially from Argentina, Canada, and the U.S.A. grew quickly at this time, helped by the development of steamships and railways. Another problem was the movement of labour to the towns which was depopulating the countryside. Between 1881 and 1901 the number of farm labourers fell from 983,919 to 689,292. Agricultural output recovered in the early part of this century, mainly in the form of the dairy trade. This was fairly immune to foreign competition and enjoyed rising demand from the increasing urban population. During the first world war the German government intensified submarine warfare which hindered the import of food from abroad. To overcome this problem the British government chose to produce as much food at home as possible, bringing back into cultivation much of the land lost to grass in the 1870s. This accounts for the rise in domestic production for 1917/1918. A brief recovery ensued after 1918, before the major slump of the 1930s. The early part of the second world war saw much reliance on indigenous food supplies and agrarian output rose steeply. The same policy was adopted as in the first world war, although in 1939 the new measures were adopted much more quickly and greater effort was made in giving farmers essential machinery and labour. By 1945 overall tillage in Britain was 55% greater than the average for the years 1935-1939. The post-1945 period has been one of great change both technically and organizationally. Furthermore, while agriculture was largely unprotected from foreign competition before the second world war, it has enjoyed heavy subsidies thereafter. Indeed, when Britain joined the E.E.C. in 1973 the level of subsidies increased still further. Protected by these subsidies farmers have invested heavily in machinery, drainage, and buildings. There has also been greater economies of scale by the amalgamation of farms.

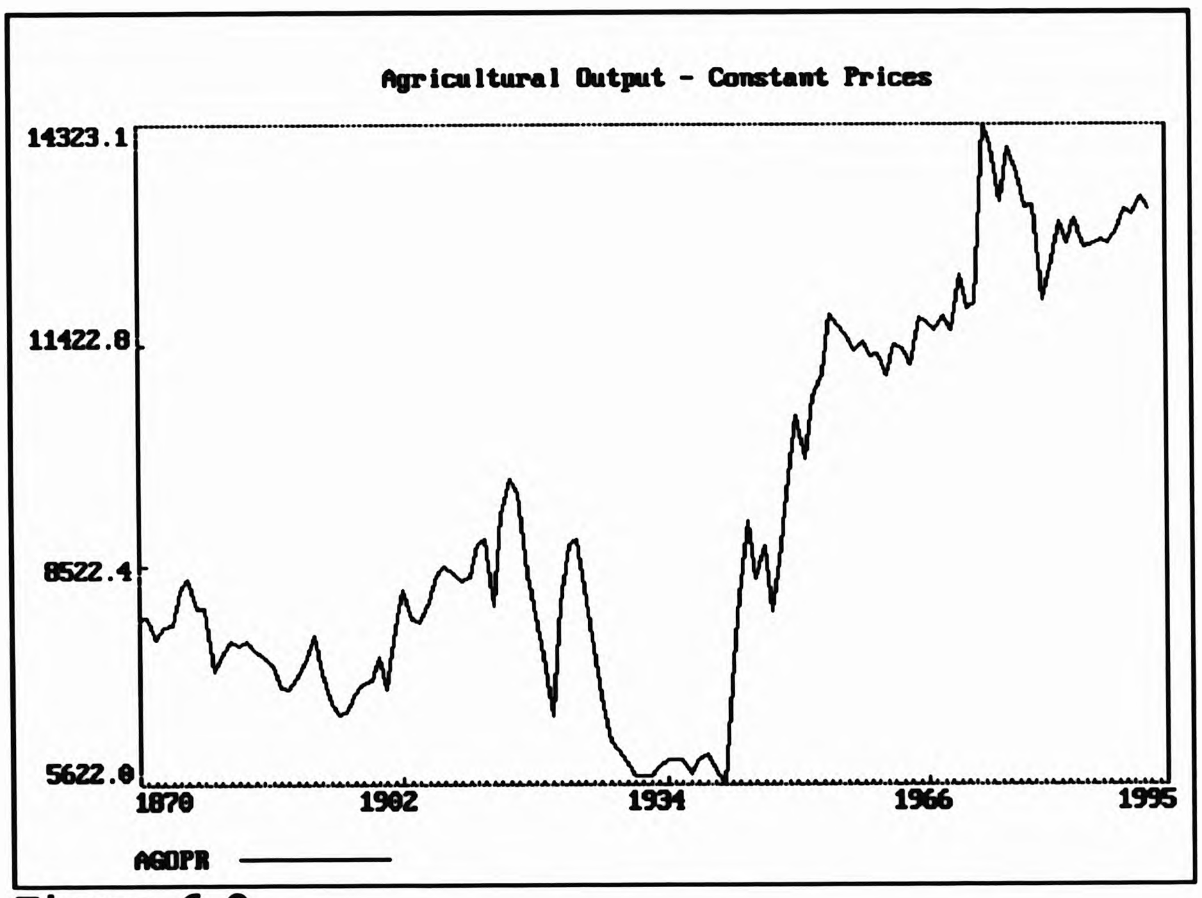

Figure 6.2

Expenditure on final goods and services represents the final transactions between retail/service firms and households. However, there is an omission, that is transactions between wholesalers and retailers, where statistical data before the second world war was not available. Cramer (1981a) suggests a fixed mark up of industrial output. But there must be some doubt as to the accuracy of such a measure. On the one hand industrial output includes exports which do not enter the domestic distribution system and on the other, wholesalers sell imported goods which are not included in domestic industrial production.

Furthermore, some producing firms sell direct to large retailers, and the mark up may vary over time and between industrial sectors. For these reasons the estimate of current transactions must be always be lower than its true value. With the exception of the two world wars, expenditure on final goods and services, figure 6.3, has risen almost continuously over the sample period.

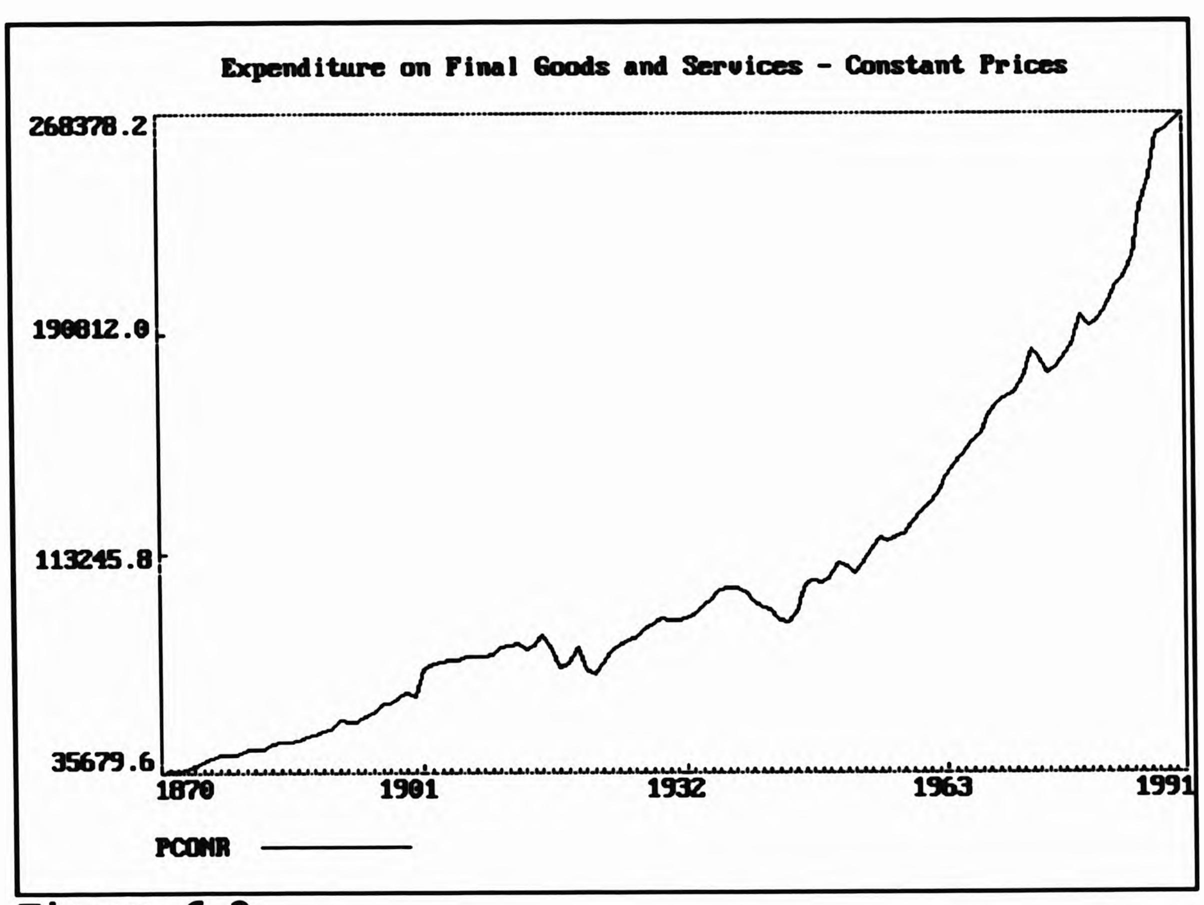

Figure 6.3

Income must include that from employment, self employment, profits of companies and public corporations, together with rent. To avoid the double counting of transactions, income tax and national insurance contributions deducted at source must be excluded. In consequence it is possible to define income as:

IN = INEMP + INSEMP - TAXI + PROFITCO + SURPCO +

SURPENT + RENT (6.4)

where INEMP = income from employment, INSEMP = income from self employment, TAXI = taxes on personal income, PROFITCO = gross trading profits of companies, SURPCO = gross trading surplus of public corporations, SURPENT = gross trading surplus of other public enterprises, RENT = rents. Excellent data sources are available for all income variables. Feinstein (1972) provides most of the required statistics, supplemented by Mitchell and Deane (1962) where necessary. Incomes measured in constant prices are shown graphically in figure 6.4. The growth rate of incomes was fairly low in the latter years of the nineteenth century and early years of this century. Between the wars, the economy was for the most part in a state of considerable depression and incomes fell. However, by 1934 incomes were growing quickly as the economy came out of the Great Depression. After the second world war incomes rose more rapidly around a fairly constant upward trend. Of course, there were variations, most notably the Barber Boom, the decline in incomes during the oil crisis of the mid 1970s and the depression of the early 1980s.

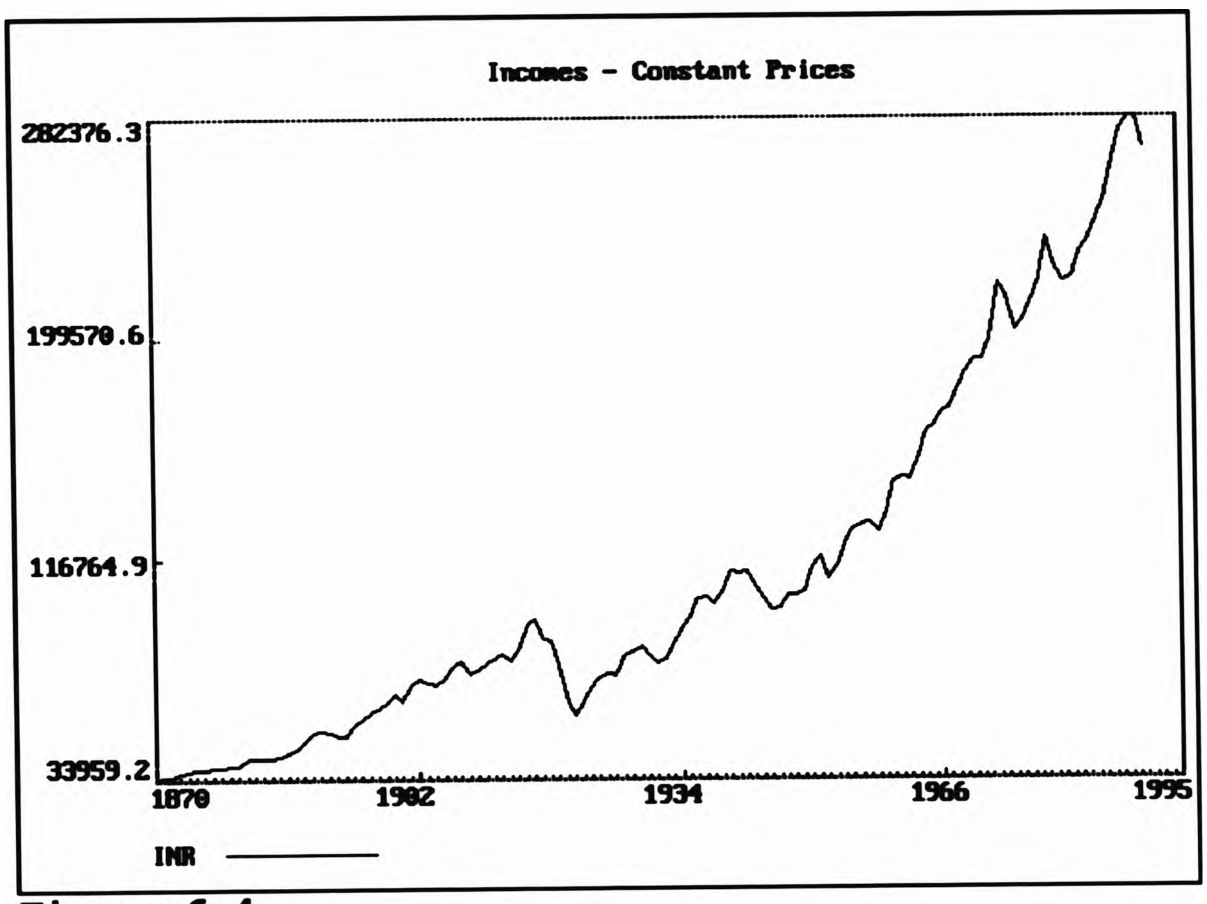

Figure 6.4

The payment for public sector goods and services (PAPG) includes the public sectors contribution to production/output. Following Cramer (1981a) it consists of final consumption, gross domestic capital formation and stockbuilding by both central and local Government. It is defined algebraically as;

PAPG = GFC + GCF (6.5)

where GFC = government final consumption, GCF = government capital formation. However, the correct classification of payments for public goods and services in our framework of analysis is somewhat in doubt. Cramer (1981a) argues that on the one hand the services that the general public receive are not directly paid for, and as such do not give rise to transactions. On the other hand, it is possible to argue that this output has a counterpart in the form of Government revenue, either through taxation or charges, and that such payments are linked with current transactions. The latter view is adopted here.

The payment for public goods and services is dominated by the two peaks caused by the world wars, as illustrated in figure 6.5. But these mask, to some extent, the changes which have taken place in the number of government transactions. Views on the role of the state in the economy changed considerably over the sample period. Adam Smith (1776) defined three roles for government. First, the external defence of the country. Second, to ensure that law and order were maintained in that country. Last, the erection and maintenance of certain works and other public institutions where an individual or company would not obtain a reasonable profit, but which were important to society as a whole. In consequence, the latter half of the nineteenth century saw a policy of laissez-faire. Where market forces were left to determine production and consumption patterns, and the government played a very limited role. However, in the early twentieth century there was a greater awareness of the issues of public health, education, poverty, and unemployment, and that it was appropriate for state intervention and provision. This decline in the views of economic individualism and the rise in socialist ideas led to the liberal welfare reforms before the first world war. The inter-war years can be seen as a period of transition. While the role of the state had greatly increased since the turn of the century, many Victorian values remained. It was the influence of the new economics of Keynes after the second world war, which was to lead to the transformation of fiscal policy. This led to demand management of the economy in an attempt to avoid major booms and slumps and maintain full employment, the adoption of universal welfare benefits, and the nationalization of major industries. These changes led in turn to a rapid increase in the governments transactions in the economy. During the 1970s the size of public expenditure became a major political issue. First, the 1974-1979 Labour Government made efforts to curb the growth of government expenditure after pressure from the International Monetary Fund. Second, a Conservative Government was elected which sought to give priority to controlling public expenditure in order to reduce the burden of taxation. While government expenditure on goods and services has continued to rise, government capital formation has fallen since 1976.

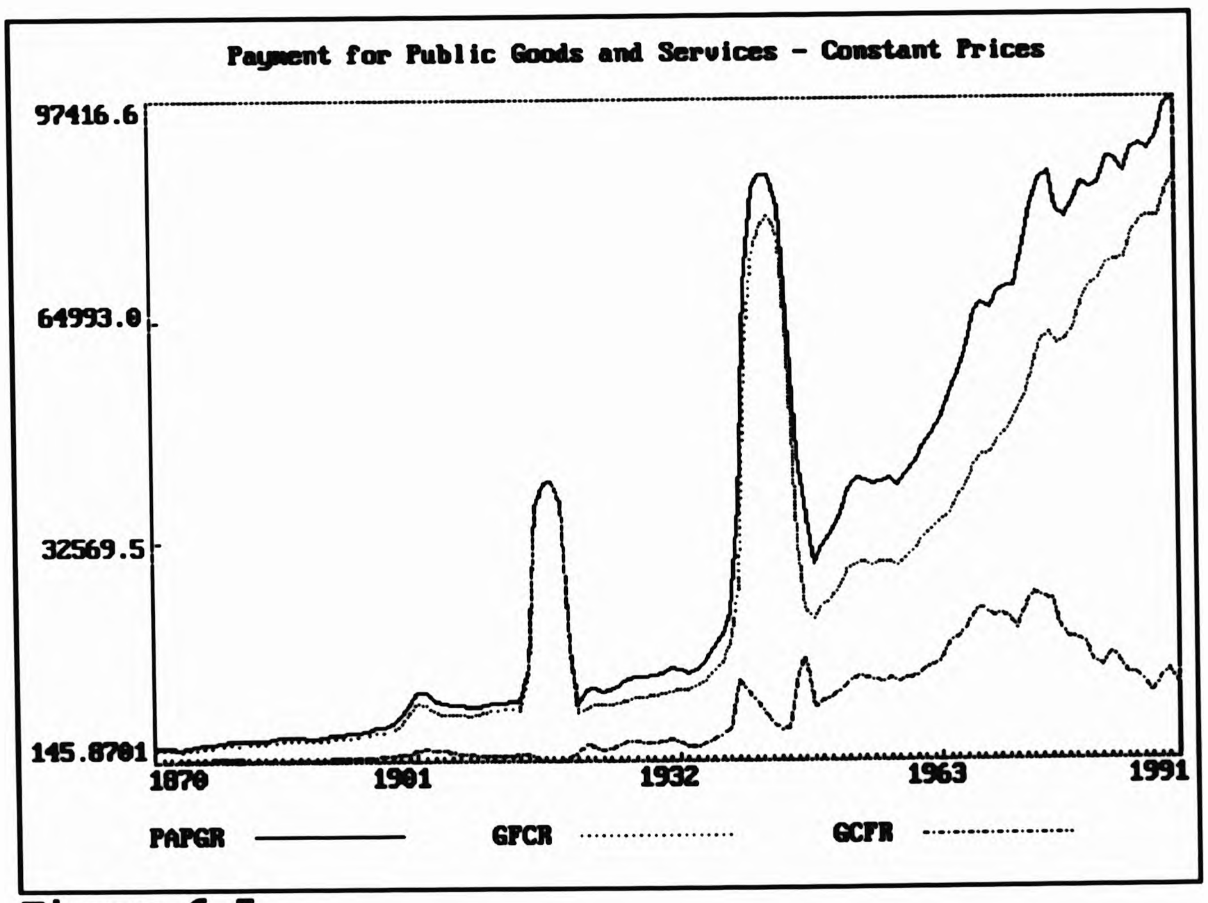

Figure 6.5

6.5 Transfer Transactions

The second category of transactions are transfer payments. These can be divided into three groups. First, transfers between households and the financial sector. These include insurance premiums and payments, life assurance, and benevolent funds. Second, the transfer of funds between the State and other economic agents. These include taxation, national insurance contributions, grants, subsidies and social security payments. Last, transfers between central and local government. Transfers within households are not included, because it is argued that households cannot trade with themselves. In consequence transfers can be defined as:

$$TF = TFPS + TFGS + TFCLG \qquad (6.6)$$

where TFPS = transfers of the private sector, TFGS = transfers of the government sector (including inter-governmental transfers), TFCLG = transfers - central to local government.

Income transfers of the private sector consist of insurance premiums together with pensions and benefits deriving from superannuation or life insurance. Turnover of collecting societies and friendly societies are also included in the total. Consequently transfers of the private sector can be written as:

$$TFPS = LABIN + LABOUT + LAINDIN + LAINDOUT + IPOL + TOCS + OGCS + TOFS + BPFS \qquad (6.7)$$

where LABIN = life assurance business (ordinary business) - Income, LABOUT = life assurance business (ordinary business) - outgoings, LAINDIN = life assurance business (industrial business) - income, IPOL = insurance premiums and outgoings -

other than life, TOCS = turnover collecting societies, OGCS = outgoings collecting societies, TOFS = turnover friendly societies, BPFS = benefits paid friendly societies.

The Life Assurance Acts of 1867, 1870, and 1872 set up the regulatory framework for this sector of insurance companies' business. It is from the resulting parliamentary papers that much of the early data is found. While insurance premiums and outgoings other than life appear as a total in IPOL, they are in fact derived from several categories, accident, employers liability, fire, marine, motor vehicle and miscellaneous. Sheppard (1971) provides an excellent source for insurance premiums, but data for outgoings are less reliable, using insurance industry sources. The Friendly Society Acts between 1793 and 1855 set up the legislative framework in which these charitable or non-profit organizations were to operate. The resulting parliamentary reports are the source for much of the corresponding data, although nineteenth century observations were difficult to obtain. Collecting Societies activities peak in 1968 and decline until 1980, when a resurgence takes place. While Friendly Societies transactions peak in 1935 before falling to new low levels in the 1950s and 1960s. Greater activity takes place after 1976.

Transfers of the private sector, figure 6.6, show modest growth until the second world war and more rapid growth thereafter. However, there is a fall in transfers in the mid 1970s, brought about by a sudden fall in the area of life assurance business.

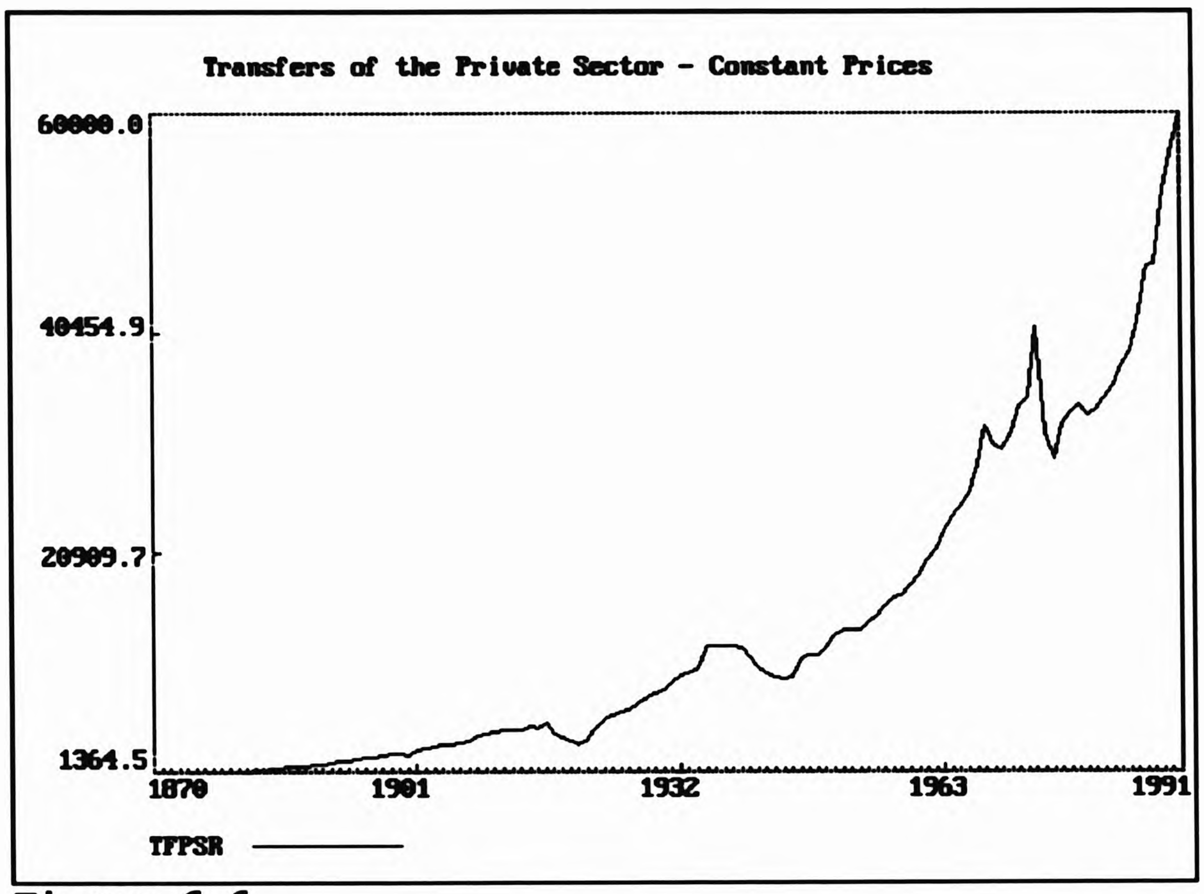

Figure 6.6

Transfers of the public sector cover receipts and expenditure of both central and local Government. They can be defined as:

TFGS = TFGEXP + TFGR (6.8)

where TFGEXP = transfers - Government expenditure, TFGR = transfers - Government receipts. During the sample period, as we have already discussed in some depth, the Government played an increasingly significant role in shaping the development of transfers. In particular changes in government policy in the social and fiscal field had a large impact. The Old Age Pension Acts following 1908, the National Health Insurance Act and the Unemployment Income Act of 1911, the Blind Act of 1920, the War Pensions Scheme Act of 1915, and the Old Age Contributing Pension Act of 1925 all increased the level of Government transfers. However, the biggest impact was the establishment of the Welfare

State after the Second World War. In the latter part of the sample period higher unemployment and a growing elderly population has increased transfer payments still further.

Transfers of the government sector, figure 6.7, are small until 1914, when they grow more rapidly. The new level is maintained until 1939 when government transfers rise once again. The 1950s are characterised by a period of constancy. After this point, with minor exceptions, they increase more rapidly, until the late 1980s. It is interesting to note the Displacement Effect identified by Peacock and Wiseman (1961) in a study of trends in public expenditure 1890 to 1955. This suggested that government expenditure grew very much in line with national income during peacetime. While in the wars public spending rose substantially, but this was never reversed at the cessation of hostilities. The ratchet effect can be seen clearly in figure 6.7. What is particularly important to transfers, is the fact that the ratchet effect is much less marked if government consumption is excluded. This the authors suggest is due to a greater acceptance of redistribution after the sacrifice of wartime.

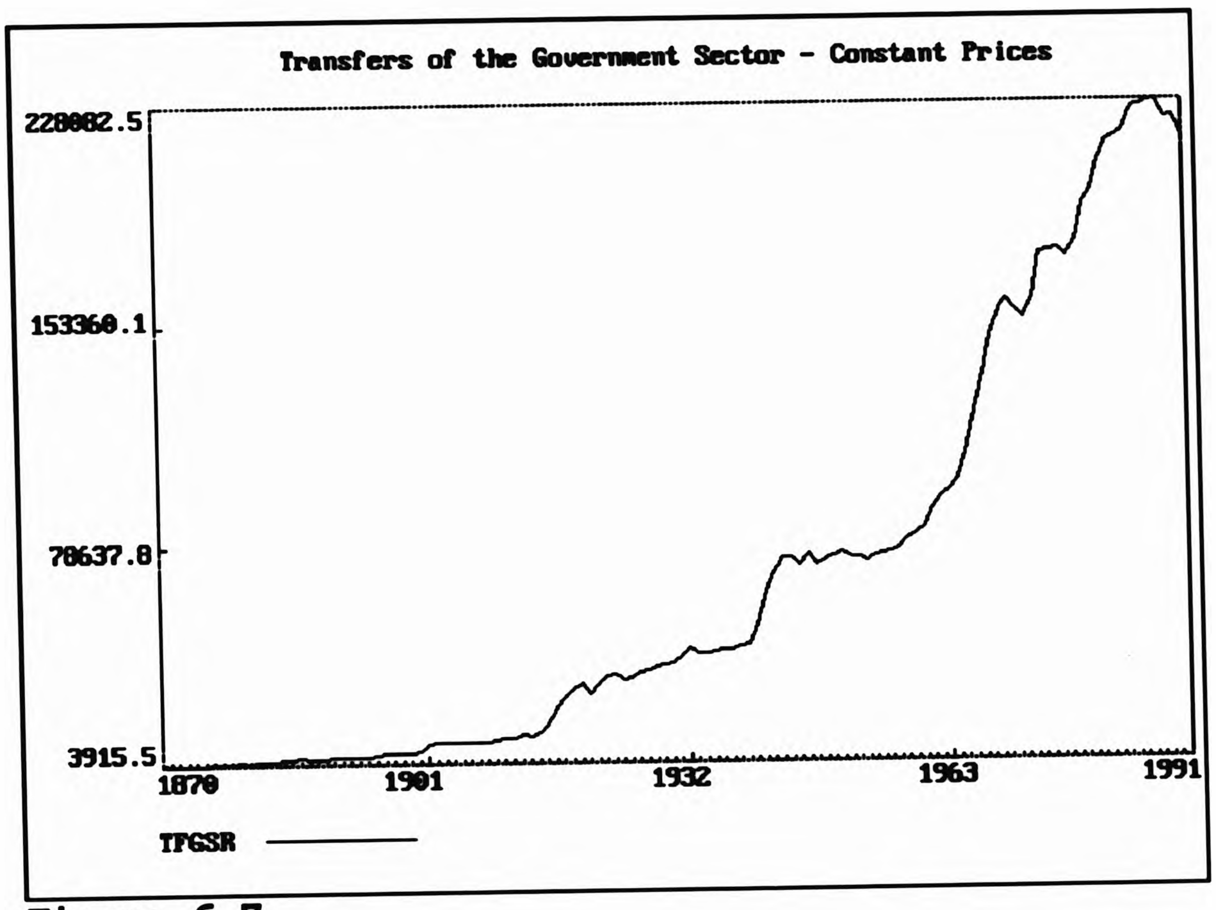

Figure 6.7

Transfers from central to local government behave much the same as other government transfer statistics until 1974 when they fall suddenly due to the fiscal policy changes discussed above. These transfers regain their previous level in the early 1980s before falling again. Growth is restored once more at the end of the sample. (see figure 6.8). It is unclear whether transfers from central to local Government involve monetary payments or are just accounting entries by Government institutions or entries in its accounts at the Bank of England. Nevertheless, if the equation of exchange is to be maintained, these transactions must be included.

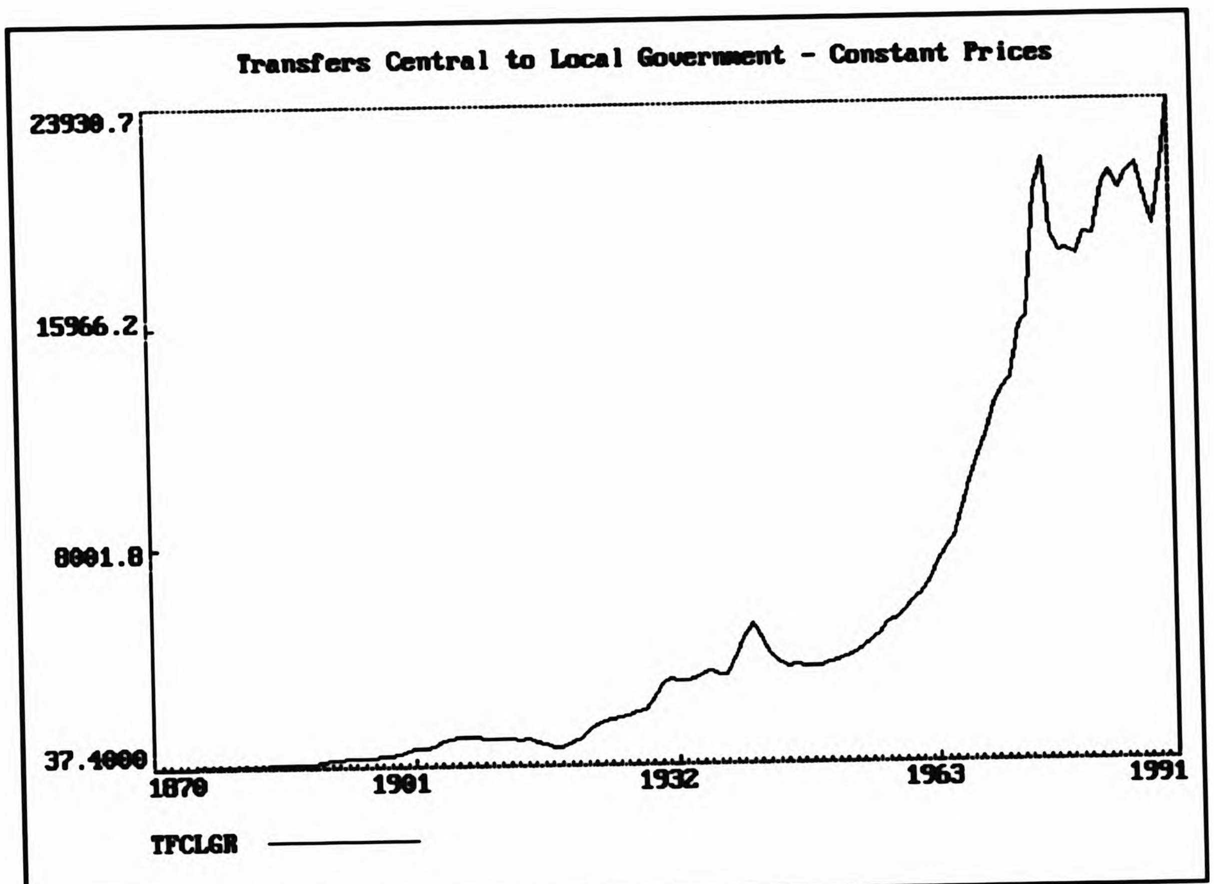

Figure 6.8

6.6 Asset and Portfolio Adjustment Transactions

The third category identified by Cramer (1981a) is asset and portfolio adjustment. This includes capital investment by firms, the movement of funds in and out of financial institutions, advances and repayments of house mortgages and the turnover of ordinary shares and gilts. Unfortunately, as with earlier work in this field there are omissions due to lack of comprehensive data. These include direct borrowing by industry from financial institutions, transactions in antiques, second hand cars, used machinery and plant, and the cash component of company mergers and acquisitions. So asset and portfolio adjustment transactions are always understated. It is also important to note that for the equation of exchange identity to hold, all payments in money must be exchanged for something else, for example goods, services, claims, fiscal obligations, shares. Therefore exchange of money for money, for instance drawing cash from an individuals bank account or transfers of funds between two accounts held by the same person, must be excluded. By the same token, barter, where no money changes hands must also not be counted. Asset and Portfolio adjustment can be defined as:

APA = PCF + PORTA (6.9)

where PCF = private sector capital formation, PORTA = private sector portfolio adjustment.

Private sector capital formation, that is business investment in plant and machinery and house building, is shown in figure 6.9, it is cyclical around a constant mean until 1938. There is a break in the series between 1939 and 1945. The final years, for the most part, follow an upward trend until 1988, when a decline takes place.

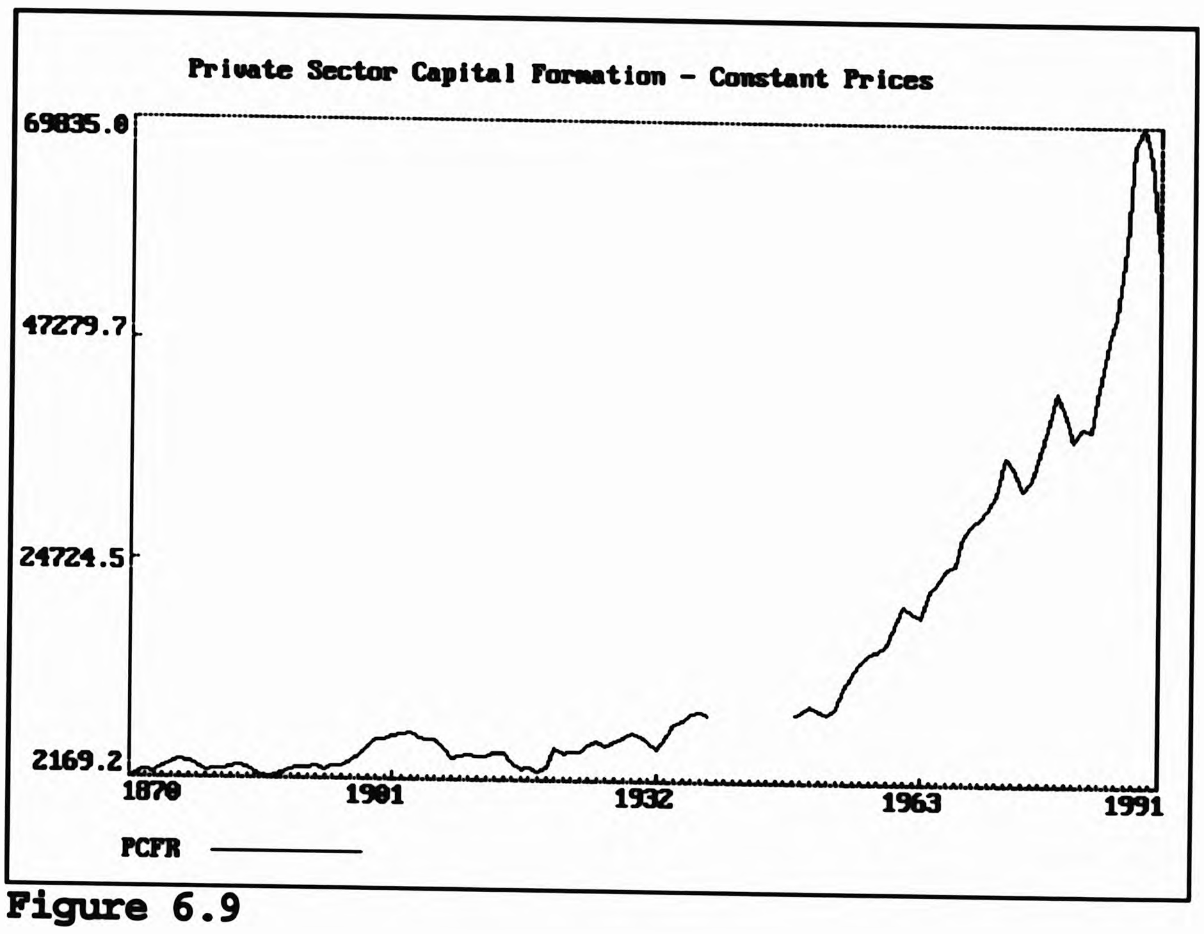

Figure 6.9

Private sector portfolio adjustment covers the gross movement of funds in and out of Building Societies, National Savings, Unit Trusts, together with mortgage advances and repayments, and an estimate of the turnover of securities, both ordinary shares and government gilts. The corresponding sub total is:

PORTA = BSDEP + BSWITH + BSDEPREC + BSDEPWITH + NSDEP
+ NSWITH + UTDEP + UTWITH + BSAD + MORTR + MORTI
+ TOSECRORD + TOSECRGIL (6.10)

where BSDEP = Building Society shares subscribed (deposits), BSWITH = Building Society shares withdrawn (including interest), BSDEPREC = Building Society deposits received, BSDEPWITH = Building Society deposits withdrawn (including interest), NSDEP = National Savings Deposits, NSWITH = National Savings withdrawals, UTDEP = Unit Trust deposits, UTWITH = Unit Trust withdrawals, BSAD = mortgage Advances (Building Societies), MORTR

= Mortgage repayments of principal, MORTI = mortgage interest, TOSECRORD = turnover securities (ordinary shares), TOSECRGIL = turnover securities (government gilts).

There is some doubt as to whether these financial transactions constitute demand for money or if they are just the placement of temporary idle balances. Indeed, many involve banks, and the money they use in completing their business may not be part of the money supply. Furthermore, many of these transactions take place in a restricted and very well organized market place with special payment techniques. As Keynes (1930, p.41) and Garvy and Blyn (1970, p.46) point out, such technology allows a large turnover on relatively small balances. This leads to the transactions velocity of circulation being much larger than in other cases.

Private sector portfolio adjustment shows little variation until 1963, as shown in figure 6.10. There was cyclical behaviour around a slight upward trend for the next twenty years. However, major structural changes took place in the financial markets during the 1980s. Traditionally the Building Societies had collected savings from members and provided mortgages to owner occupiers. The Building Society Act of 1986 broadened the range of financial services that they were allowed to undertake. This led to increased activity in estate agency, insurance broking, fund management and financial advice. The booming housing market of the late 1980s acted as a catalyst to these changes and this led to rapid growth. There were also large reforms on the London

Stock and Securities markets during this period. These were introduced on Monday 27th October 1986, known commonly as "Big Bang". These changes embraced advancements in computer technology, and led to large new market makers being created, usually by merging broking and jobbing firms and sometimes with banks. Many overseas banks and finance houses also saw this as a unique opportunity to enter the London security markets. The new arrangements attracted new capital into the market, and there was a large increase in turnover, especially foreign securities, in what was already a rising market. However, in October 1987 share prices and turnover fell dramatically. The renaissance of the Building Societies and the financial markets led to all but one of the components of PORTAR to behave in a similar manner, that is growing very quickly until 1987 and then falling spectacularly. The one exception is National Savings. These peak in 1973 and then fall quickly before settling at a fairly constant level. It is also of interest to note the peaks in National Savings deposits during the two world wars.

This completes the framework used to construct total transactions and its three component, current transactions, transfers, and asset and portfolio adjustment. With the model at hand it is possible to consider the empirical evidence for the United Kingdom for the period 1870-1991 as a whole.

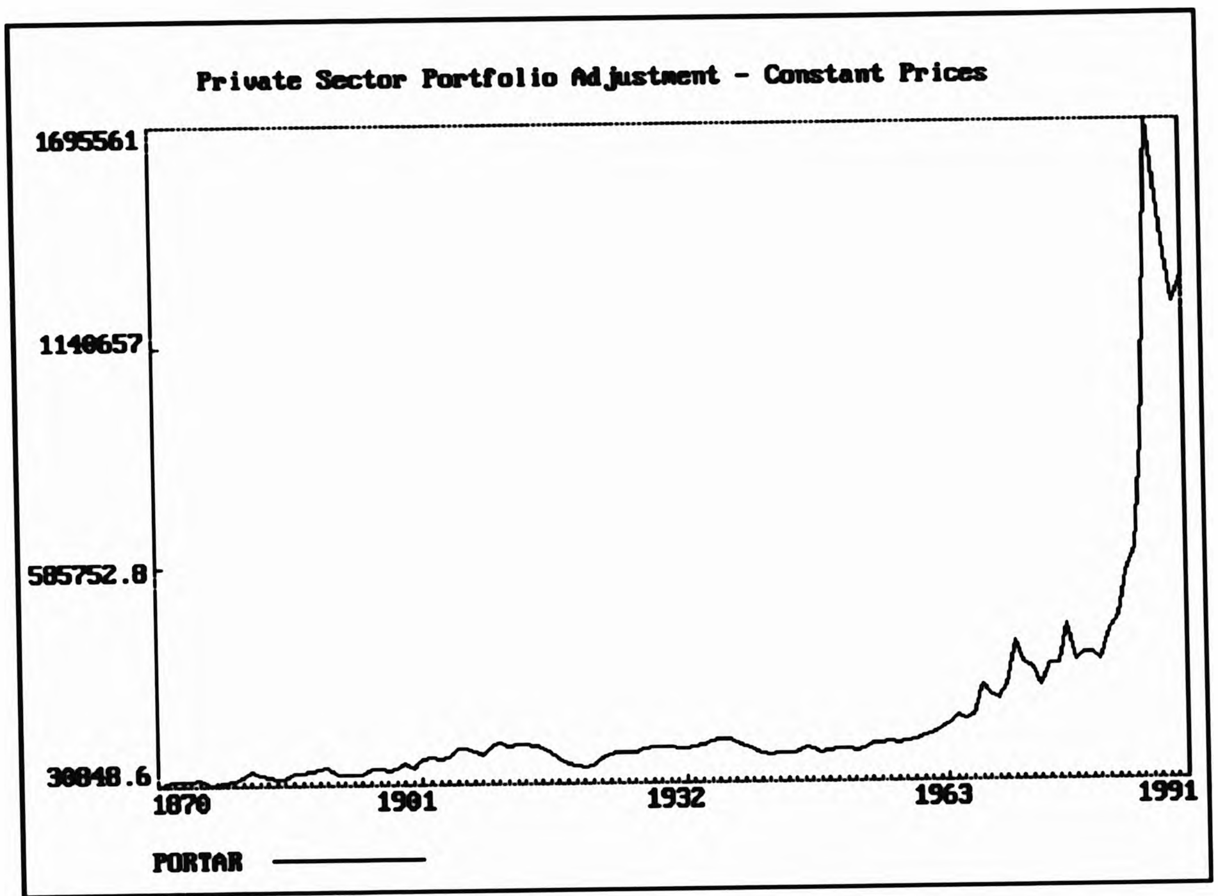

Figure 6.10

6.7 The Composition of Total transactions

The total transactions variable generated by the framework outlined above is shown in terms of constant prices in figure 6.11. This graph by itself is not very informative. Illustrating that, for the most part, total transactions in real terms have risen throughout the sample period until latter years. There is a moderate trend until the Second World War, followed by a more pronounced one during the 1960s and 1970s, and a very steep upward trend in the 1980s. The major exception to the rule is the period of depression in the mid 1920s.

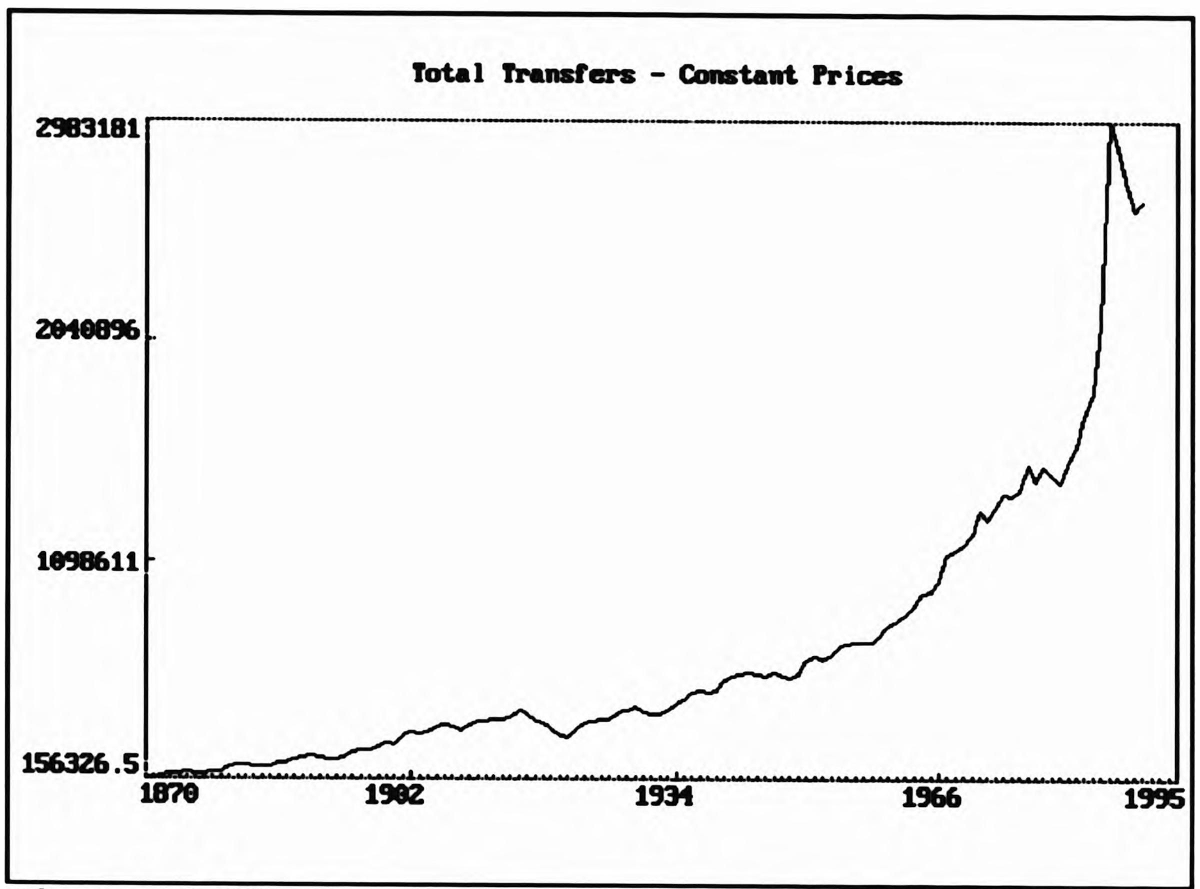

Figure 6.11

Of more interest are the ratios of the various categories of transactions to all transactions. Current transactions as a ratio to total transactions is illustrated in figure 6.12. In 1870, 76% of total transactions were accounted for by current transactions. This fluctuated around a constant mean until the turn of the century when it fell to approximately 60%. At this point, with the exception of the First World War, it remained until hostilities broke out against Nazi Germany in 1939, when the ratio rose steeply. The 1950s and early 1960s saw a gradual decline in current transactions associated with production compared with transfers, and asset and portfolio adjustment components. In the late 1960s and early 1970s the ratio stabilized around a value of approximately 58%. However, the early 1980s saw a rapid decline to 31% in 1987, after which a slight recovery took place.

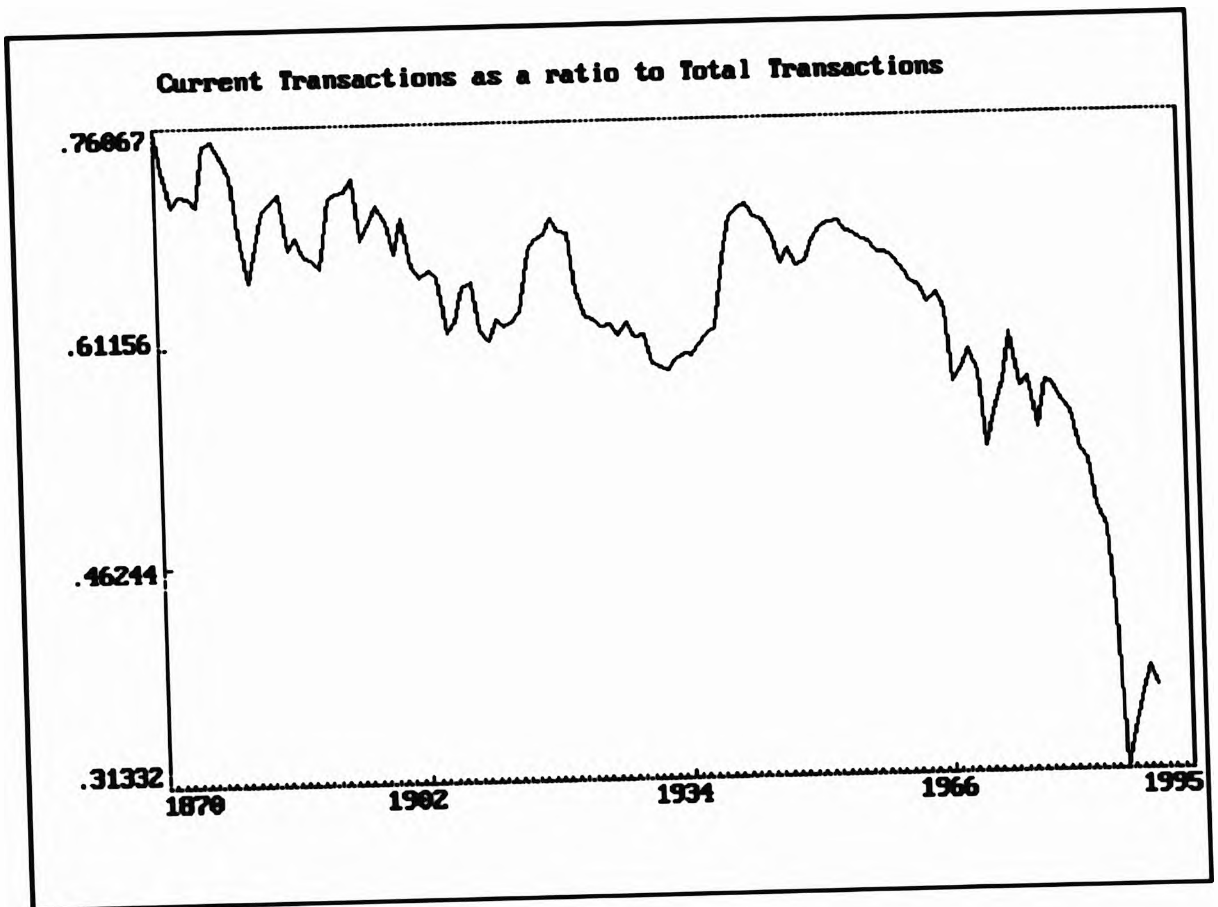

Figure 6.12

The ratio of transfer transactions to total transactions is portrayed in figure 6.13.

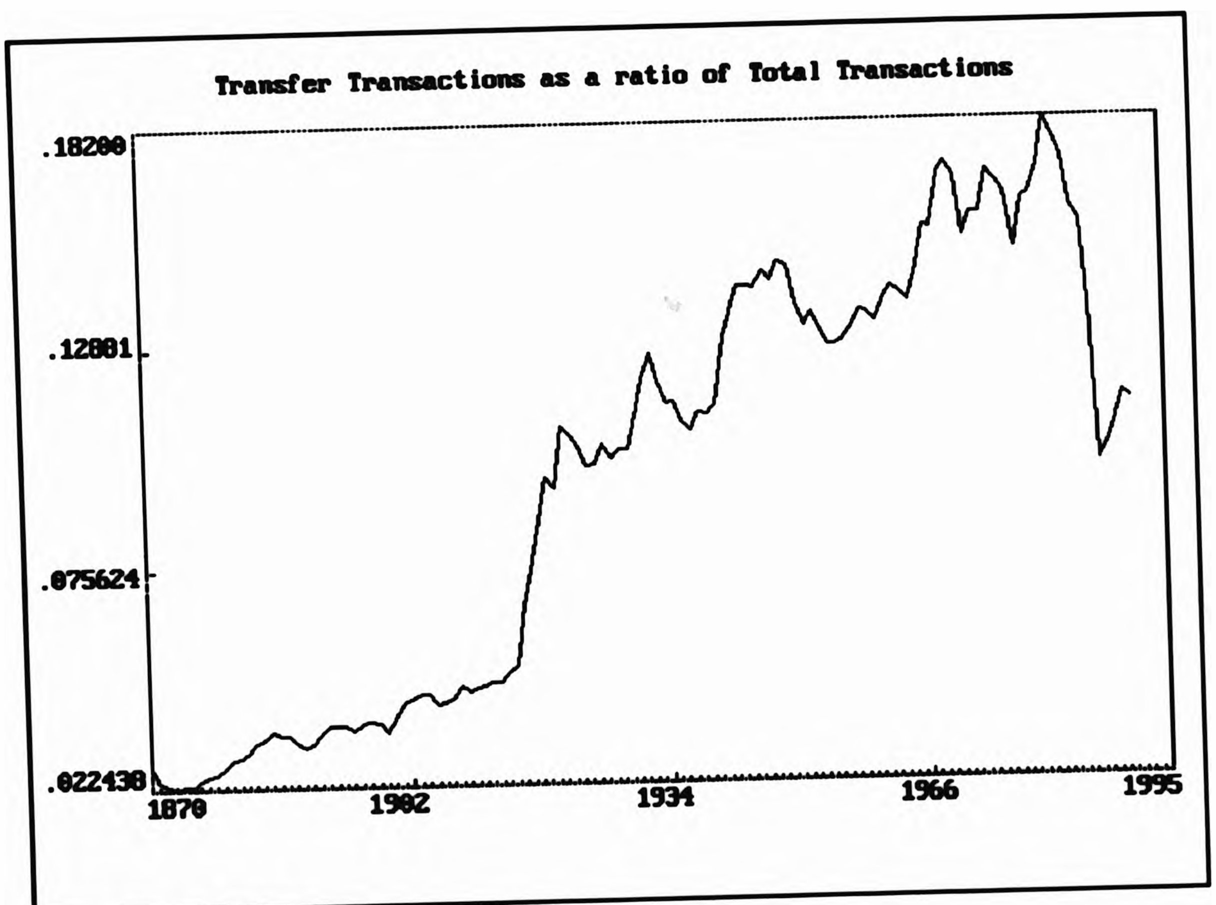

Figure 6.13

Transfer transactions made up only 2% of total transactions in 1870. This rose slowly during the nineteenth and early twentieth centuries. A major increase took place at the start of the first world war, after which an upward trend was followed until the mid 1960s. This whole period corresponded with greater government intervention in the economy and the establishment of the welfare state. A notable deviation above trend being the years of the second world war. The ratio stabilized in the 1970s, before reaching a peak of 18%. The early Thatcher era saw a steep decline in transfers compared with earlier years.

The final ratio of interest is that between asset and portfolio adjustment and total transactions. This is shown in figure 6.14.

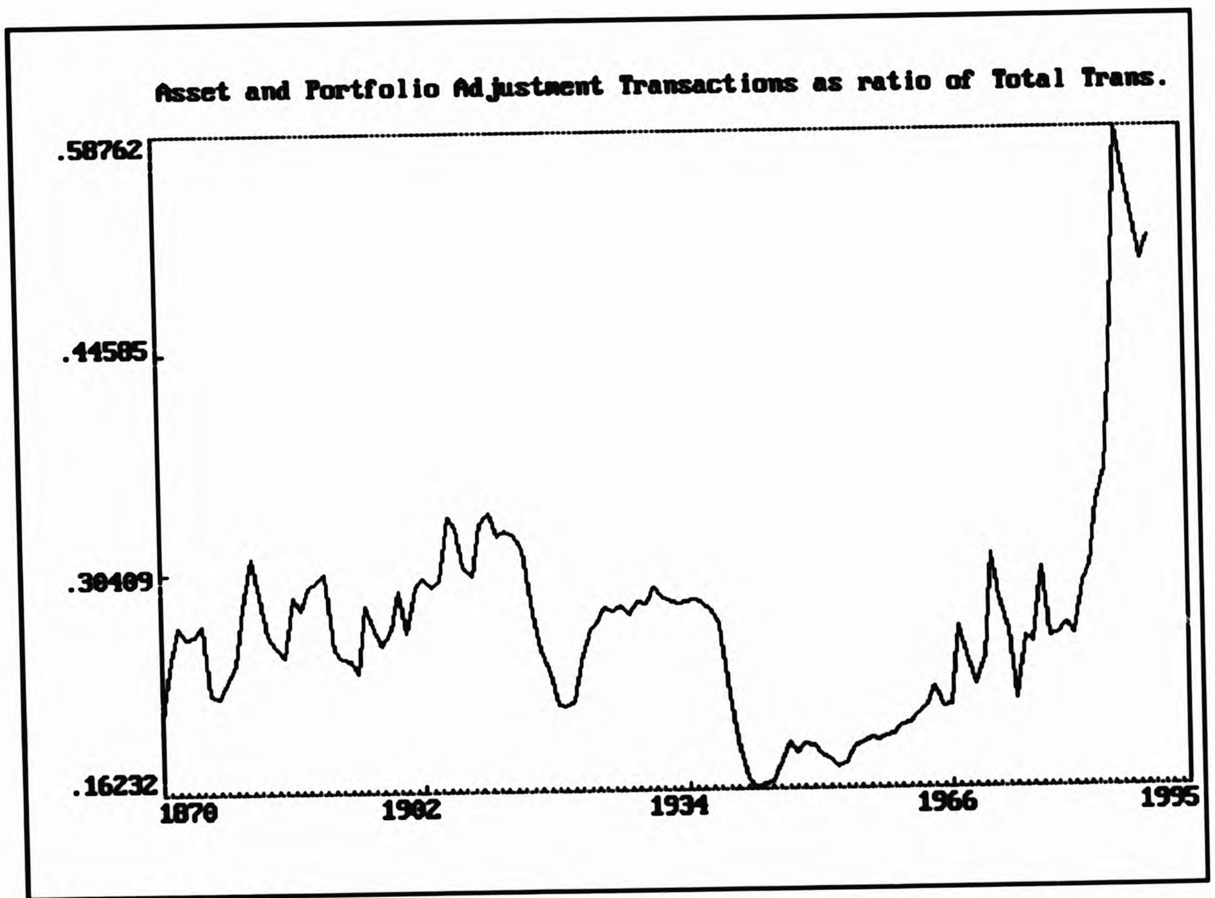

Figure 6.14

This ratio varies around a constant mean of approximately 29% between 1870 and 1939. The major exception being the Great Depression of the 1920s. There is a slow recovery after the Second World War, followed by a period of some stability. However, there is a very steep increase in the ratio during the late 1980s, followed by a moderate decline. This period corresponding with the Lawson "boom" and "bust", together with major technological changes to the financial markets in the City. Indeed, in 1987, 58% of all transactions were in the asset and portfolio adjustment category. Perhaps reinforcing Keynes (1930) concerns of whether financial transactions should be included in the total, when this is distorted so badly by their inclusion.

6.8 Is Income a good proxy for transactions ?

As we discussed earlier, the transactions variable is much neglected in modern macroeconomic and monetary theory. The demand for money is customarily related to income. However, since one of the prime uses of money is a means of payment, one could argue that income is the incorrect variable to use, unless there is a strong correlation between itself and transactions. Cramer (1981b) points out, that if income is used instead of transactions in the definition of velocity, then there must be an additional assumption arising from the identity:

$$\frac{\text{National Income}}{\text{Money Stock}} = \frac{\text{National Income}}{\text{Transactions}} \times \frac{\text{Transactions}}{\text{Money Stock}} \qquad (6.11)$$

The left hand side of this equation is of course income velocity. Its movement may be caused by either of the terms on the right hand side. However, it is usual that these are attributed to the second term. The assumption being made that the income-transactions ratio is a constant. Nevertheless, this is not necessarily the case. Whether or not this is true is an empirical issue. A plot of the income-transactions ratio is illustrated in figure 6.15.

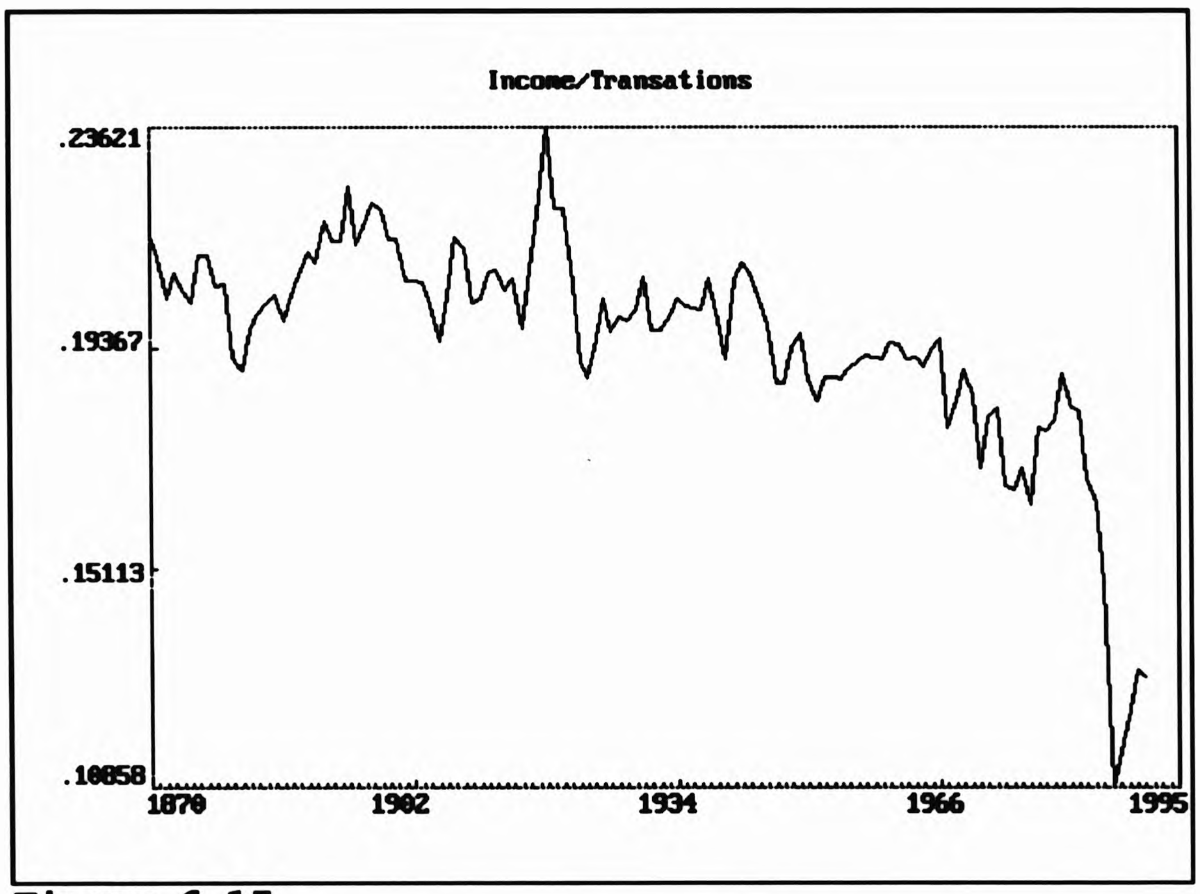

Figure 6.15

The income-transactions ratio fluctuates around a constant mean between 1870 and 1939. The only exception being in the early 1920s. After the second world war the ratio for the most part begins a gentle decline. There follows a sharp rise in the mid 1970s. The behaviour of the ratio in the 1980s is characterised by a dramatic fall when transactions rose much quicker than income followed by a mild recovery.

More formally it is possible to test, following Cramer (1981b), the relationship between transactions and income by estimating the relationship:

$$\ln T = \alpha + \beta \ln Y \qquad (6.12)$$

where T = total transactions (current prices) and Y = income (current prices). Using data for the whole sample period gave the following results:

Ordinary Least Squares

1870-1991

$$\ln T = \underset{(33.7263)}{1.1609} + \underset{(277.8012)}{1.0541} \ln Y \qquad (6.13)$$

$R^2 = 0.99843$ s.e. = 0.07513
n = 122
k = 1
D.W. = 0.39659 [$d_L = 1.522$ $d_U = 1.562$ $(4-d_U) = 2.438$]
$t_{90} = 1.980$
$t_{95} = 1.658$
$F_1(1,119) = 209.3010$ [3.92]
$F_2(1,119) = 41.9021$ [3.92]
$\chi^2(2) = 256.2962$ [5.991]
$F_3(1,120) = 31.9642$ [3.92]

The correlation coefficient between T and Y over the period 1870-1991 is very high at 0.99843. Nevertheless, this may in part be due to the effect of price inflation which both variables have in common. To test for this possible problem, the equation was examined again using transactions and national income measured in constant prices. While the parameters differ in size, the characteristics of the relationship are much the same, and so are not reported. This is similar to the conclusion reached by Cramer (1981b). The slope coefficient of equation (6.13) is approximately one, and the constant close to log (3.19) which is 1.1600. This result being remarkably similar to the parameter value of 3.20 found by Cramer (1981a) for the period 1968-1977.

However, the reported equation has a number of problems. The Durbin Watson statistic is smaller than the corresponding critical value d_L which suggests positive autocorrelation. This is confirmed by the Lagrange multiplier test for serial correlation, $F_1(1,119) = 209.3010$ [3.92]. It also fails the test for normality $\chi^2(2) = 256.2962$ [5.991] which also puts in doubt the reliability of all the classical tests, as these are based on the assumption of normality. So although it would appear that tests for functional form (F_2) and heteroscedasticity (F_3) fail, their reliability is unclear. Furthermore, while the R^2 suggests a high percentage of transactions are explained by income, if one looks at the residuals, figure 6.16, there are a number of outliers.

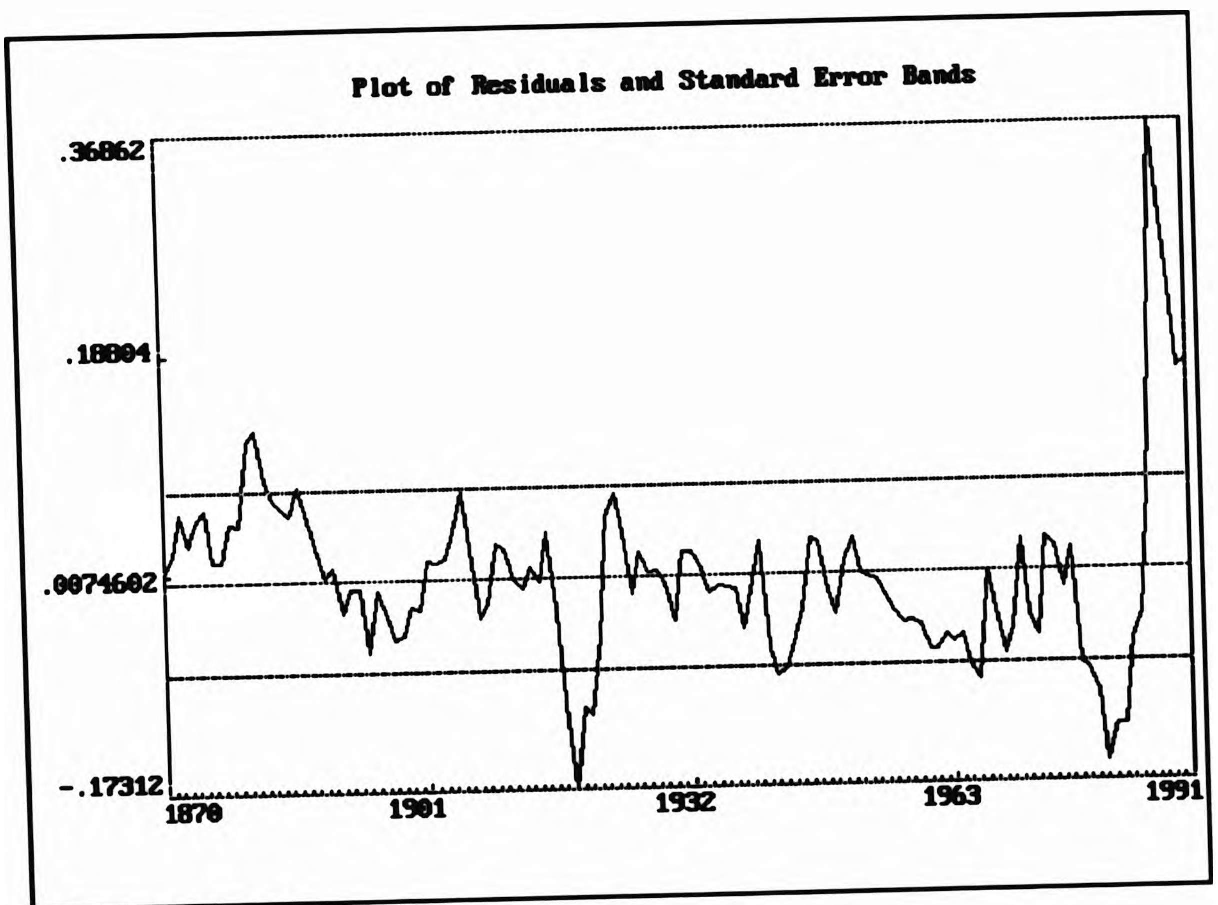

Figure 6.16

Those of most interest are 1880-1887, 1917-1920, 1978-1983 and 1986-1991. These groups also correspond with periods where transactions and income diverged in their behaviour. Between 1879 and 1881 total transactions grew much faster than income, as illustrated in figure 6.17.

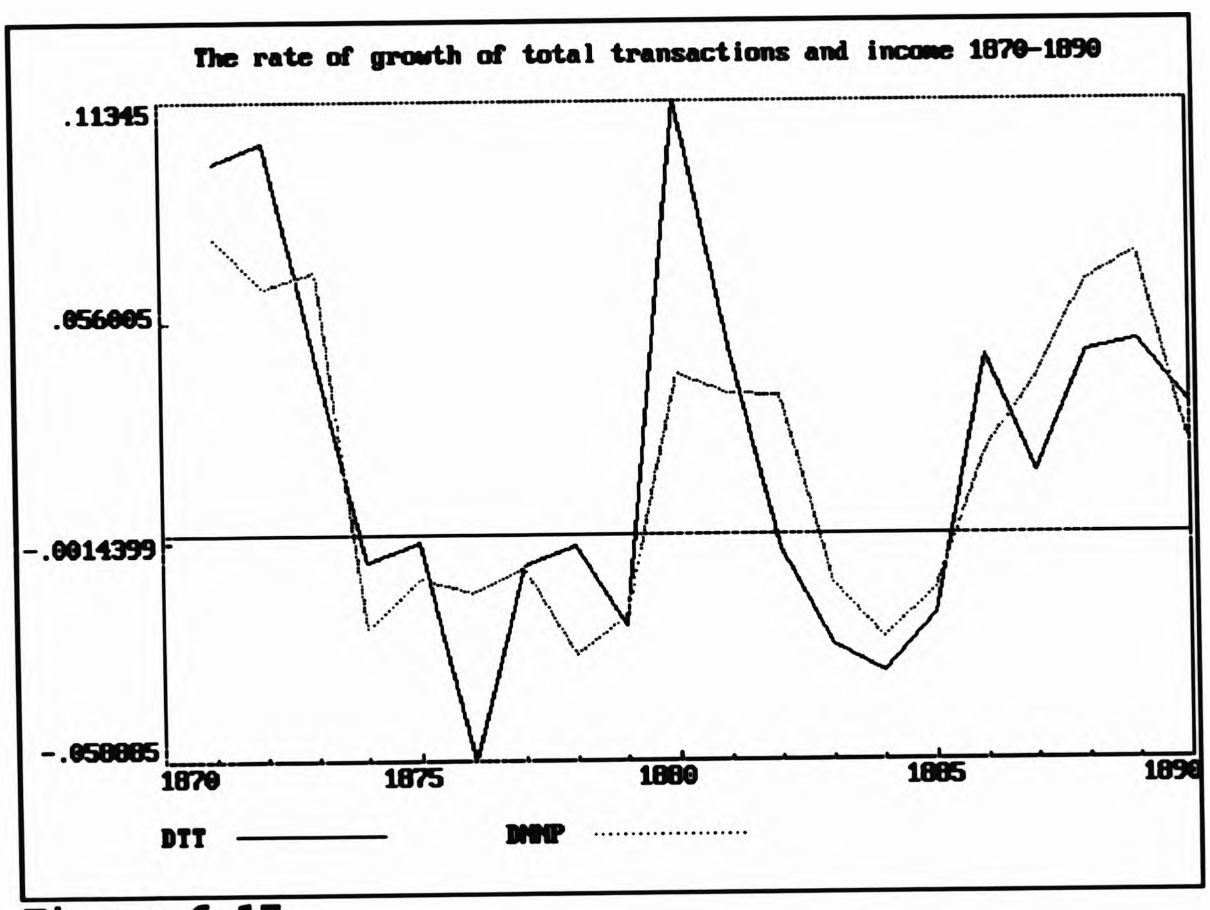

Figure 6.17

By considering a graph of the rates of growth of the three components of total transactions, figure 6.18, it is clear that much of this deviation is brought about by asset and portfolio adjustment (DSAPA). While the obvious conclusion is that this is due to high activity in financial transactions, this is probably not the case. For the early 1880s were a period when Life Assurance, Building Society and other innovative financial institutions were entering the data base for the first time, and this is a more likely scenario in explaining this distortion.

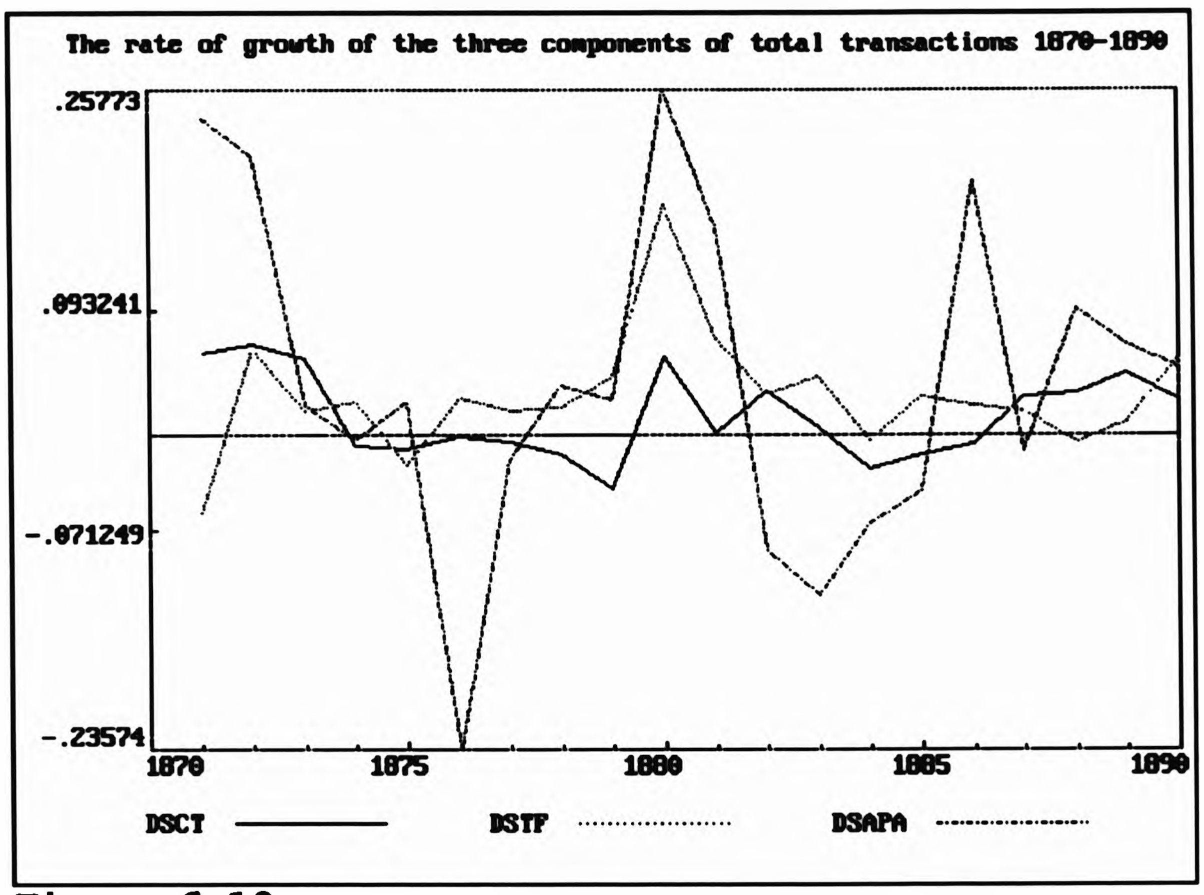

Figure 6.18

Another period of interest is that towards the end of the first world war, and immediately afterwards. Once again transactions increase more rapidly than income between 1916-1918, grows less rapidly in 1919 before matching income growth in 1920. This is shown in figure 6.19.

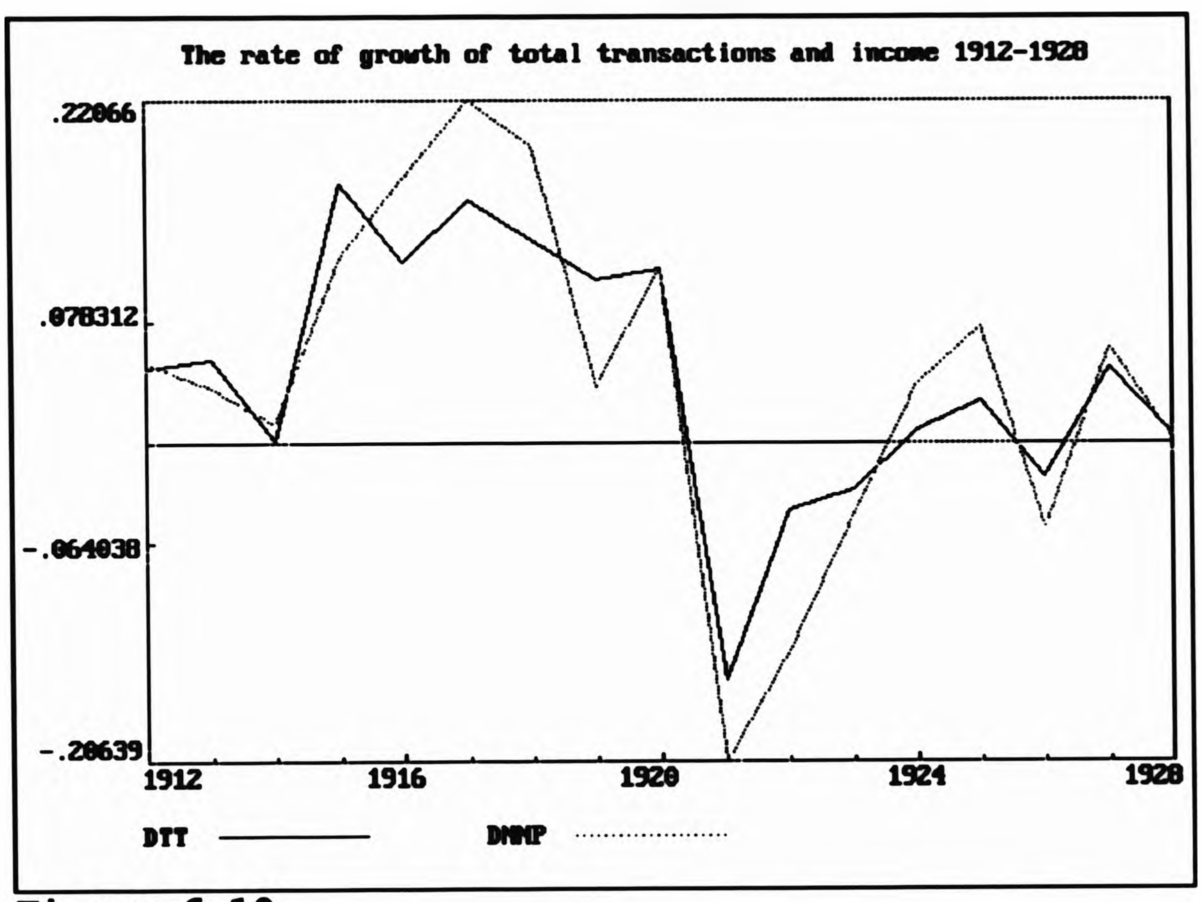

Figure 6.19

Closer analysis of the component parts of transactions indicates that transfers are the biggest contributor to this behaviour, as illustrated in figure 6.20. One must assume that the increase was due to the war effort and the introduction of the basic social security payments introduced by the Liberal government discussed earlier.

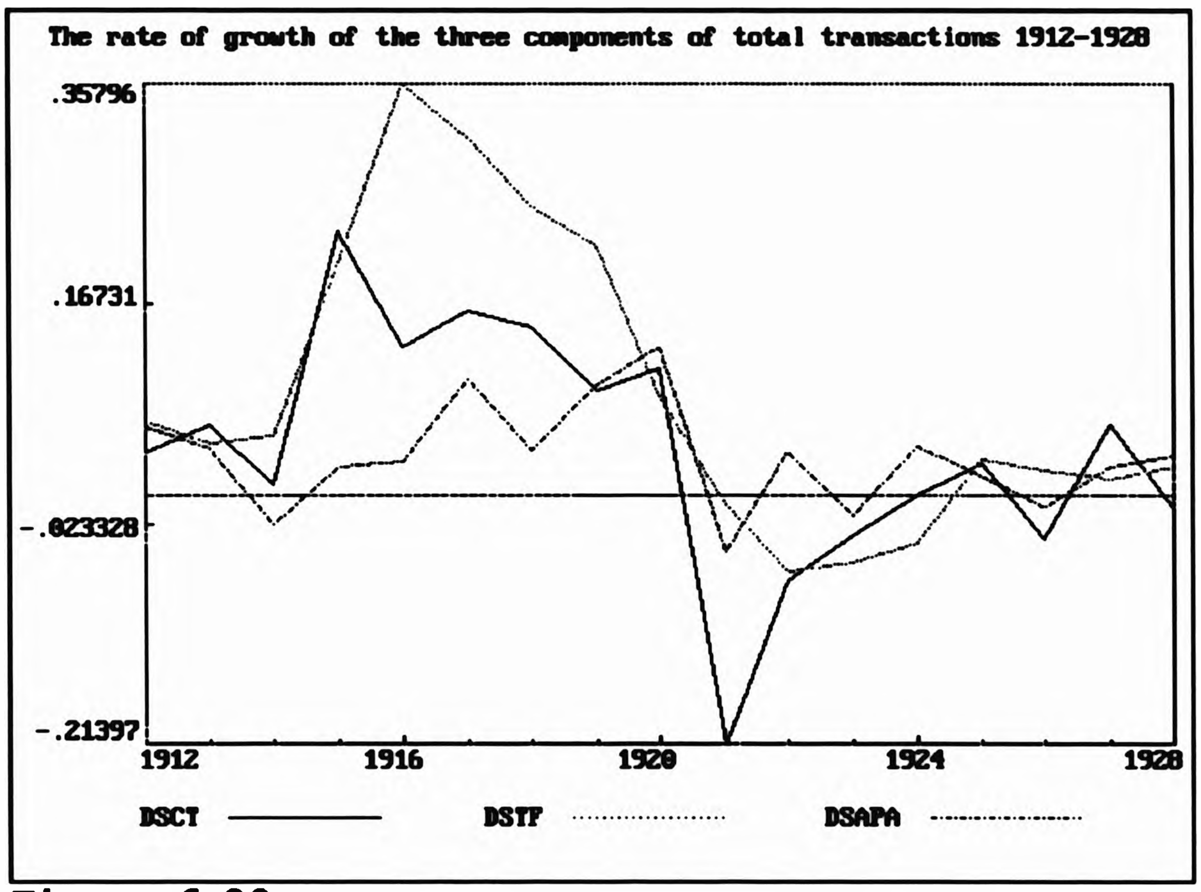

Figure 6.20

The final two groups of outliers, 1978-1983 and 1986-1991, can be considered together. In the first, income growth is fairly constant for the initial three years of the sub sample before declining. While there is great variation in transactions, as shown in figure 6.21. A similar situation occurs in 1986-1991, with income growing at a constant rate throughout, but with major swings in the rate of change of transactions.

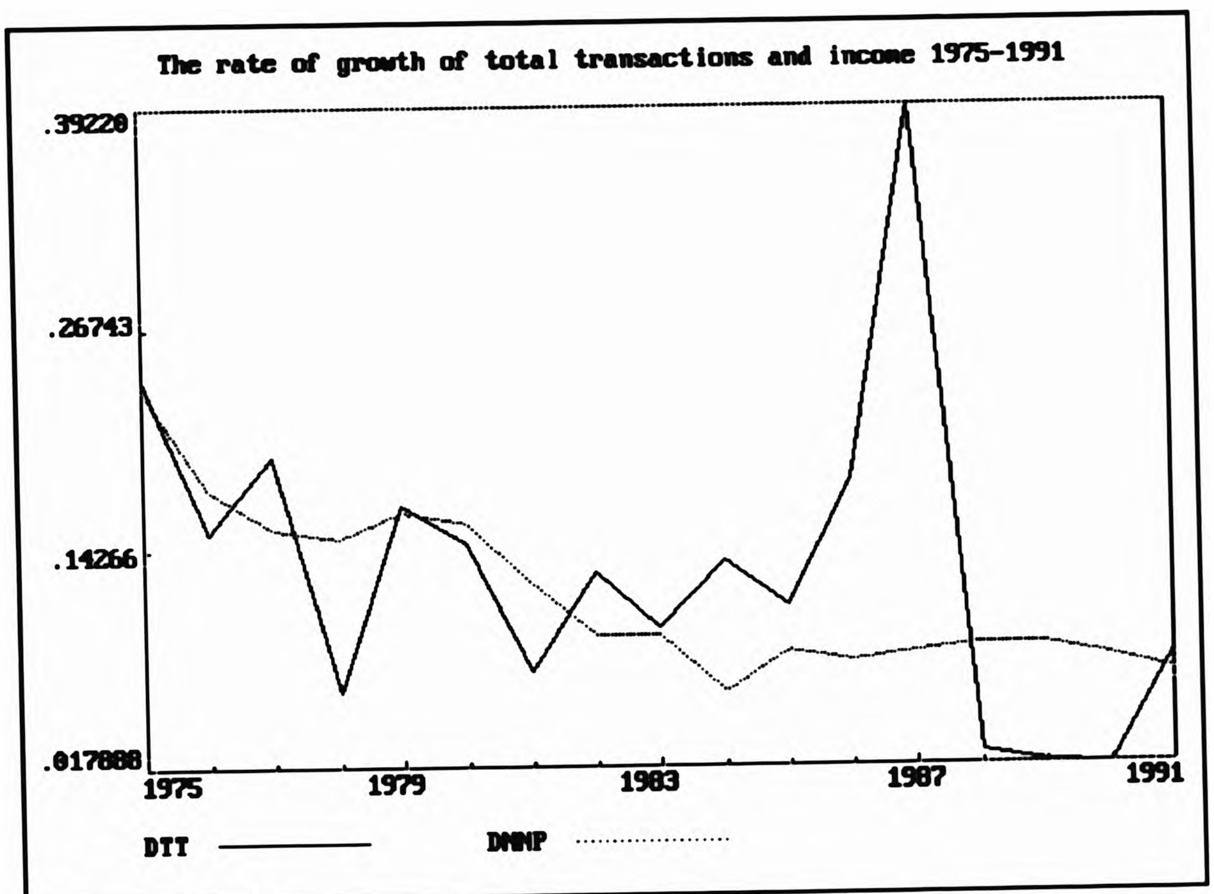

Figure 6.21

Comparison of the rates of growth of the three components of total transactions, figure 6.22, shows that in both sub samples it is the deviation of asset and portfolio adjustment which causes these variations, while the growth of current transactions and transfers are relatively stable.

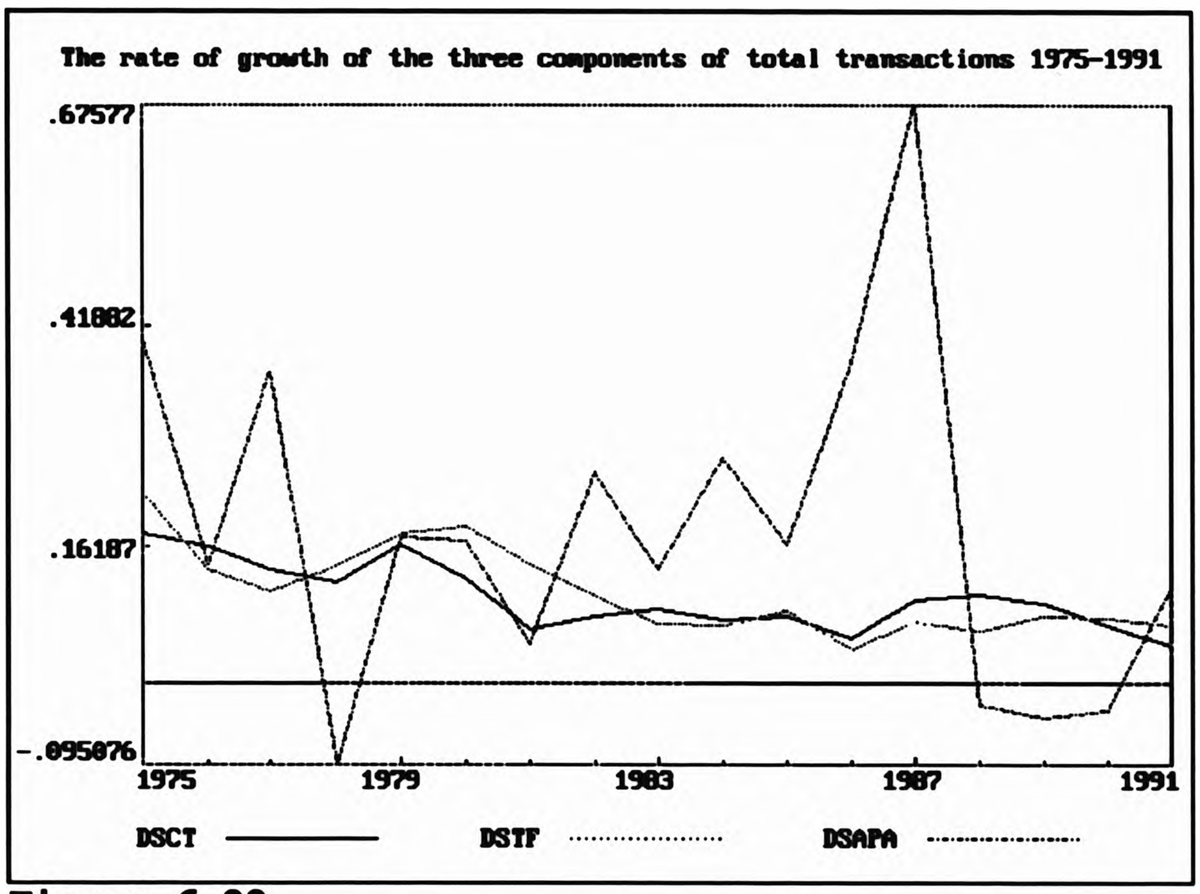

Figure 6.22

The large swings in asset and portfolio adjustment transactions are probably due to two factors. First, the short term influence of the "Lawson" boom and bust of the late 1980s, which in particular affected the housing market statistics. Second, the long term changes brought about by the deregulation of the financial markets and the resulting financial product innovations which took place at this time. The potential break down of the income transactions relationship is a subject we will return to in a moment.

To check parameter stability the regression was estimated recursively and the plots of the intercept and the coefficient on ln Y illustrated in figures 6.23 and 6.24.

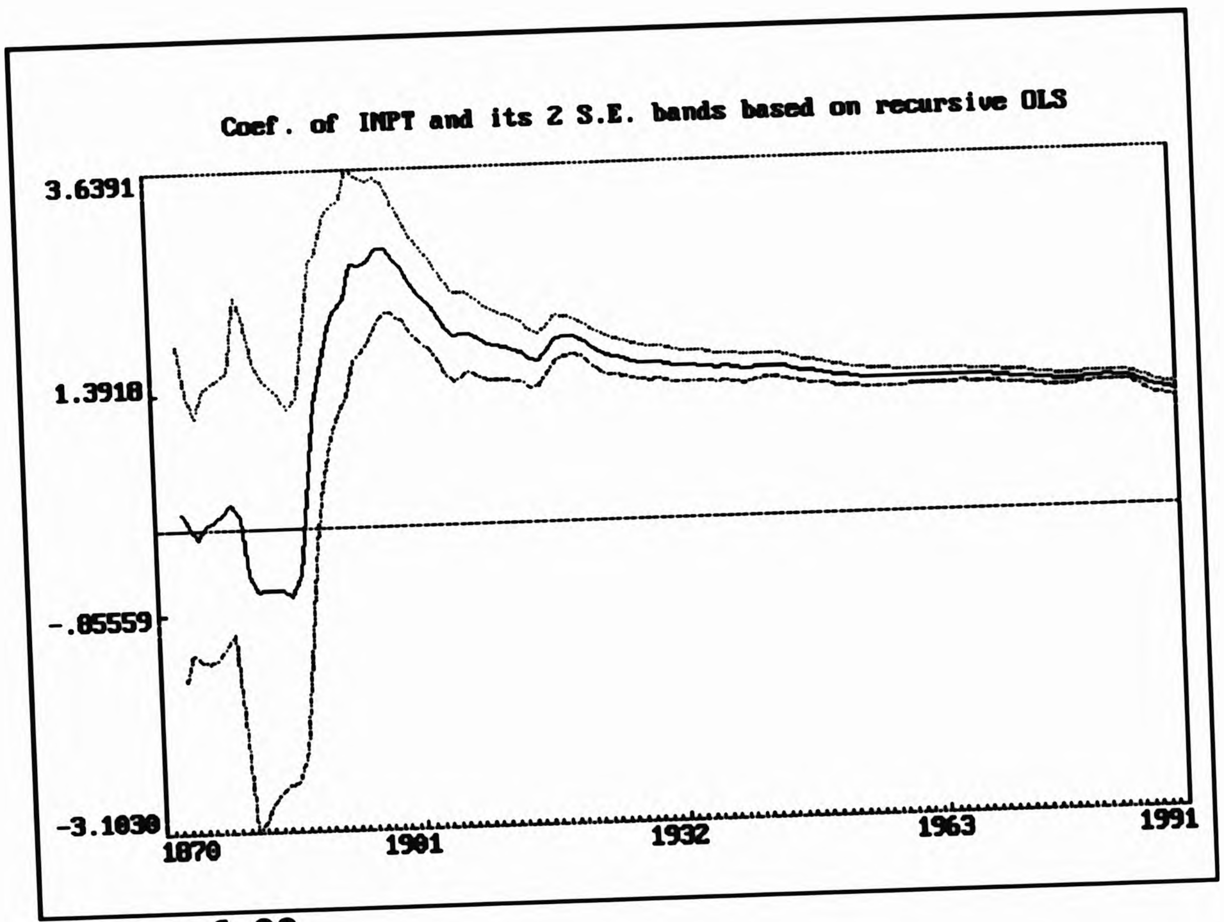

Figure 6.23

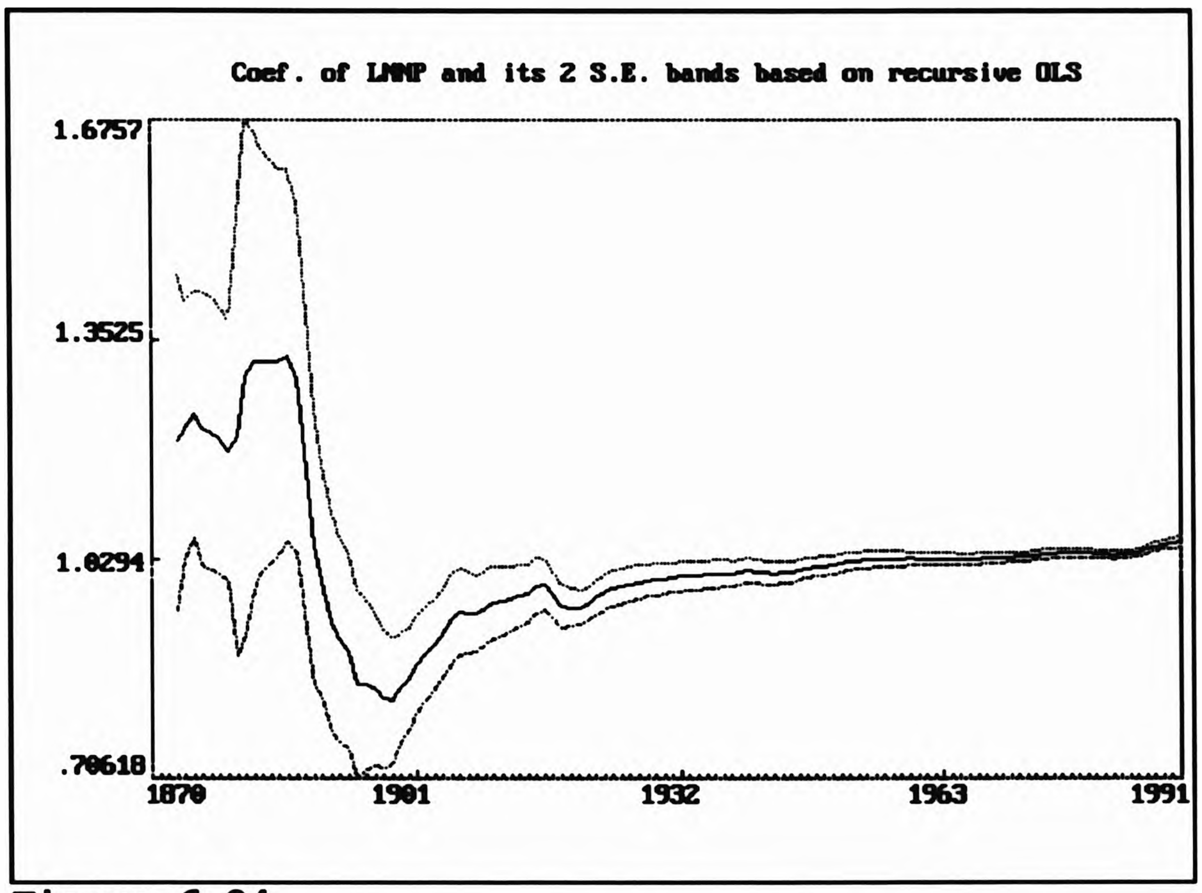

Figure 6.24

This suggets that the parameters are very unstable in the period before the first world war, but fairly stable thereafter. One of the main reasons for the early variation may be the less reliable transactions data in the nineteenth century.

Yet we must interpret these graphs with some caution given the problem of autocorrelation. It is possible to correct for this using the Cochrane-Orcutt method, as used in equation (6.14).

Cochrane-Orcutt Method AR(2) Converged after 1 iteration

1870-1991

$$\ln T = \underset{(12.8042)}{1.1504} + \underset{(108.4606)}{1.0556} \ln Y \qquad (6.14)$$

$R^2 = 0.99943$ s.e. $= 0.04528$
$n = 122$
$k = 1$
D.W. $= 1.9727$ [$d_L = 1.522$ $d_U = 1.562$ $(4-d_U) = 2.438$]
$t_{90} = 1.980$
$t_{95} = 1.658$

Parameters of the Autoregressive Error Specification

$$U = \underset{(10.4811)}{0.95939}\, U_{t-1} - \underset{(1.9978)}{0.18755}\, U_{t-2}$$

It is interesting to note that the parameters vary only very slightly from the original regression (6.13) when the Cochrane-Orcutt technique is applied.

One pertinent question is whether the relationship between income and transactions significantly changed in the late 1980s. A method of testing for this is to reconsider equation (6.13) for the period 1870-1979, the year that Thatcher came to power, and to use these results to forecast transactions for the following twelve years to 1991. This gave the following results:

Ordinary Least Squares

1870-1979

$$\ln T = 1.2955 + 1.0375 \ln Y \qquad (6.15)$$
$$(49.6374) \quad (341.5188)$$

$R^2 = 0.99907$ s.e. $= 0.04338$
$n = 110$
$k = 1$
D.W. $= 0.67809$ [$d_L = 1.522$ $d_U = 1.562$ $(4-d_U) = 2.438$]
$t_{90} = 1.980$
$t_{95} = 1.658$
$F_1(1,119) = 82.7538$ [3.94]
$F_2(1,119) = 11.5333$ [3.94]
$\chi^2(2) = 15.5015$ [5.991]
$F_3(1,120) = 0.0060205$ [3.92]
$F_4(12,108) = 21.0003$ [1.85]
$F_5(2,118) = 61.1547$ [3.09]

Two diagnostic tests are of most interest, F_4, Chow's second test of adequacy of predictions, and F_5, Chow's test of the stability of the regression coefficients. Both tests fail, putting aside concerns about normality, in the case of equation (6.15), and this suggests poor predictive performance for the period 1979-1991, which is confirmed by figure 6.25. The forecast is very good up until 1985. However, after that point actual transactions exceeds the forecast by a large amount. Nevertheless, a lack of future observations makes it impossible to discuss whether this is an irreconcilable break down of the income/transactions relationship or a temporary disturbance.

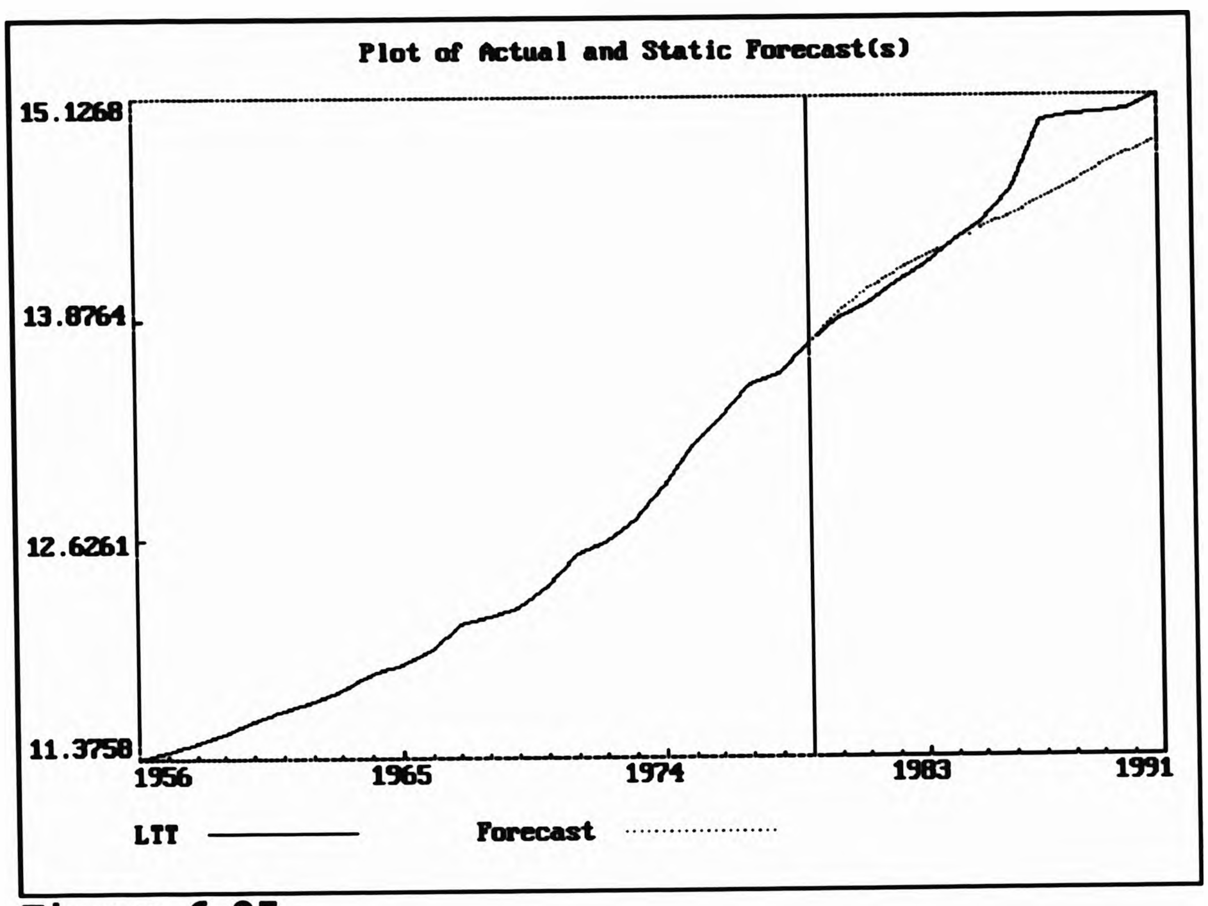

Figure 6.25

Nevertheless, there are still a number of statistical problems with equation (6.15), the main one remains autocorrelation. This was corrected once again using the Cochrane-Orcutt technique, which gave the following results:

Cochrane-Orcutt Method AR(1) Converged after 2 iterations

1870-1979

$$\ln T = 1.3282 + 1.0337 \ln Y \quad (6.16)$$
$$(22.8739) \quad (155.0922)$$

$R^2 = 0.99946$ s.e. $= 0.03280$
$n = 110$
$k = 1$
D.W. $= 1.8117$ [$d_L = 1.522$ $d_U = 1.562$ $(4\text{-}d_U) = 2.438$]
$t_{90} = 1.980$
$t_{95} = 1.658$

Parameters of the Autoregressive Error Specification

$$U = 0.66676\ U_{t-1}$$
$$(9.1255)$$

Once again equation (6.16) gives very similar results to equation (6.15).

The overall conclusion from the statistical results are that, for the most part, total transactions are proportional to income. As Cramer (1981b) suggests;

" .... this is largely fortuitous since it is the result of compensating movements in otherwise unrelated components of the total. It is not due to the predominance of current transactions commonly associated with income generation."

(Cramer, 1981b, p.309)

However, while these results suggest that T and Y are very similar, they are not identical, and there are a number of periods where the two series diverge, albeit briefly, except in the case of the late 1980s. In consequence it is important to test both income and transactions velocity in our empirical work.

6.9 Conclusion

The substitution of income velocity for transactions velocity has become prevalent in modern literature. This replacement is only acceptable if there is a strong and stable relationship between the two series. However, investigation of this problem has always been frustrated by the lack of a reliable source for transactions data. This chapter has attempted to construct such a series using Cramer's (1981a) framework. Nevertheless, it can at best, only be considered a rough estimate of the order of magnitude of transactions. For there are numerous measurement problems, leading to assumptions and a great amount of extrapolation and interpolation. Given these reservations, it provides a number of interesting insights into transactions behaviour in the United Kingdom. These include the major changes which have taken place in the composition of total transactions between its three main components, current, transfer, and asset and portfolio adjustment, over the last century. There also appears to be a stable relationship between transactions and income, at least until the late 1980s, although major deviations can occur. Whether this relationship is close enough to allow simple substitution is a matter for debate.

Chapter 7

The Long-run Relationship

7.1 Introduction

The review of monetary theory concerning the determinants of velocity identified two distinct groups of variables. Those which are associated with long-run behaviour, in particular institutional change, and a second collection which have a short run impact. In addition two contrasting views of velocity behaviour were recognized. On the one hand, the monetarist view of a stable function of a few variables, including the opportunity cost of holding money or alternative assets, and permanent income. On the other hand, the alternative theory, that velocity follows a random walk. In line with Keynes's view that velocity is, for the most part, volatile and depends on the structure of banking, industrial practices, social habits, the distribution of income, and the effective cost of holding idle balances. The concept of cointegration is ideal in embracing and testing these arguments, as the model can be separated into long and short term elements. This chapter concerns itself with the long run relationship, the next uses the error correction term generated here, to build a short run dynamic model.

7.2 The Long-run Model

The review of previous economic literature found four types of determinants in the long term; the traditional ones, wealth and interest rates; the institutional factors, those associated with monetization and financial development of a nation's economic infrastructure[1]. In consequence the long run model can be written in general terms as;

Velocity = f (interest rates, wealth, monetization, financial sophistication)

Once the proposed model is identified, the first task is to consider each variables definition, measurement, together with an interpretation of their behaviour in the United Kingdom for the period of interest 1870-1991.

Holding money has a certain opportunity cost, for money is just one way that an economic agent can hold their liquid wealth. Indeed, an individual may have a whole portfolio of assets each with different returns. In the traditional sense holding money has no return, therefore, as rates of return increase on alternative assets money is moved into these alternatives. As this takes place velocity is expected to rise. Following Bordo and Jonung (1987), the long term interest rate (RL) is measured by the rate of interest on consols (2.5%), as illustrated pictorially in figure 7.1. Lathane (1954,1960) suggests that movements in long term interest rates are the main determinant of long run movements in velocity. Throughout the nineteenth and early twentieth centuries the rate of interest on consols was low. After 1910 they rose rapidly, reaching 5.32% in 1920. Between 1921 and 1947 RL for the most part declined. In the twenty five years following the Second World War, long term interest rates moved in an upward trend, reaching a peak of 13.01% in 1981, after which they fell back, levelling off at around 9%, until the late 1980's.

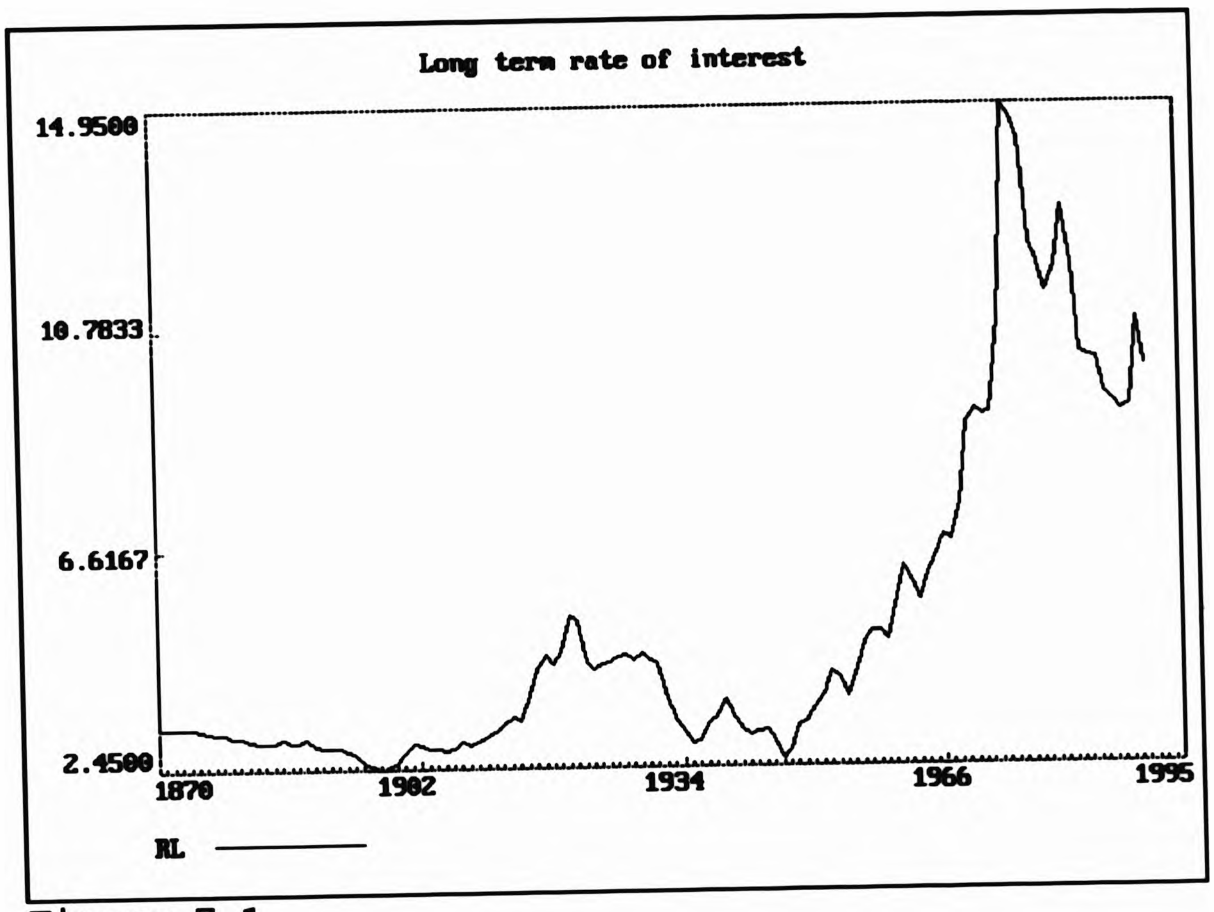

Figure 7.1

Klein (1974a and 1974b) suggests that studies in the demand for money that ignore the own rate of return on money, for instance seven day deposit accounts, underestimate the sensitivity of the demand for money to the opportunity cost of holding it. When market interest rates rise, so does the own rate of return on money. Therefore, the interest differential between money and alternative assets alters less than the value of market interest rates. The observed change in velocity under such circumstances should be attributed to the relatively smaller change in interest differentials, rather than the larger changes in the overall level of interest rates. In calculating the own rate of interest on money (ROWN), we follow Klien (1974b). This variable is constructed as:

ROWN = (1-H/CWM3) RS (7.1)

where H = the stock of high powered money, consisting of currency held by the public (C), plus reserves of the commercial banks (BRES). CWM3 = the money stock M3 (Capie and Webber definition), RS = the short term interest rate, measured by the Prime Bank Bill Rate. The own rate of return on money is illustrated in figure 7.2. It will be recalled from our earlier discussion that ROWN will enter the velocity function with a negative sign.

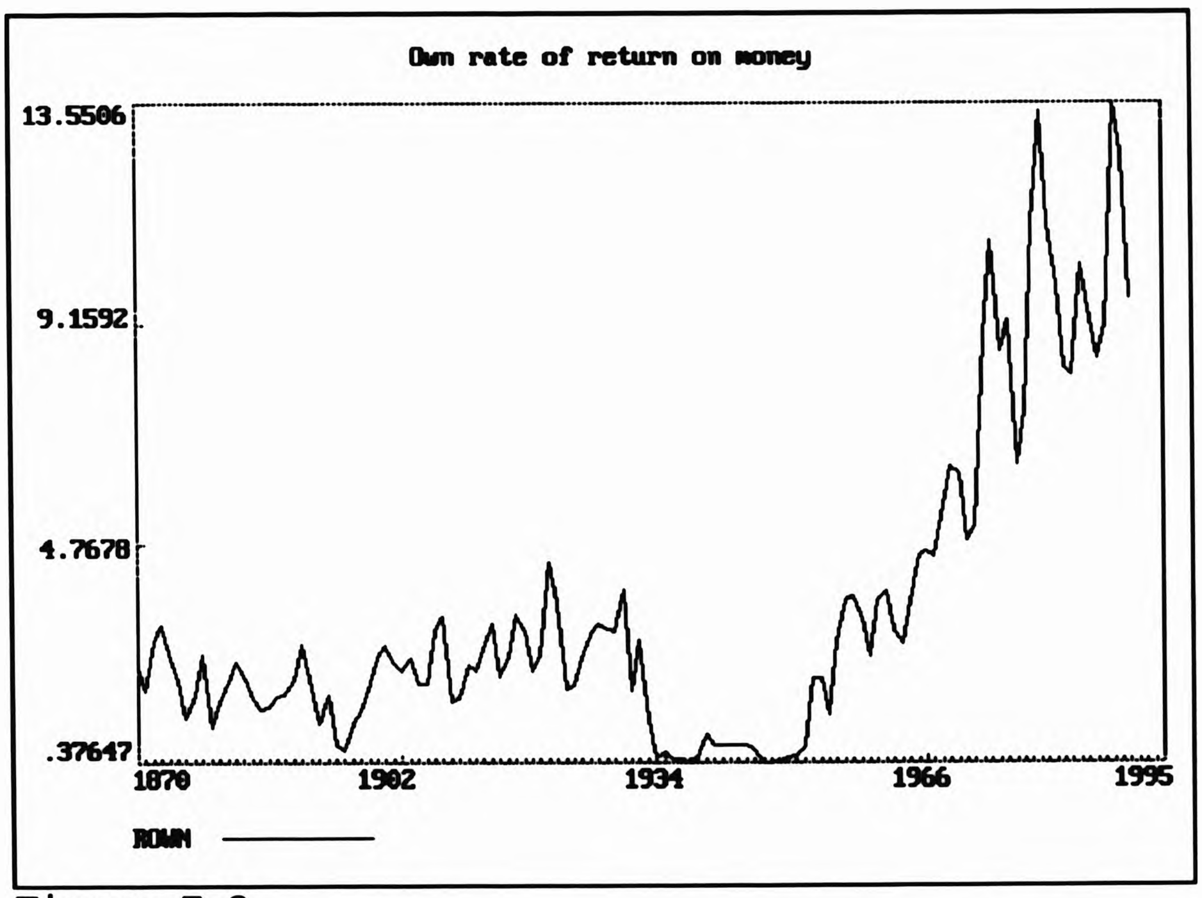

Figure 7.2

The own rate of return on money is cyclical around a fairly constant mean between 1870 and 1933. The period 1934-1950 sees the variable follow a low of approximately 3.7%. In the post Second World War period it is cyclical around a steep upward trend.

Friedman (1959) concludes from his empirical work that the main determinant of the demand for money is permanent income, that is an average expected future income. In order to generate real per capita permanent income (PIM), we adjusted real per capita income (Y/PN) using Friedman's (1957) weights and accounted for the long term growth rate of real per capita income 1870-1991 of 1.42%. The formula used was:

$$\left(\frac{Y}{PN}\right)_t^P = \frac{\beta}{\beta-\alpha}\left[w_1\left(\frac{Y}{PN}\right)_t + w_2\left(\frac{Y}{PN}\right)_{t-1}^P\right] \qquad (7.2)$$

The permanent income series was generated using α = 0.0142, β = 0.4, w_1 = 0.32968 and w_2 = 0.67032. α being the long term growth rate of real per capita income, β, w_1, w_2 as given by Friedman (1957). This produced the algorithm:

$$\left(\frac{Y}{PN}\right)_t^P = 1.0368\left[0.32968\left(\frac{Y}{PN}\right)_t + 0.67032\left(\frac{Y}{PN}\right)_{t-1}^P\right] \qquad (7.3)$$

The calculated series is shown in figure 7.3. This illustrates the fact that permanent income has risen during most of the sample period. However, there has been some criticism of this weighted method of obtaining permanent income, which in itself is a substitute for a measure of wealth. Hall (1978) suggests that current consumption is a good approximation for permanent income or wealth. A full discussion can be found in Hadjimatheou (1987). In consequence, real consumer expenditure (PCONR), was considered as a substitute measure. Given that PIM and PCONR follow a similar pattern, and for ease of comparison with earlier literature, the latter variable was not pursued.

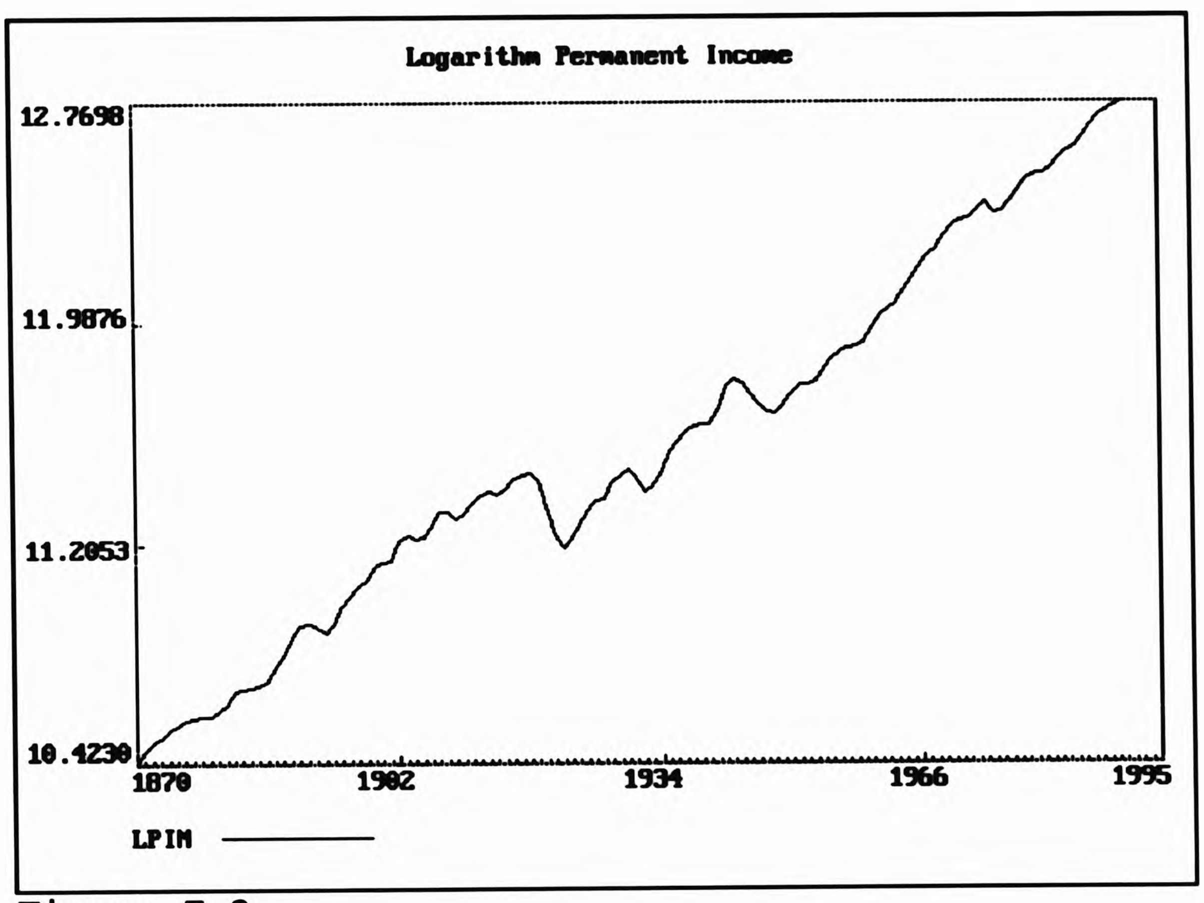

Figure 7.3

A proxy for the financial sophistication of a country is the ratio of total non-bank financial assets to total financial assets (TNBFA/TFA), and represents a measure for financial institution development. This variable is expected to enter the velocity equation with a positive parameter. A graphical representation is shown in figure 7.4. It is interesting to note that this variable is similar in shape to income velocity itself. In 1870 over 90% of total financial assets were in the hands of the non-bank financial sector. However, with the rise of commercial banking in the late nineteenth century and early twentieth century this ratio fell slowly, reaching a trough in 1947. Nevertheless, since the Second World War the rise of non-bank financial institutions have reversed this trend, and the ratio has grown rapidly, reaching 96% by 1988. The table in appendix D gives full details of the sources of this ratio, updating the original data of Goldsmith (1969).

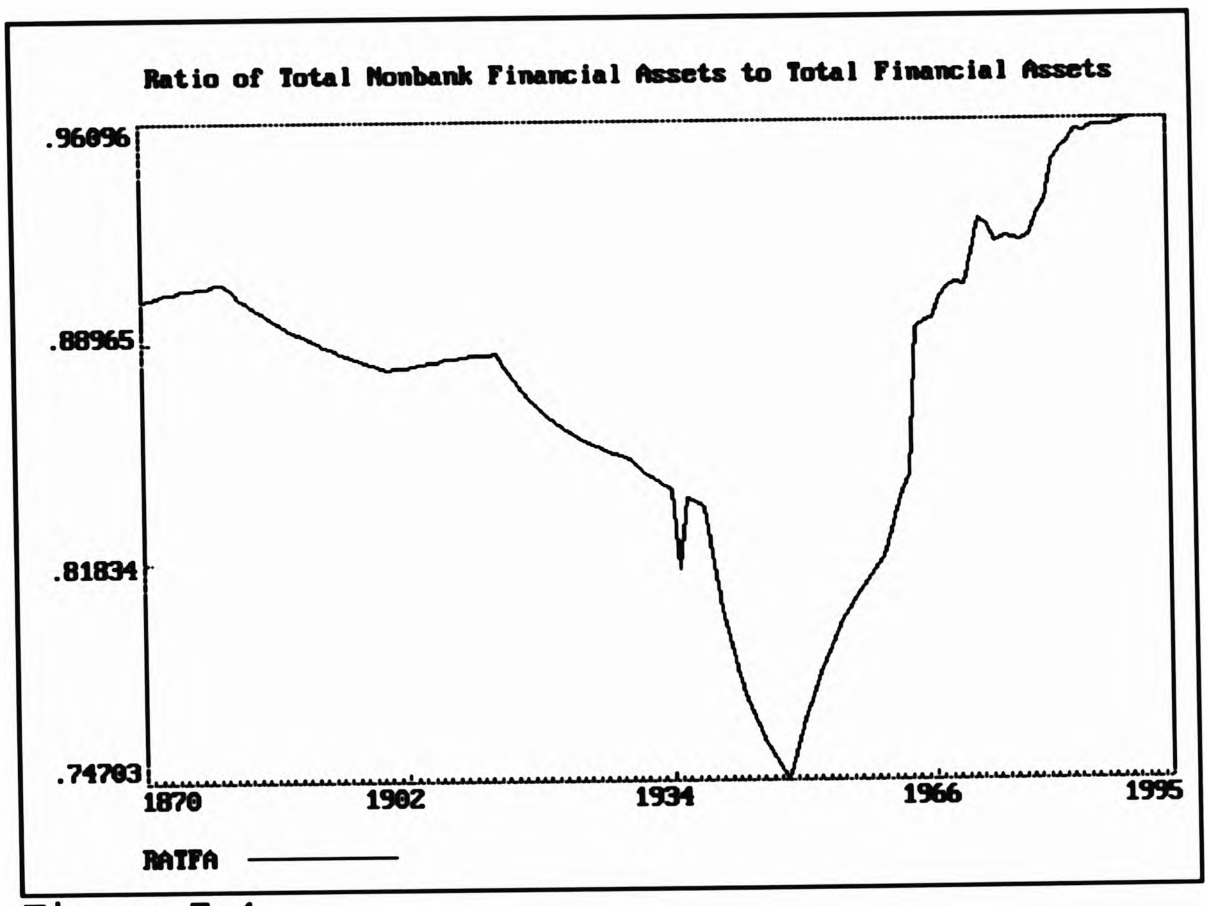

Figure 7.4

It is unfortunate that direct measurement of monetization factors is not possible. It is, therefore, necessary to follow Bordo and Jonung (1987) and develop a number of proxy variables. The first of these is the ratio of the number of people working in non-agriculture pursuits (LNA) to the total number of people employed (L). As the primary sector declines in importance, this ratio will move towards one, and the demand for money will rise, as bartering and payments in kind, are replaced with money transactions. It is expected that this ratio will be positively related to the development of the monetary economy, and should, therefore, enter the velocity function with a negative sign. A plot of the ratio of labour in non-agricultural pursuits to total labour force is shown in figure 7.5. In 1870 84% of the employed labour force were not involved in agriculture, but with mechanization and other technological advances by 1989 over 98% were employed outside farming. In other words, over the one hundred and twenty years under study, those people employed by the agricultural sector as a percentage of the total employed labour force, fell from 15.23% to 1.45%.

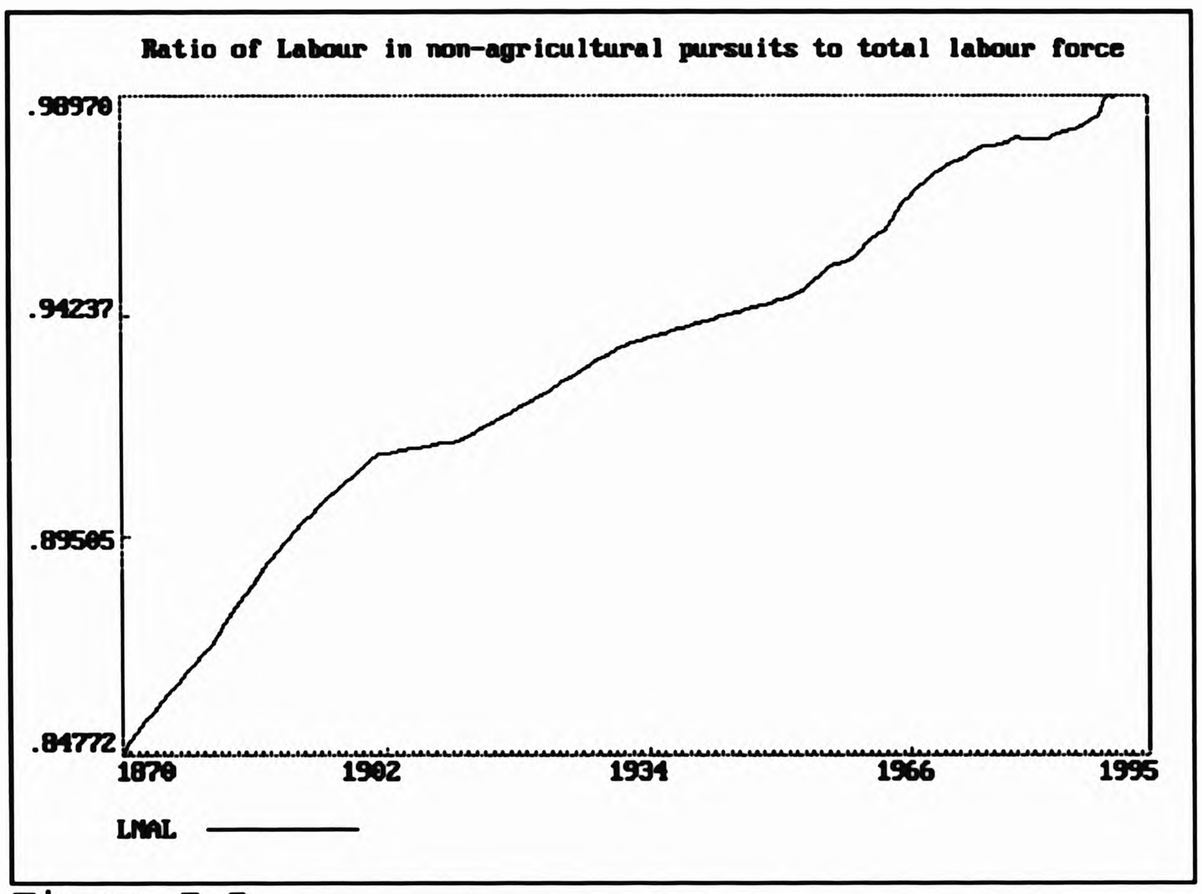

Figure 7.5

The second proxy is for the spread of commercial banking, which is measured as the currency money ratio. That is the currency (notes and coin in circulation outside the Bank of England (C)), divided by the total money stock measured by M3 (CWM3). The currency money ratio is expected to be negatively correlated with the development of the money economy and hence enter the velocity function with a positive sign. Figure 7.6 illustrates the currency money ratio for the United Kingdom. In 1870 24.48% of the money stock was made up by the currency component. This ratio fell during the last quarter of the nineteenth century to a level period of about 17% between 1899 and 1913. At the start of the First World War, the currency money ratio began to rise, peaking at approximately 23.74% in 1918, from whence it fell until the mid 1930's. During the Second World War the ratio peaked again, falling back during the 1950's. The final high of the current post war period occurred in 1961, when currency made up 23.65% of the broad money stock. From then onwards, apart from a blip in the late 1970's, the ratio has fallen uniformly, reaching just 7.24% in 1988, reflecting the decline in use of currency in transactions.

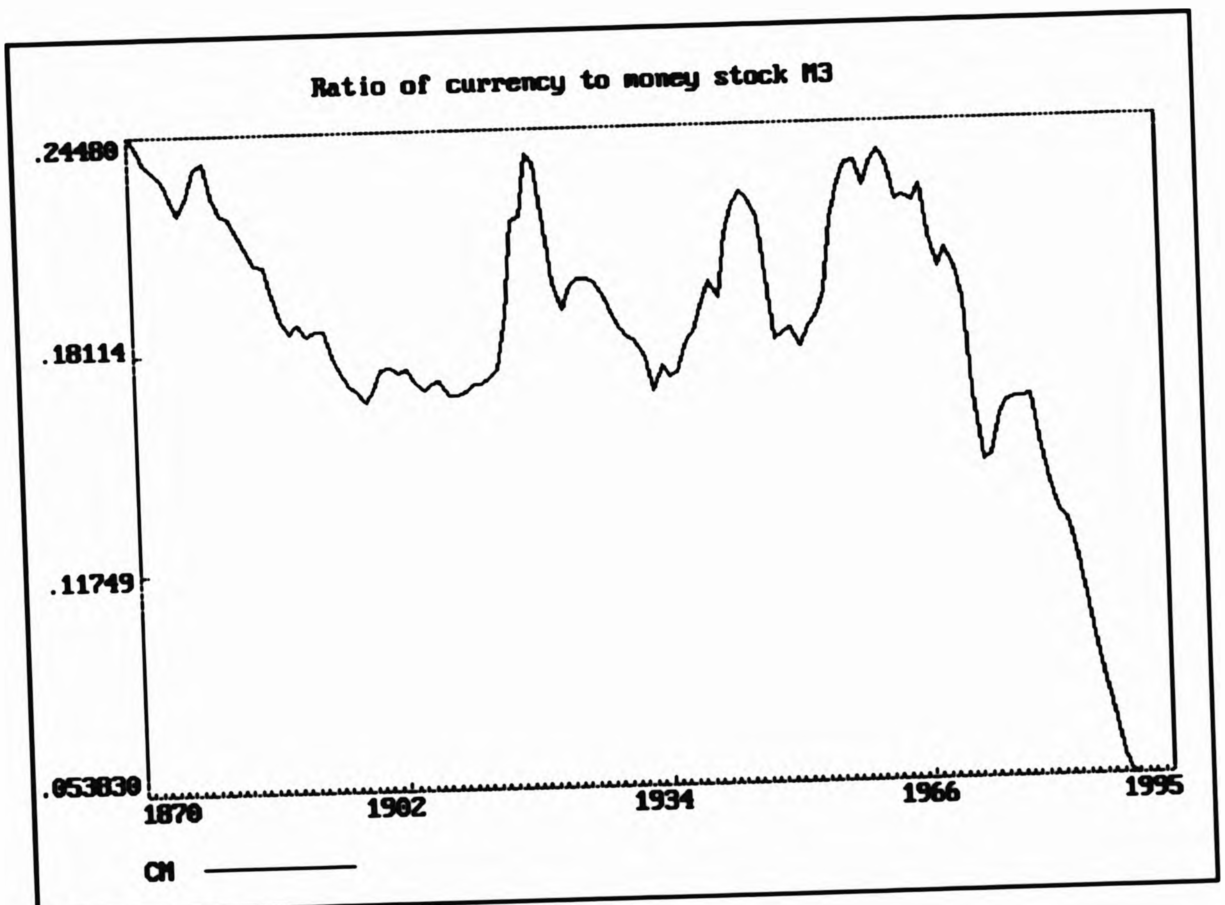

Figure 7.6

Capie and Wood (1986) discuss a number of alternative monetization variables. Among these is the number of bank branches (BANKS), which are shown in figure 7.7. It is assumed that the demand for money will rise as the number of bank branches increases. Therefore, this variable should enter the velocity function with a negative sign. The number of branches rose steadily until the start of the Second World War, and then fell during hostilities, when many branches were closed. The majority lost during this period were reopened after the war, although not all were restored. The 1950's and early 1960's were a period when the number of bank branches remained fairly constant. The late 1960's saw a flurry of activity, however, this was short lived, and the number of bank branches has declined ever since.

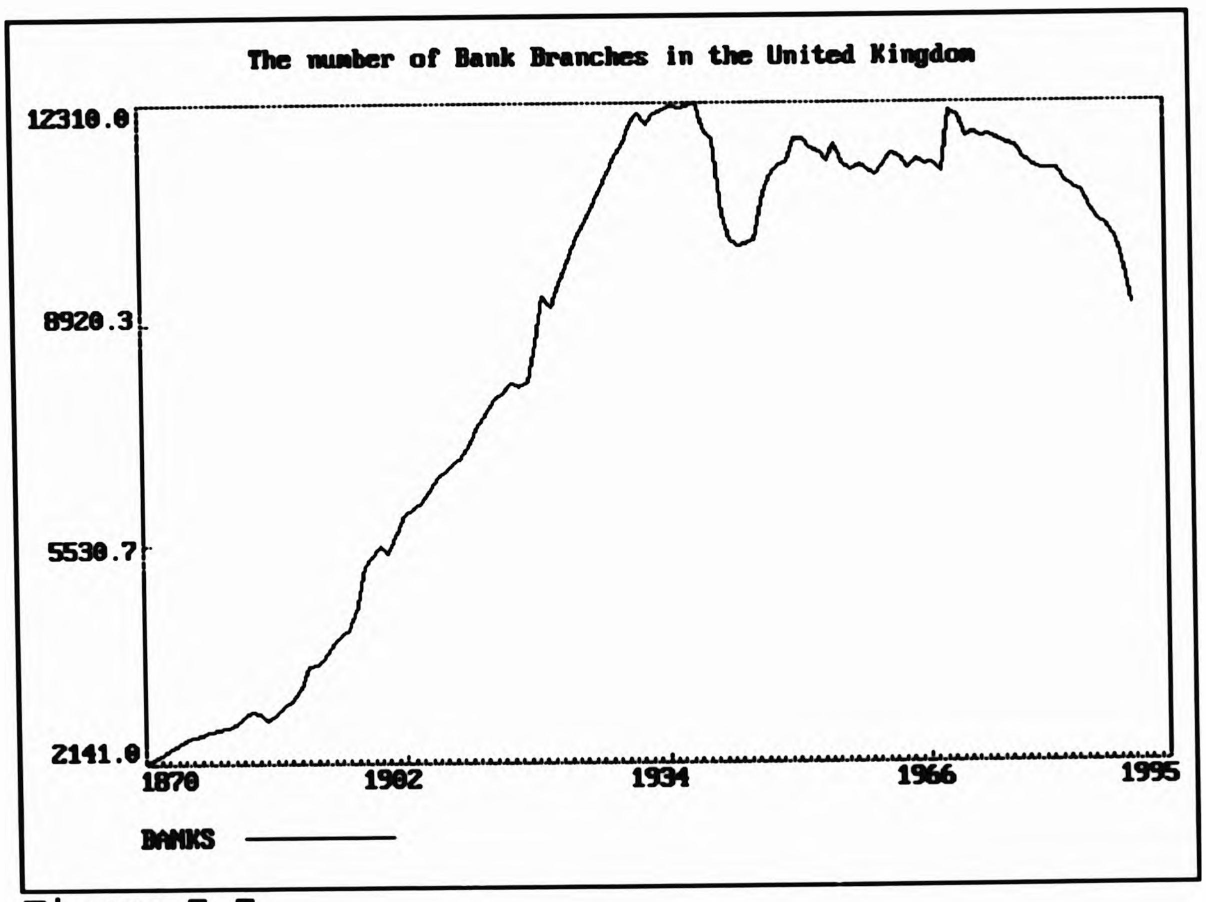

Figure 7.7

With consideration of each proposed variable complete, it is now possible to write the long run model. It should be noted, that in line with earlier work this is semi-logarithmic in form.

$$\ln V = f\ (\underbrace{\overset{+}{RL},\ \overset{-}{ROWN}}_{\text{interest rates}},\ \underbrace{\overset{+}{\ln(Y/PN)^P}}_{\text{wealth}},\ \underbrace{\overset{+}{\ln(TNBFA/TFA)}}_{\text{financial sophistication}},$$

$$\underbrace{\overset{-}{\ln(LNA/L)},\ \overset{+}{\ln(C/M)},\ \overset{-}{\ln BANKS}}_{\text{monetization}})$$

where V = the velocity of circulation, RL = the long term interest rate (consols 2.5%), ROWN = own rate of interest on money, $(Y/PN)^P$ = permanent income, (TNBFA/TFA) = the ratio of total non bank financial assets to total financial assets, (LNA/L) = the ratio of the number of people working in non agricultural pursuits to the total number of people employed, (C/M) = the currency money ratio, and BANKS = the number of bank branches.[2]

7.3 Testing for Unit Roots

With the theoretical model derived, the next step is to consider the time series properties of the proposed variables, and check their order of integration. The augmented Dickey-Fuller equation;

$$\Delta y_t = \alpha + \beta time + \rho y_{t-1} + \sum_{i=1}^{i=q} \theta_i \, \Delta y_{t-i} + e_t \qquad (7.4)$$

was estimated for each variable, and the resulting statistical tests computed. These are reported in Table 7.1. Columns 2-4 report the Φ_1, Φ_2, and Φ_3 statistics derived from Dickey and Fuller (1981), with 5% critical values given in parenthesis. Column 5 is the standard t statistic for the constant α, with standard 95% critical values in parenthesis. Column 6 is the equivalent for the parameter on time, β. Column 7 declares whether the time series is trended or not, which in turn affects the computation and critical values of the ADF statistics. Column 8 reports the ADF for the non differenced series. If the series is not stationary, it is differenced, and the resulting ADF statistic reported in column 9. This process is repeated in columns 10 and 11 where necessary, until stationarity is achieved. Column 12 reports the number of lags required in the augmented Dickey Fuller equation to eliminate autocorrelation.

We begin with the income velocity series. To eliminate serial correlation in the residuals of the augmented Dickey Fuller equation, just one lag in the first difference of ln $V1_t$ was required. Table 7.1, therefore, reports the results of the ADF(1) regression. A variable deletion test, which imposes zero coefficients on V_{t-1} and the time trend, give a computed value of 3.0243 for Φ_3. The critical value for Φ_3 can be found in Dickey and Fuller (1981). Using hypothesis tests at the 5% significance level, and 100 observations (the regression actually uses 119), we find a critical value of 6.49. As computed Φ_3 is less than the critical value, the null hypothesis cannot be rejected, implying that the series contains a unit root. Using the sequential procedure for unit root testing suggested by Holden and Perman (1994), we consider the t statistic for ln V_{t-1} to test for ρ = equals one. As it is assumed that β is zero, non standard critical values are required, and these are obtained from Fuller (1976), Table 8.5.2. The relevant t statistic is reported in

Table 7.1 Time Series Properties of Long Run Relationship Variables

Variable	Φ_1	Φ_2	Φ_3	t_{α} (constant)	t_{time}	type	I(0)	I(1)	I(2)	I(3)	k
ln V1	0.19812 (4.71)	2.0252 (4.88)	3.0243 (6.49)	2.0251 (1.96)	0.44511 (1.96)	non trended	-2.4271 (-2.8855)	-5.9267 (-2.8857)			1
ln V2	2.3140 (4.71)	1.8367 (4.88)	2.6920 (6.49)	2.2311 (1.96)	1.5212 (1.96)	non trended	-1.7424 (-2.8855)	-7.7820 (-2.8857)			1
ln(Y/PN)'	2.7756 (4.71)	7.9401 (4.88)	1.4266 (6.49)	1.6416 (1.96)	1.6660 (1.96)	non trended	0.27642 (-2.8857)	-6.3422 (-2.8859)			2
RL	5.0288 (4.71)	2.3541 (4.88)	2.7716 (6.49)	0.18393 (1.96)	2.2425 (1.96)	non trended	-0.72186 (-2.8857)	-6.0796 (-2.8859)			2
ROWN	3.7851 (4.71)	1.5008 (4.88)	2.1153 (6.49)	-0.73975 (1.96)	1.9455 (1.96)	non trended	-0.072813 (-2.8857)	-6.4912 (-2.8859)			2
ln TNBFA/TFA	2.1917 (4.71)	1.0489 (4.88)	1.5035 (6.49)	-1.3970 (1.96)	1.4804 (1.96)	non trended	-0.89857 (-2.8857)	-3.8539 (-2.8859)			2
ln (C/M)	2.0980 (4.71)	1.4159 (4.88)	1.2055 (6.49)	0.11300 (1.96)	-1.4485 (1.96)	non trended	0.55680 (-2.8855)	-5.1400 (-2.8857)			1
ln (LNA/L)	6.1457 (4.71)	9.6947 (4.88)	7.5561 (6.49)	-2.3315 (1.96)	2.4791 (1.96)	trended	-3.0552 (-3.4478)	-3.1865 (-3.4478)	-10.7449 (-3.4481)		1
ln BANKS	6.7143 (4.71)	8.0461 (4.88)	9.2407 (6.49)	0.14116 (1.96)	-2.5912 (1.96)	trended	0.28968 (-3.4475)	-6.4618 (-3.4478)			1

column 8 of table 6.1, with the critical value in parenthesis. The computed value of -2.4271 is higher than the critical value of -2.8855, so this reinforces our earlier inference that the income velocity series contains a unit root. To determine whether a drift component is present, the value of the Φ_2 statistic is calculated. This is derived using a variable deletion test, which imposes zero coefficients on ln V_{t-1}, the time trend, and the intercept. Φ_2 is the resulting F statistic. As the computed Φ_2, 2.0252 is less than the critical value of 4.88, it is not possible to reject the null hypothesis, which implies the absence of a drift in the process. We can reinforce our conclusions by using the Φ_1 statistic to test the null hypothesis of a unit root and zero drift. In this instance Φ_1 is 0.19812, smaller than the critical value of 4.71. Therefore it is not possible to reject the null. Having established the series is not I(0), we need to confirm that the income velocity series requires only to be differenced once to achieve stationarity. The above process is repeated for the differenced variable, although not reported here, and the corresponding ADF statistic is shown in column 9 of table 7.1. This is -5.9267, smaller than the critical value of -2.8857, and this confirms that the income velocity series is I(1).

The sequential procedure for unit root testing is conducted for each of the proposed long run relationship variables. The transactions velocity series (V2) is a random walk without drift. The permanent income series ($\ln(Y/PN)^P$) is a random walk with drift. While RL, ROWN, ln(TNBFA/TFA), and ln(C/M) are all random walks without drift. All the above variables are also I(1). However, the computed Φ_3 statistic for the ratio of the number of people working in non agricultural pursuits to the total number of people employed, ln(LNA/L), is larger than the corresponding critical value. Therefore, the null hypothesis, H_0: (α,β,ρ) = $(\alpha,0,1)$ is rejected. So we know that either $[\beta\neq0,\rho=1]$ or $[\beta=0,\rho\neq1]$ or $\beta\neq0,\rho\neq1]$. The next step is to test for $\rho=1$ using the corresponding t statistic obtained in the augmented Dickey Fuller equation. Critical values from the standard normal tables are used when β is non-zero. These tests conclude that ρ,α, and β are significantly different from zero, and implies that the series is a random walk about a non-linear time trend. This outcome being highly unusual for an economic time series (see Holden and Perman, 1994, pp.57-58 for a detailed explanation). To achieve stationarity the ln (LNA/L) series has to be differenced twice. The fact that it is I(2) is confirmed by the ADF statistic in column 10 of table 7.1.

The final long run variable to consider is the number of bank branches. Once again the computed Φ_3 statistic is larger than the corresponding critical value, and the null hypothesis H_0: (α,β,ρ) = $(\alpha,0,1)$ is rejected. Further tests on α, β, and ρ suggest the series is a random walk with a linear trend. Nonetheless, the ln BANKS series requires differencing only once to achieve stationarity, and consequently is an I(1) variable.

7.4 Unit Root Testing in the Presence of Structural Breaks

Perron (1989) argues that unit root tests which do not take into account the possibility of structural breaks may have low power. The point of a structural break may be detected informally by consulting a plot of each variable. Alternatively, it may be identified by plotting recursive estimates of ρ, in the augmented Dickey Fuller regression, and seeking periods of coefficient instability, which may be consistent with a structural break. A more formal approach, is to select the break point which minimizes the t statistic on ρy_{t-1} in regressions for all possible values of the structural break date.

In order to test for the existence of a unit root conditional on the potential presence of structural breaks we use the following equation, as specified by Holden and Perman (1994).

$$\Delta y_t = \alpha + \theta DU_t + \beta time_t + \gamma DT_t + dD(TB)_t$$

$$+ \rho y_{t-1} + \sum_{i=1}^{i=k} c_i \Delta y_{t-i} + e_t \qquad (7.5)$$

where TB = time of the possible break, DU_t = 1 if t > TB and 0 otherwise, DT_t = time if t > TB and 0 otherwise, $D(TB)_t$ = 1 at t = TB + 1 and 0 otherwise. DU_t and DT_t allow the intercept and the trend coefficient to change after the possible break. $D(TB)_t$ allows for a jump in the series at TB + 1. If the parameters on the lags of Δy_t are significant, this is in line with the view that there is a gradual change in the intercept and trend starting at TB. Otherwise the changes take place instantaneously. The null hypothesis of a unit root requires $\rho=1$ and $\nu=\beta=0$. The alternative hypothesis of a trend stationary process requires $\rho < 1$, β,ν, and $\theta \neq 0$ and d to be close to zero.

The hypothesis is tested using the t statistic on the ρ parameter, and comparing it with the critical values given in Perron (1989), Table VI.B p.1377. If the computed t_ρ is higher than the critical value we accept the null hypothesis that the series contains a unit root. Otherwise we reject the null hypothesis and accept the alternative. The critical values used are dependent on the position of the possible time break. This is given as;

$$\lambda = T_b/T$$

where T_b = the observation number associated with the year selected for the possible structural break (eg. 1870=1, 1900=31), and T = the total number of observations, (in our case 121). If the null is rejected then hypothesis tests for the other parameters use the conventional t and F statistics.

The Perron equation to test for unit roots in the presence of possible structural breaks was estimated for each of the proposed long run variables (excluding ln(LNA/L). The results are reported in table 7.2. Column 2 gives the possible date of break in the trend function. Column 3 is the value of the truncation lag parameter k. Columns 4-8 give the key parameters with critical values in parenthesis. Column 9 reports ρ. Column 10 gives the t statistic associated with ρ, with its corresponding critical value taken from Perron (1989). Column 11 indicates the position of the break, and corresponding ratio. At the 5% significance level, the null hypothesis of a unit root is maintained for seven of the eight series. The exception is the own rate of interest (ROWN) with a break date of 1931. The computed t statistic on ρ is -4.6284, while the critical value equals -4.24. Therefore the null hypothesis cannot be accepted and the alternative hypothesis of stationary fluctuations around a determining breaking trend function is adopted. As the unit root hypothesis can be rejected, it is possible to assess the significance of the other coefficients given the fact that the asymptotic distribution of their t statistic is standardized normal. The constant (α) is not significant, while the post break constant dummy (θ) is significant. The trend (β) is not significant, although the opposite is true for the post break slope dummy (ν). The break dummy (d) is not significantly different from zero at the 95% level (1.96) but is at the 90% level (1.64). These results suggest that ROWN does not possess a unit root, is untrended until 1931 and exhibits a positive trend from that point. It could be argued that these results be preferred to those of the standard Dickey Fuller tests. However, given how close t_ρ is to its critical value, and given the fact that large sample test procedures are being concluded, we regard the above evidence on the unit root in the own rate of interest series as inconclusive. Nevertheless, we use the Perron equation to test for unit roots in the presence of possible structural breaks for all the series in first differences. In all cases the unit root hypothesis is rejected, as expected. These are reported in Table 7.3.

Table 7.2 Trend, Unit Root and Structural Change in Proposed Long Run Variables (Levels)

Variable	T_b	k	α	θ	β	γ	d	ρ	t_ρ	λ
ln V1	1919	1	0.066581 (2.6036)	-0.078527 (1.91161)	0.0002688 (0.047902)	0.008555 (1.2671)	0.11005 (1.8713)	-0.11242	-3.1858 [-4.22]	49/121 = 0.40495
ln V2	1920	1	0.30436 (3.2611)	-0.12771 (2.2722)	0.000333 (0.057542)	0.0016610 (1.9928)	-0.11909 (1.9883)	-0.14023	-3.2738 [-4.22]	50/121 = 0.4132
ln(Y/PN)'	1922	2	0.38336 (0.90214)	-0.027230 (1.3252)	0.002611 (0.27995)	0.005630 (2.0924)	0.028035 (1.1190)	-0.034731	-0.84620 [-4.22]	52/121 = 0.4297
RL	1903	2	0.013275 (0.42587)	-0.019272 (0.45088)	0.002589 (0.18986)	0.005178 (0.35328)	0.010000 (0.14373)	-0.0075218	-2.0672 [-3.99]	33/121 = 0.2727
	1920	2	0.006724 (0.028387)	-0.087575 (1.7068)	0.0015112 (2.1822)	0.003562 (0.38784)	-0.015570 (0.22297)	-0.010730	-2.8079 [-4.22]	50/121 = 0.4132
ROWN	1898	2	-0.042786 (0.27488)	-0.095739 (0.48686)	0.0043738 (0.52235)	-0.008985 (0.10400)	0.37400 (1.1366)	-0.027406	-1.9335 [-3.66]	28/121 = 0.231
	1931	2	0.12705 (1.4338)	-1.8300 (4.1677)	0.0034181 (1.5387)	0.020515 (3.8509)	-0.54064 (1.6768)	-0.10554	-4.6284 [-4.24]	61/121 = 0.50413
ln TNBFA/TFA	1915	2	-0.0030160 (1.0012)	-0.012397 (2.1715)	-0.0003479 (0.36197)	0.001725 (1.5312)	0.0030773 (0.38018)	-0.029498	-1.9631 [-4.17]	45/121 = 0.3719
	1943	2	-0.0032348 (0.81018)	-0.028617 (0.93680)	-0.001558 (2.1133)	0.004304 (1.2711)	-0.0085955 (1.0250)	-0.056867	-1.3068 [-4.24]	73/121 = 0.6033
ln(C/M)	1918	1	-0.012038 (0.35891)	0.048125 (1.8590)	0.007050 (1.4472)	-0.0011738 (2.2395)	-0.057213 (1.3597)	0.0033735	0.15244 [-4.22]	48/121 = 0.39669
	1954	1	-0.12441 (2.8009)	0.39262 (3.4951)	0.0002238 (0.12475)	-0.0041128 (3.6948)	0.049074 (1.1701)	-0.074581	-2.6985 [-4.18]	84/121 = 0.69421
ln BANKS	1896	1	0.077410 (0.67491)	0.037221 (1.7457)	0.0013052 (1.7136)	-0.0016534 (2.2612)	0.081155 (3.1421)	-0.0090876	-0.60703 [-3.99]	26/121 = 0.214876
	1941	1	-0.36437 (1.4080)	-0.062655 (0.98076)	-0.0018855 (1.9194)	0.0012541 (1.2537)	-0.027809 (0.96347)	0.052233	1.5299 [-4.24]	71/121 = 0.58677

Table 7.3 Trend, Unit Root and Structural Changes in Proposed Long-Run Variables (First Differences)

Variable	T_b	k	α	θ	β	γ	d	ρ	t_ρ	λ
ΔM1	1919	1	0.0075880 (0.41868)	-0.008935 (0.026164)	-0.003145 (0.52360)	0.002237 (0.32758)	0.060769 (1.0169)	-0.59230	-5.5671 [-4.22]	49/121 = 0.40495
ΔM2	1920	1	0.0047338 (0.25366)	0.015048 (0.41709)	-0.001900 (0.31341)	0.0004434 (0.063622)	-0.18375 (3.0397)	-0.89161	-8.2491 [-4.22]	50/121 = 0.4132
Δ(Y/PN)^P	1922	2	0.025257 (3.0601)	-0.016452 (1.0969)	-0.005384 (2.2706)	0.006050 (2.1699)	0.023054 (0.88413))	-0.66522	-5.7785 [-4.22]	52/121 = 0.4297
ΔRL	1903	2	-0.013405 (0.42956)	0.024500 (0.61681)	0.004968 (0.33985)	-0.004933 (0.33095)	-0.0047330 (0.066636)	-0.83379	-6.0904 [-3.99]	33/121 = 0.2727
	1920	2	-0.031040 (1.3466)	0.0026221 (0.061473)	0.0014426 (1.9195)	-0.0010266 (1.2230)	-0.053722 (0.75519)	-0.88303	-6.3689 [-4.22]	50/121 = 0.4132
ΔROWN	1898	2	-0.15522 (0.93424)	0.091295 (0.46698)	0.0080242 (0.89008)	-0.0069297 (0.76068)	0.25901 (0.76111)	-1.2010	-6.4376 [-3.66]	28/121 = 0.231
	1931	2	-0.044310 (0.48858)	-0.026105 (0.10707)	0.0013809 (0.56994)	-0.001539 (0.045246)	-1.1163 (3.3782)	-1.1785	-6.7307 [-4.24]	61/121 = 0.50413
ΔNBFA/ TFA	1915	2	-0.003449 (0.12167)	-0.004975 (1.0212)	-0.000071 (0.071604)	0.0007873 (0.71338)	-0.003365 (0.041478)	-0.55195	-4.1900 [-4.17]	45/121 = 0.3719
	1943	2	0.0012833 (0.64313)	0.010245 (1.2195)	-0.0007572 (1.6371)	-0.000048 (0.051561)	-0.010751 (1.3112)	-0.71064	-5.1525 [-4.24]	73/121 = 0.6033
Δ(C/M)	1918	1	-0.018093 (1.3317)	0.054672 (2.0901)	0.007212 (1.5714)	-0.0012716 (2.3524)	-0.063052 (1.4980)	-0.55374	-5.8499 [-4.22]	48/121 = 0.39669
	1954	1	-0.0072730 (0.78822)	0.20513 (2.5831)	0.001304 (0.71415)	-0.0022833 (2.8659)	0.078020 (1.8939)	-0.69318	-6.6553 [-4.18]	84/121 = 0.69421
ΔBANKS	1896	1	0.0051084 (0.41997)	0.031314 (2.1447)	0.0012702 (1.7801)	-0.0016875 (2.3152)	0.084900 (3.3822)	-0.84842	-7.4742 [-3.99]	26/121 = 0.214876
	1941	1	0.31769 (3.9481)	0.026175 (0.98179)	-0.004084 (2.5491)	-0.002004 (0.66142)	-0.023763 (0.81268)	-0.75532	-6.1670 [-4.24]	71/121 = 0.58677

As stated earlier, usually only I(1) variables will occur in any long run relationship. All the proposed variables of the long run model are I(1) except the ratio of the number of people working in non agricultural pursuits to the total number of people employed (ln(LNA/L)), which is I(2). Consequently, this variable is dropped from the proposed specification. It should be noted that Siklos (1993) also drops this variable, due to lack of variation in the post war period. The doubts concerning the stationarity of ROWN arising from the structural break of 1931 remain, although it is not omitted. The long term model for Johansen estimation purposes thus becomes:

$$\ln V = f\,(\underbrace{\overset{+}{RL},\ \overset{-}{ROWN}}_{\text{interest rates}},\ \underbrace{\overset{+}{\ln}(Y/PN)^{P}}_{\text{wealth}},\ \underbrace{\overset{+}{\ln}(TNBFA/TFA)}_{\text{financial sophistication}},$$

$$\underbrace{\overset{+}{\ln}(C/M),\ \ln \overset{-}{BANKS})}_{\text{monetization}}$$

7.5 Cointegration Analysis

Before proceeding with the Johansen estimation, it is necessary to determine the lag length k of the VAR (vector autoregressive model). Sequential F tests were calculated, starting with a large value of k, (3 in this case), and the specification reestimated for ever smaller values of k. A variable deletion F test was used to ascertain the smallest lag length which is acceptable. This should be large enough to ensure that the residuals are approximately white noise. The computed F tests and critical values are shown in Table 7.4.

Table 7.4 Determination of the lag length k of the VAR (vector autoregressive model)

Income Velocity Model (V1)

Lag Length	F statistic	critical value
1 to 0	F(21,91) = 15.5969	1.71
2 to 1	F(14,91) = 2.2154	1.81
3 to 2	F(7,91) = 1.8987	2.11

Transactions Velocity Model (V2)

Lag Length	F statistic	critical value
1 to 0	F(21,91) = 7.7537	1.71
2 to 1	F(14,91) = 1.9581	1.81
3 to 2	F(7,91) = 1.2566	2.11

The results show, that for both the income and transactions velocity models, the null hypothesis cannot be rejected until the lag length is reduced from 2 to 1. Therefore, the VAR is set at 2 for both models.

The next step is to apply the Johansen estimation techniques. First, let us consider income velocity (V1). Initial analysis of the model suggested the possibility of two cointegrating vectors[3]. However, consulting the corresponding vectors revealed that while all variables are significantly different from zero, the sign of the parameter on ln(C/M) in vector one, and RL in vector 2 are incorrect. The model was reestimated omitting ln BANKS. This again suggested two vectors. Unfortunately, there are problems with the two associated vectors. The parameters on ln(C/M) in both vectors are of the incorrect sign. Additionally, the parameters on $\ln(Y/PN)^P$, ROWN, and ln(TNBFA/TFA) in vector two also have inappropriate signs. Furthermore, the parameters on $\ln(Y/PN)^P$, ln(TNBFA/TFA) and ln(C/M) are not significantly different from zero. Finally, the long term model for income velocity was reduced to:

$$\ln V1 = f\ (\underbrace{\overset{+}{RL},\ \overset{-}{ROWN}}_{\text{interest rates}},\ \underbrace{\overset{+}{\ln(Y/PN)^P}}_{\text{wealth}},\ \underbrace{\overset{+}{\ln(TNBFA/TFA)}}_{\text{financial sophistication}})$$

The corresponding Johansen test statistics are reported in Table 7.5. Both the LR tests, the maximal eigenvalue and the trace of the stochastic matrix suggest just one cointegrating vector. This is exhibited in Table 7.6. All the parameters are of the correct sign, and are significantly different from zero. The single cointegrating vector in normalized form is:

(-1.00 0.44685 0.11847 -0.26820 6.97990)

corresponding to a long run relationship of:

$$\ln V1 = 0.44685\ \ln(Y/PN)^P_t + 0.11847\ RL_t - 0.26820\ ROWN_t + 6.97990\ \ln\ (TNBFA/TFA)_t$$

Table 7.5

120 observations from 1872-1991 Maximum Lag in VAR = 2 List of variables included in cointegrating vector: ln V1, $\ln(Y/PN)^P$, RL, ROWN, ln(TNBFA/TFA)				
List of eigenvalues in descending order: 0.32180 0.14852 0.11559 0.060540 0.0096045				
LR Test Based on Maximal Eigenvalue of the Stochastic Matrix (with trend in DGP)				
Null	Alternative	Statistic	95% critical value	90% critical value
r=0	r>=1	46.5975	33.4610	30.9000
r<=1	r>=2	19.2936	27.0670	24.7340
r<=2	r>=3	14.7398	20.9670	18.5980
r<=3	r>=4	7.4940	14.0690	12.0710
r<=4	r>=5	1.1581	3.7620	2.6870
LR Test Based on Trace of Stochastic Matrix				
r=0	r>=1	89.2829	68.5240	64.8430
r<=1	r>=2	42.6855	47.2100	43.9490
r<=2	r>=3	23.3919	29.6800	26.7850
r<=3	r>=4	8.6521	15.4100	13.3250
r<=4	r>=5	1.1581	3.7620	2.6870

Table 7.6

Sample 1872-1991 Maximum lag in VAR = 2				
Variable	Vector 1			$x^2(1)$
ln V1	-1.00000			
$\ln(Y/PN)^P$	0.44685			6.7338
RL	0.11847			7.6096
ROWN	-0.26820			25.9589
ln(TNBFA/ TFA)	6.97990			17.0568
				critical value $\chi^2(1) = 3.841$

Economic interpretation of the long run relationship is not straightforward. Cointegrating vectors are obtained from the reduced form of a system of jointly endogenous variables. Therefore, they cannot be interpreted in the same way as structural equations, as it is difficult to go back from the reduced form to the structure. However, Bernake (1986) and Blanchard and Quah (1989) have shown that it is possible to give a structural interpretation to these vectors by imposing identifying restrictions on the reduced form parameters. Nevertheless, for our purposes, the Johansen vectors can be thought of as a constraint that an economic structure imposes on the long run relationship of the jointly endogenous variables.

The residuals and residuals adjusted for short run dynamics are shown in figures 7.8 and 7.9 respectively.

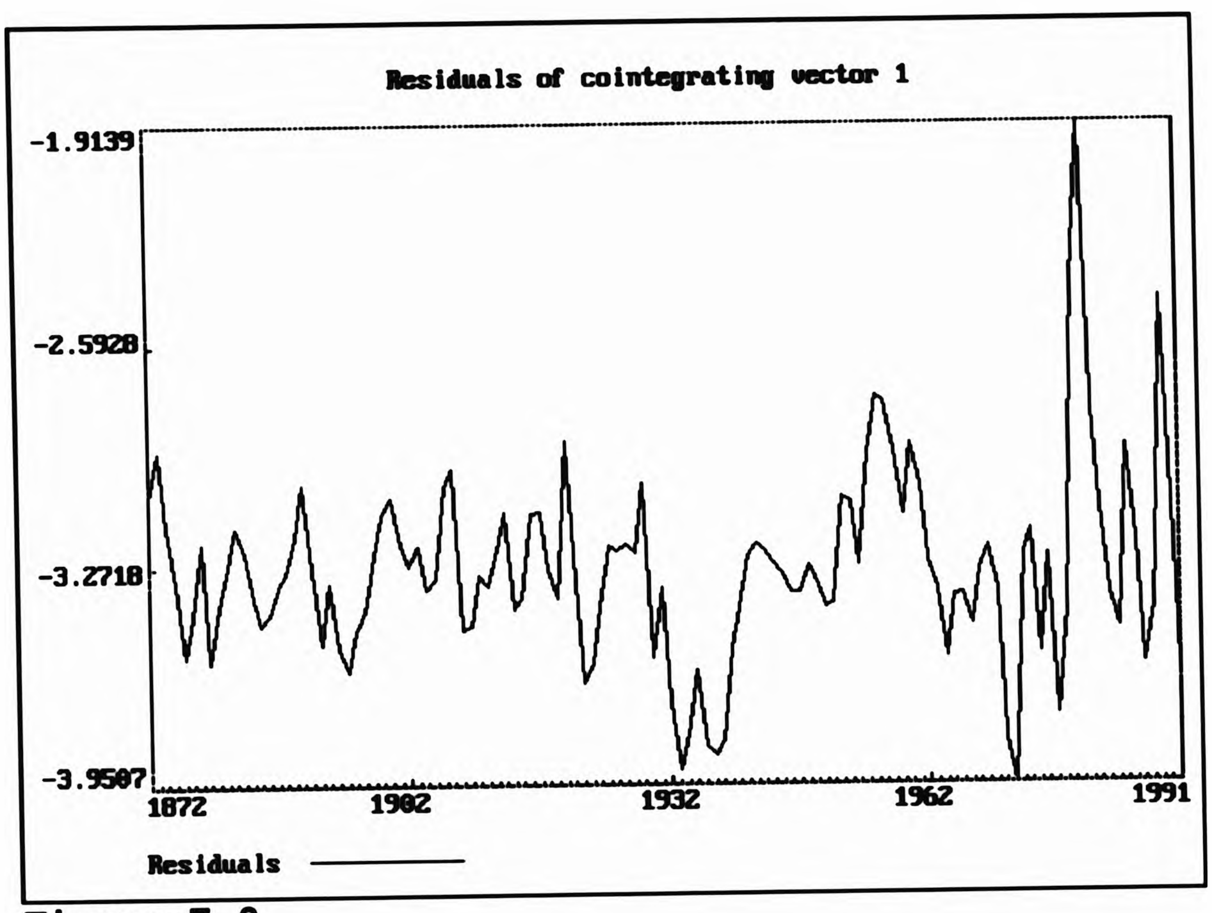

Figure 7.8

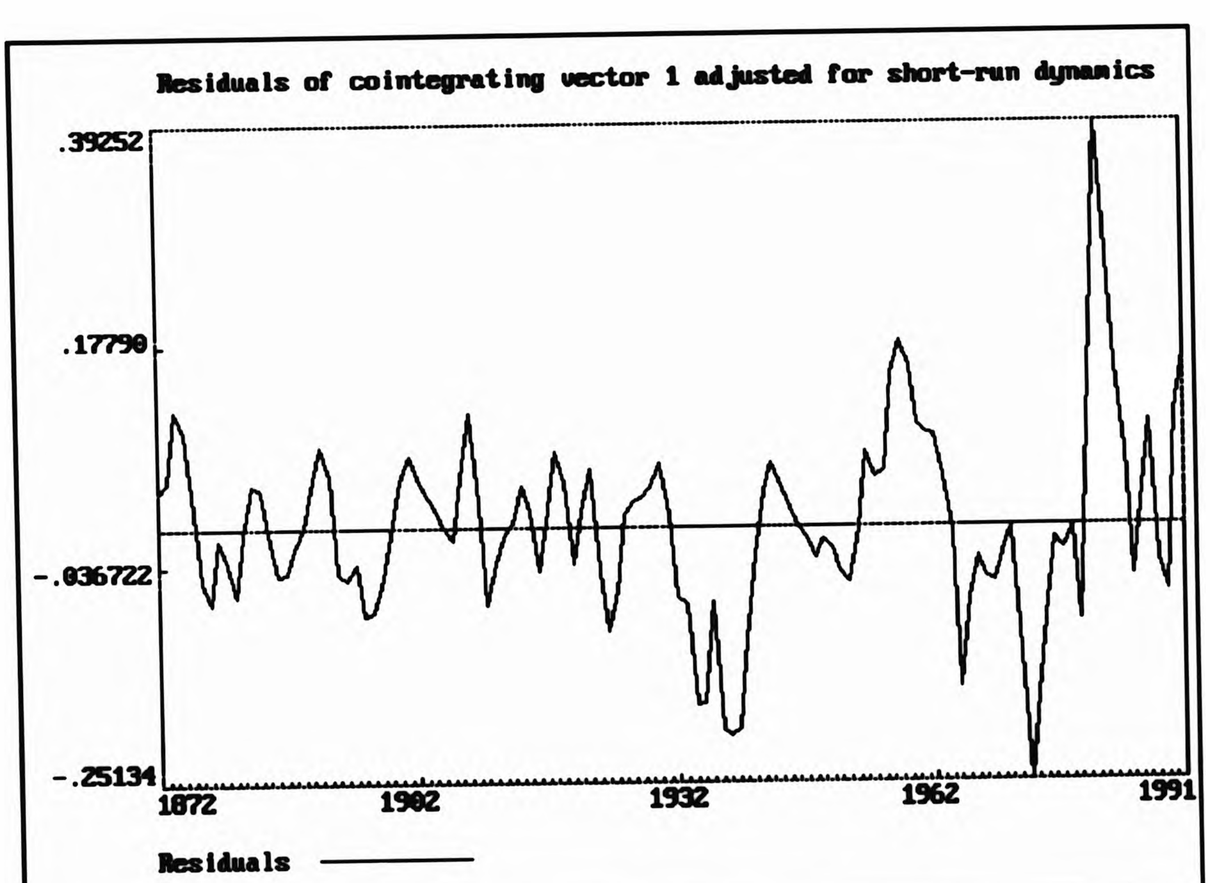

Figure 7.9

Informal analysis appears to confirm stationarity. However, there appears to be outliers in 1939, 1964, 1983 . Nonetheless, stationarity is confirmed by the Augmented Dickey Fuller test, ADF(2) = -4.4321 [-2.89], and the null hypothesis of a unit root is rejected.

Let us return to transactions velocity (V2). The Johansen test statistics are reported in Table 7.7, these are for the full long term model. Using the 95% critical value criteria, the LR test based on the maximal eigenvalue of the stochastic matrix suggests two cointegrating vectors. While the LR test based on the trace of stochastic matrix suggests three vectors. These were estimated, and are shown in Table 7.8. The first point to note, is the fact that according to the χ^2 tests, all parameters are significantly different from zero. However, vector one is rejected because the parameters on RL and ROWN are of the incorrect sign. Furthermore, vector three is not acceptable due to the negative sign on RL. Nevertheless, vector two is acceptable, and in normalized form is:

(-1.00 0.251970 0.027783 -0.045524 3.06910 0.046472 -0.104130)

corresponding to a long run relationship of:

$$\ln V2 = 0.2520 \ln(Y/PN)^{P}_{t} + 0.030\ RL_{t} - 0.0455\ ROWN_{t} + 3.069 \ln(TNBFA/TFA)_{t} + 0.0465 \ln(C/M)_{t} - 0.1041 \ln BANKS_{t}$$

Earlier discussion on the problems associated with economic interpretation are also relevant here.

For a full discussion on the ordering and choice of vectors when the Johansen tests suggests more than one, see Adam (1991), Arestis and Biefang-Frisancho Marirscal (1994) and Clements and Mizon (1991). Furthermore, a recent paper by Pesaran and Shin (1994) argues that in the case where there are more than one cointegrating vector, the statistical approach to identification of the long-run cointegrating relations is not satisfactory. This can lead to misinterpretation of empirical results and has implications for policy analysis. Pesaran and Shin (1994) provide appropriate algorithms to overcome this problem. Furthermore, in a later paper Pesaran and Shin (1995) show that:

"it is possible to complement the long-run analysis with some insight into the dynamics of the adjustments of the economic model by estimating "persistence profiles", namely the time profiles of the effects of shocks on the cointegrating relations that are invariant to the way shocks in the underlying VAR model are orthogonalized."

(Pesaran and Shin (1994, p.36)

The empirical work contained here, has not been able to benefit from such recent econometric developments.

The residuals and adjusted residuals for short run dynamics are illustrated in figures 7.9 and 7.10.

Table 7.7

120 observations from 1872-1991 Maximum Lag in VAR = 2 List of variables included in cointegrating vector: ln V2, ln(Y/PN)^P, RL, ROWN, ln(TNBFA/TFA), ln(C/M), ln BANKS				
List of eigenvalues in descending order: 0.38237 0.28241 0.23756 0.19407 0.076702 0.054726 0.002248				
LR Test Based on Maximal Eigenvalue of the Stochastic Matrix (with trend in DGP)				
Null	Alternative	Statistic	95% critical value	90% critical value
r=0	r>=1	57.8244	45.2770	42.3170
r<=1	r>=2	39.8234	39.3720	36.7620
r<=2	r>=3	32.5472	33.4610	30.9000
r<=3	r>=4	25.8909	27.0670	24.7340
r<=4	r>=5	9.5764	20.9670	18.5980
r<=5	r>=6	6.7537	14.0690	12.0710
r<=6	r>=7	0.0269	3.7620	2.6870
LR Test Based on Trace of Stochastic Matrix				
r=0	r>=1	172.4430	124.2430	118.5000
r<=1	r>=2	114.6185	94.1550	89.4830
r<=2	r>=3	74.7951	68.5240	64.8430
r<=3	r>=4	42.2479	47.2100	43.9490
r<=4	r>=5	16.3571	29.6800	26.7850
r<=5	r>=6	6.7807	15.4100	13.3250
r<=6	r>=7	0.0269	3.7620	2.6870

Table 7.8

Sample 1872-1991 Maximum lag in VAR = 2				
Variable	Vector 1	Vector 2	Vector 3	$\chi^2(3)$
ln V2	-1.000000	-1.000000	-1.000000	
$\ln(Y/PN)^P$	0.327080	0.251970	1.021100	11.7198
RL	-0.063278	0.027783	-0.026333	16.4432
ROWN	0.106330	-0.045524	-0.041439	28.0743
ln(TNBFA/ TFA)	1.592100	3.069100	4.185800	12.9528
ln(C/M)	0.496940	0.046472	0.597530	16.0173
ln BANKS	-0.118480	-0.104130	-0.382800	9.7594
				critical value $\chi^2(3) = 7.815$

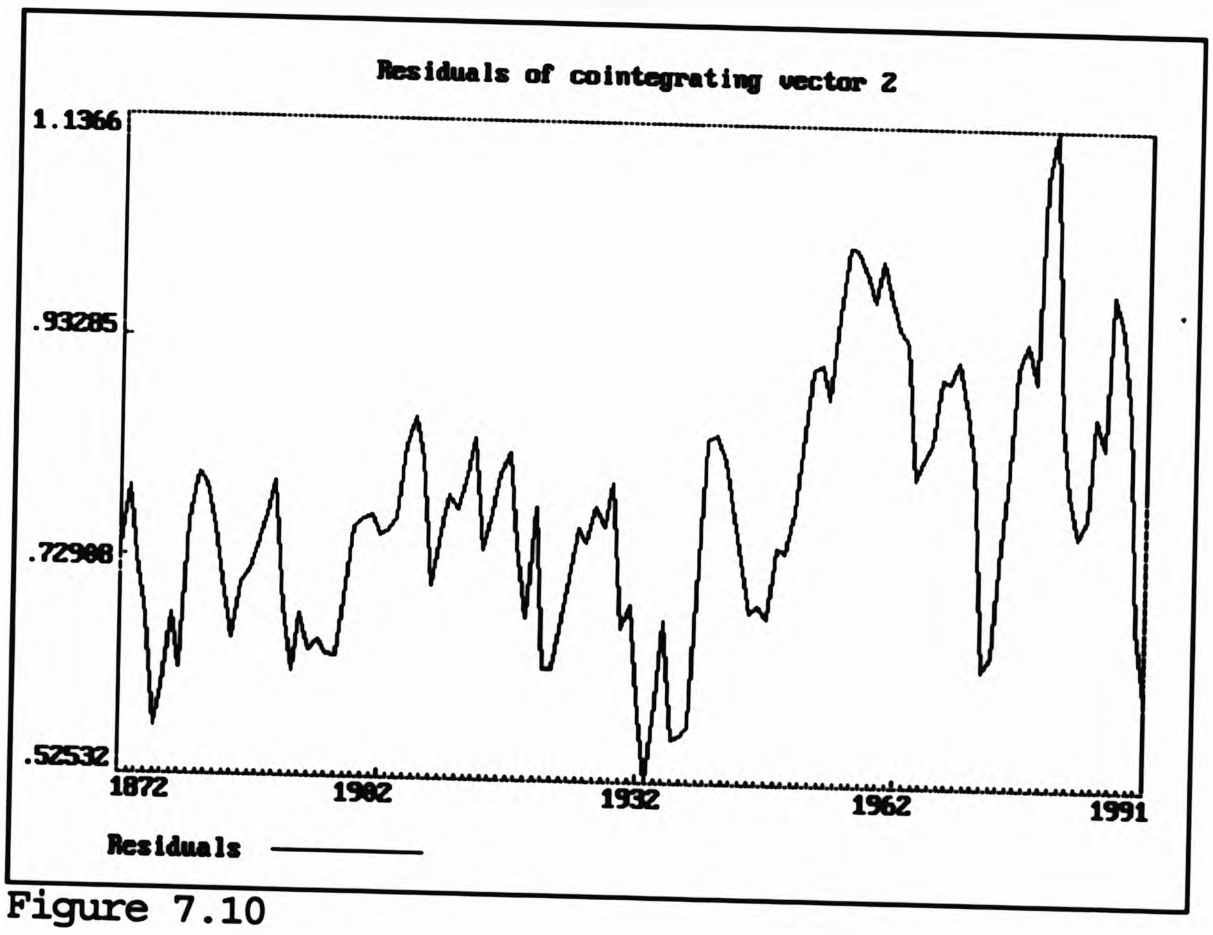

Figure 7.10

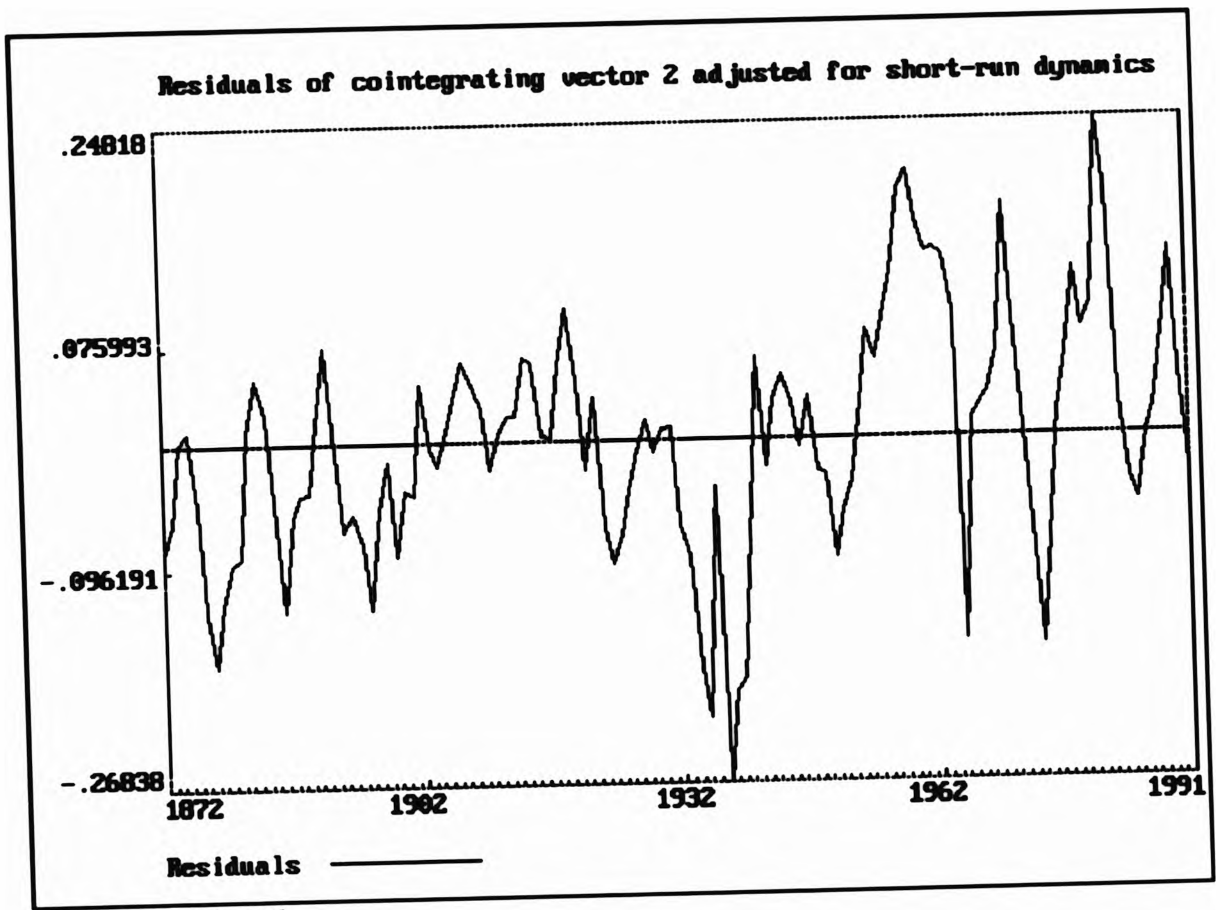

Figure 7.11

While the residuals appear stationary, there are outliers in 1987 and 1989. This is an issue we will return to later in the thesis. The Augmented Dickey Fuller statistic confirms stationarity, ADF(2) = -3.5188 [-2.89].

This chapter has established long run relationships for both income and transactions velocity. In the case of income velocity, this is a function of the long term interest rate, the own rate of interest on money, and the ratio of total non bank financial assets to total financial assets. While the long term transactions velocity function contains these variables and additionally the currency money ratio and the number of bank branches. These results are in line with the monetarist view of a stable function of just a few variables.

Chapter 8

The Short-run Dynamic Relationship - Model

8.1 Introduction

The preceding section of the thesis established a long-term relationship between velocity and a small number of explanatory variables. This chapter is concerned with the second step of cointegration, the construction of a short-run dynamic model, using the lagged residuals from the long run model as an error correction mechanism.

8.2 The Short Run Model - Preliminary View

The examination of earlier economic literature distinguishes a greater number of determinants for the short run model, than the long term one. In addition to the four types of variable already identified; interest rates, wealth, financial sophistication, and monetization; one can add; economic stability, GDP and monetary shocks, value of time, expected inflation, and financial innovation. As a result, the short run model can be written in broad terms as;

Velocity = f(interest rates, wealth, financial sophistication, monetization. economic stability, GDP and monetary shocks, value of time, expected inflation, financial innovation, error correction term)

Before moving on to the empirical work, it is necessary to consider the definition, measurement, and economic behaviour in the United Kingdom of these additional variables.

8.3 Interest Rates

Klein (1973), among others, argues that a short term interest rate be introduced into the velocity function, adjoining the long term one. Ensuing Bordo and Jonung (1987) this is measured as the Prime Bank Bill Rate (RS), as illustrated in figure 8.1.

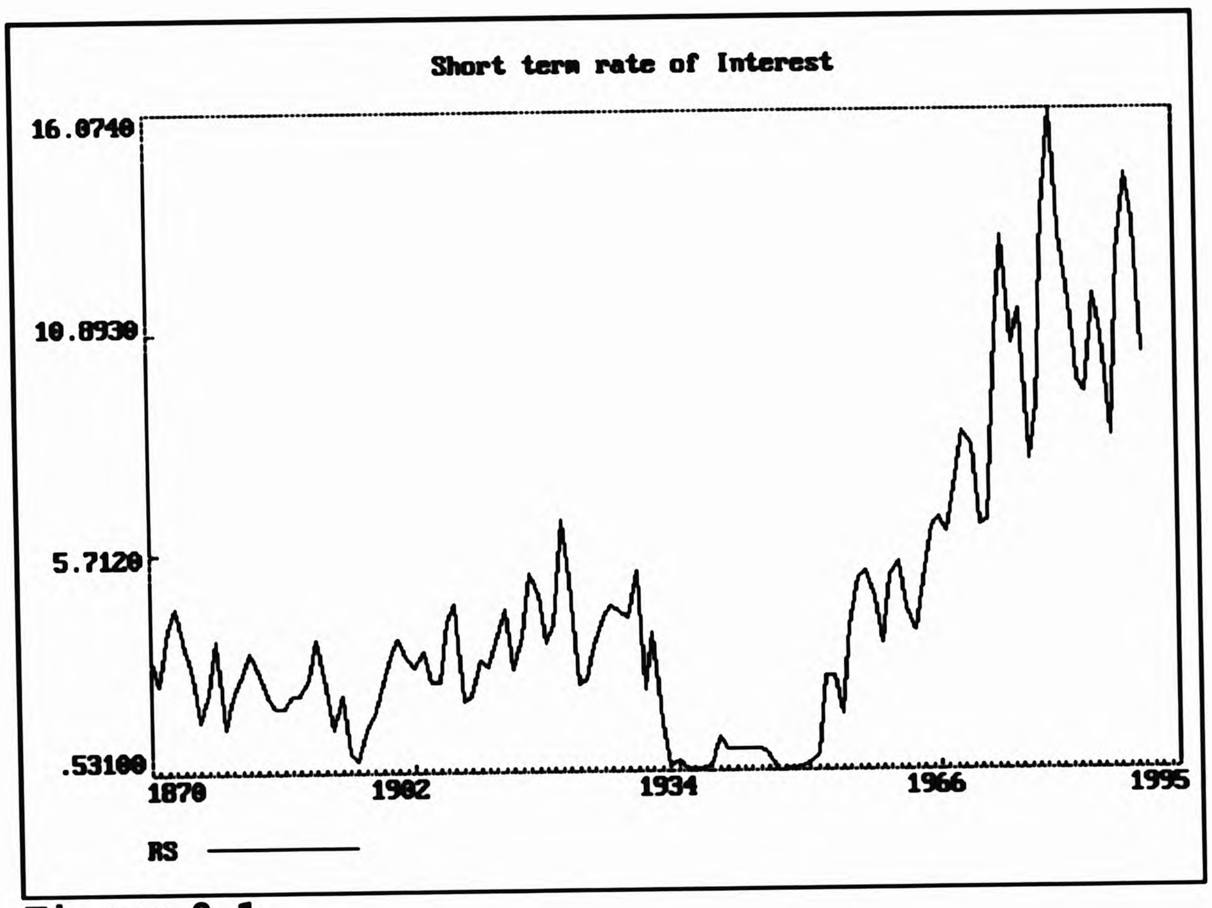

Figure 8.1

In the period 1870-1930 cyclical short term interest rates moved around a stationary mean. In the early 1930s they fell to a historical low, where they remained until after the Second World War. In the post war period RS has fluctuated around an upward trend.

So far only domestic interest rates have been considered. However, over the last decade empirical work has paid attention to open economy considerations. Brittain (1981) constructs a foreign portfolio term, which reflects the difference between domestic and foreign interest rates. This variable is expected to enter the velocity function with a negative sign.

$$RFOR = (r_f - r_d) \tag{8.1}$$

where r_d = a domestic rate of interest, r_f = a foreign rate of interest. The German scenario is chosen[1], and the differential between the German Private short term interest rate (RGER) and the domestic Prime Bank Bill Rate (RS) is considered. The resulting portfolio term (RFORG) is shown in figure 8.2.

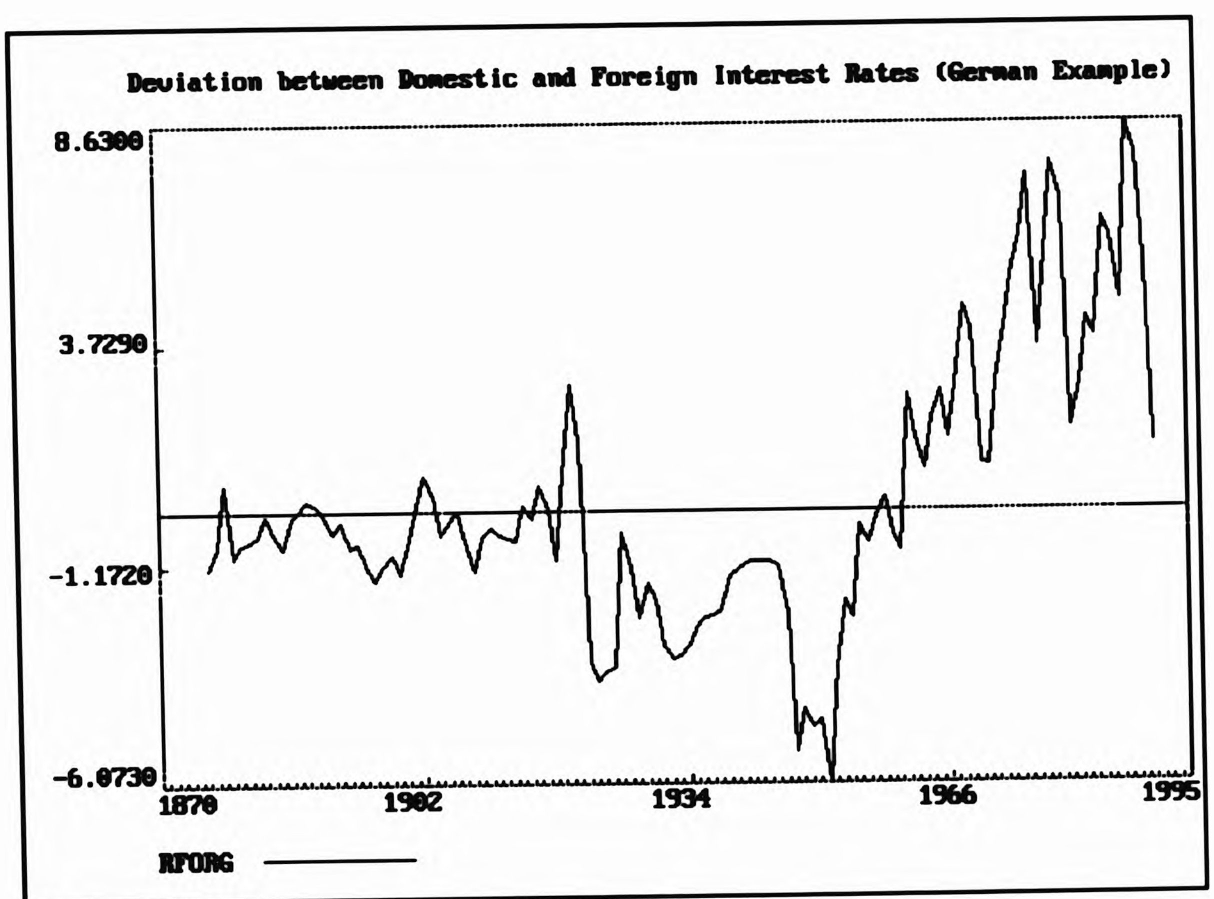

Figure 8.2

The foreign portfolio term is cyclical around zero until 1920. After a positive peak, domestic interest rates are higher than German interest rates until the mid 1960s. The final twenty five years are characterised by German interest rates being higher than United Kingdom ones.

8.4 Wealth - Transitory Income

It follows from our earlier discussion of permanent income in chapter three, that both measured income, and measured consumption contain a permanent and a transitory element. Therefore the transitory income will have an affect on money demanded and hence velocity. This can be measured, according to Bordo and Jonung (1987), as the ratio of measured per capita real income to permanent per capita real income. The resulting variable (CYCLE) is illustrated in figure 8.3. It is cyclical in nature, but stationary around a constant mean for the whole sample period. There are two notable outliers in 1919 and 1940.

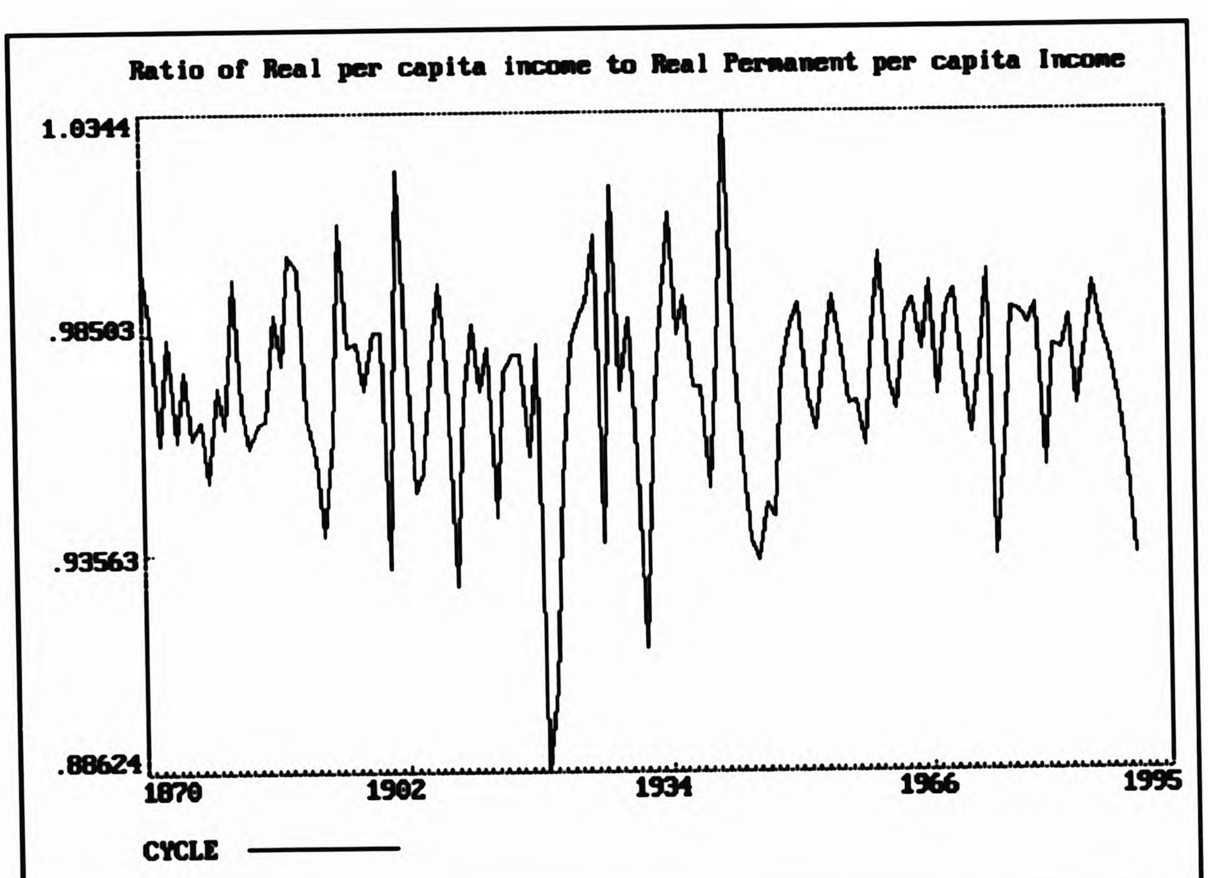

Figure 8.3

An alternative measure for fluctuations in income is the GDP gap, the difference between potential real output and actual real output. This is measured as:

ln YRGAP = ln NNPR - ln NNPTREND (8.2)

where NNPR = Net National Product (constant prices), NNPTREND = the trend of NNPR. The resulting variable (YRGAP) is illustrated in figure 8.4.

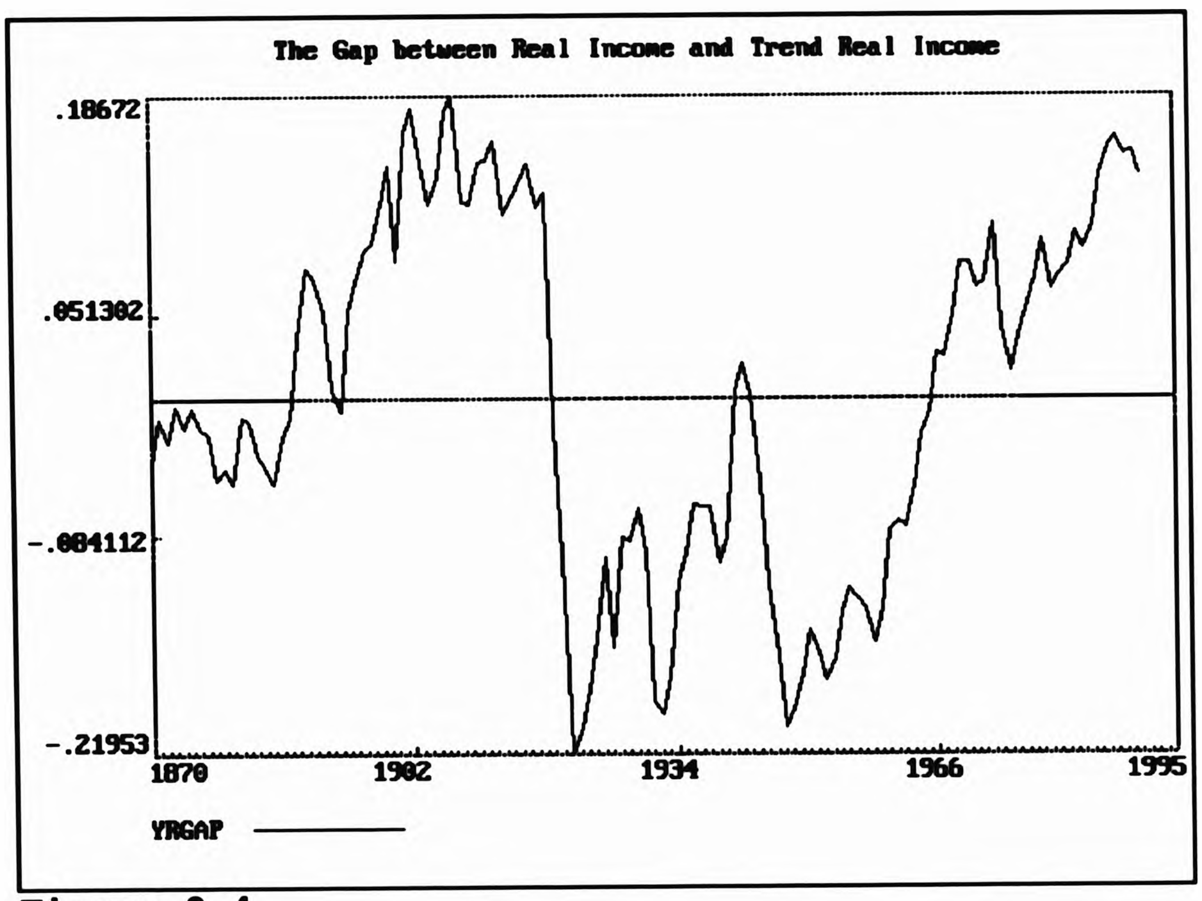

Figure 8.4

8.5 Monetization

Capie and Wood (1986) suggest urbanization as an alternative measure to the share of the labour force in non-agricultural production, and this is the only additional monetization variable. The authors argue that it is possible that industries in rural areas were slow to monetize, so that the Bordo and Jonung measure may be misleading. The ratio of the population living in towns and cities to the population as a whole (POMPT), is illustrated in figure 8.5. The latter half of the nineteenth century is characterised by an ever greater proportion of the population moving to the urban areas. However, the share of the population in major towns reaches a peak at the time of the start of the First World War. During the war, and immediately afterwards the urban population falls steeply. During the 1920s and early 1930s there is a modest increase in the population living in major towns. After 1934 there is a steady decline in the urban population. This is reversed during the 1960s, but a further decline takes place during the 1970s, a plateau being reached in the 1980s.

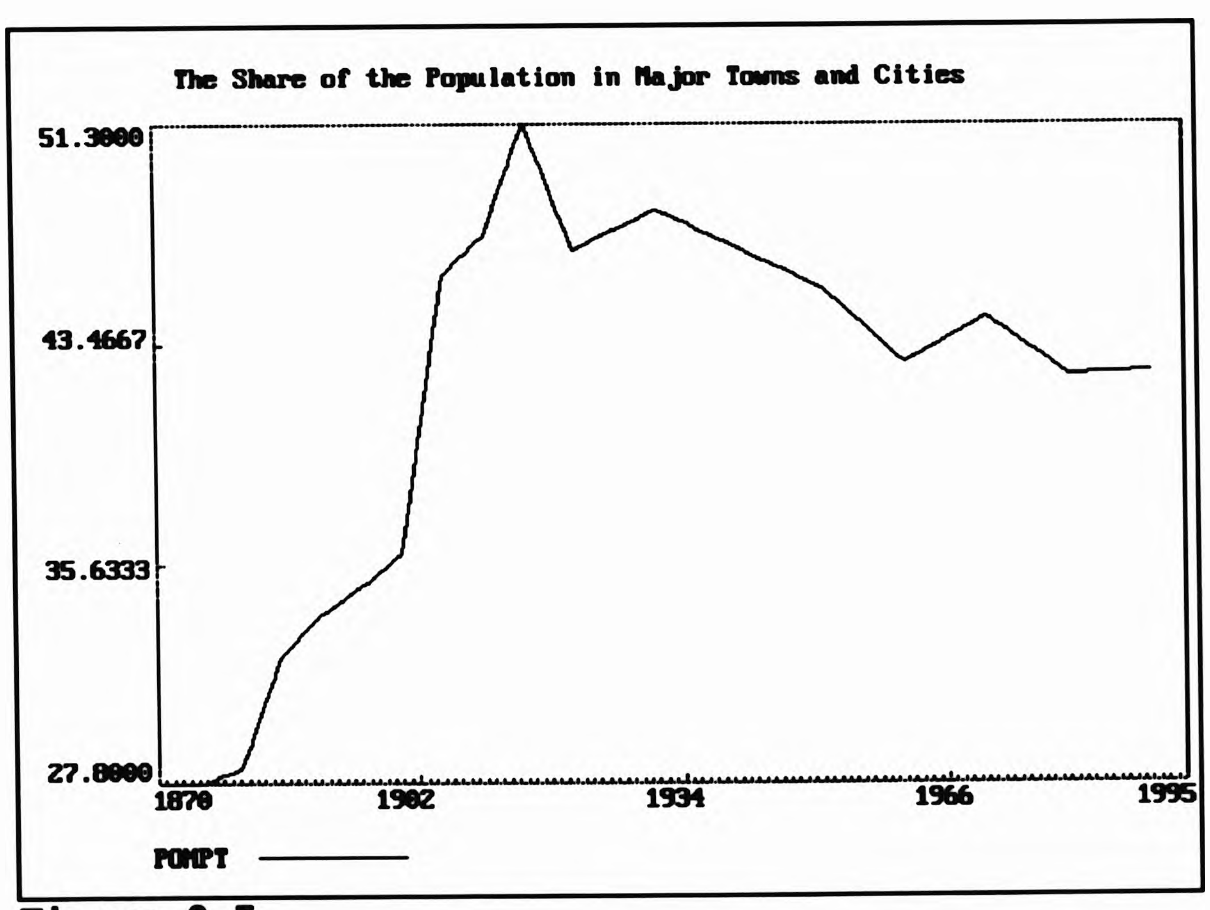

Figure 8.5

8.6 Economic Stability

In assessing their holdings of precautionary monetary balances, individuals will assess future economic stability. A proxy to encapsulate this argument based on Klein (1975), is measured as a six year moving standard deviation of the percentage change in real income per head (YSD).

$$\sigma = \sqrt{\frac{1}{n} \sum (x_i - \overline{x})^2} \qquad (8.3)$$

A decline in the certainty about the future, reflected by an increase in the standard deviation should raise the precautionary demand for money and hence lower velocity. It is illustrated in figure 8.6.

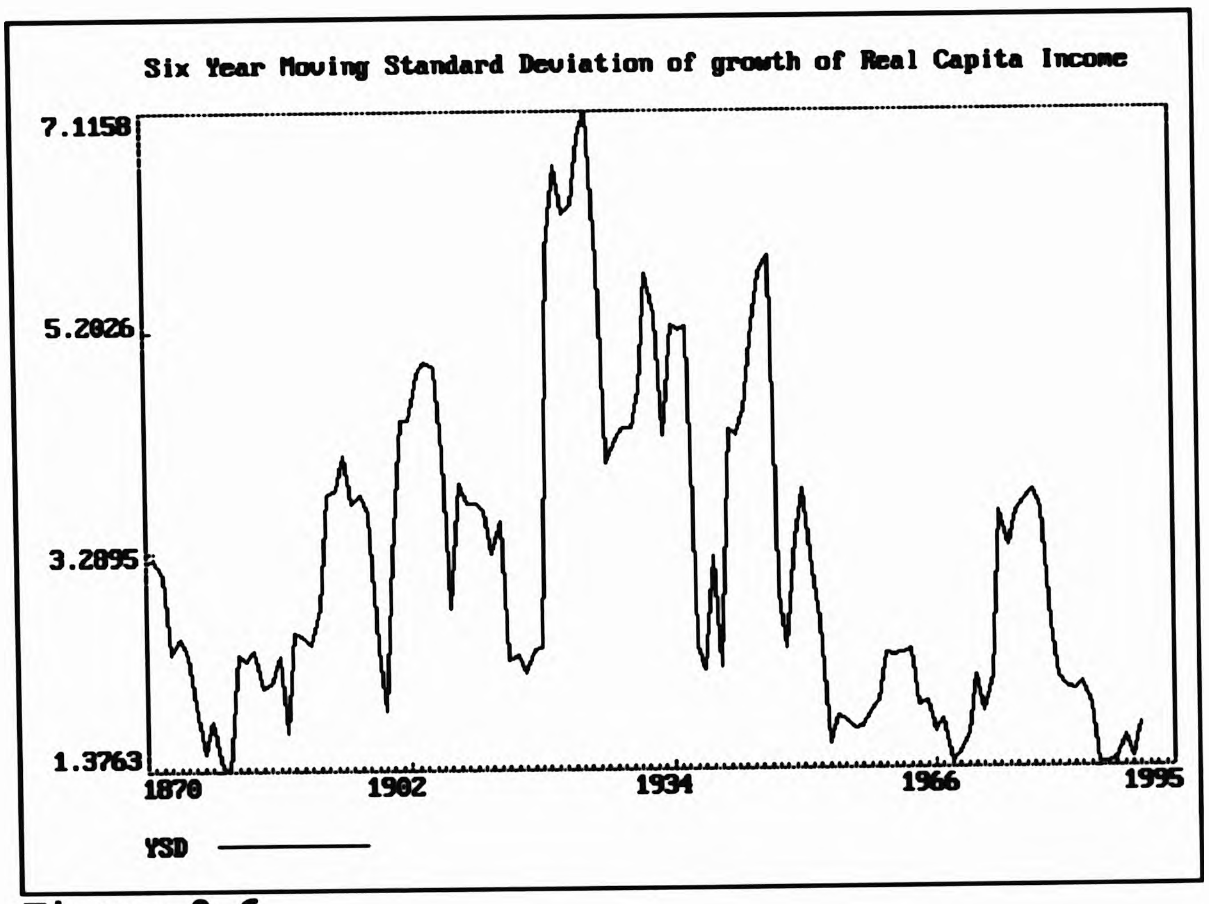

Figure 8.6

Bordo and Jonung (1987) had little success with this variable, and introduced an alternative measure of economic stability in the form of the government's share in national income. This is calculated as total government expenditure less interest payments on the national debt, divided by net national income. It is argued that increased government expenditure leads to growing economic stability and security and this in turn reduces the demand for money and raises velocity. The ratio (TG) is shown pictorially in figure 8.7.

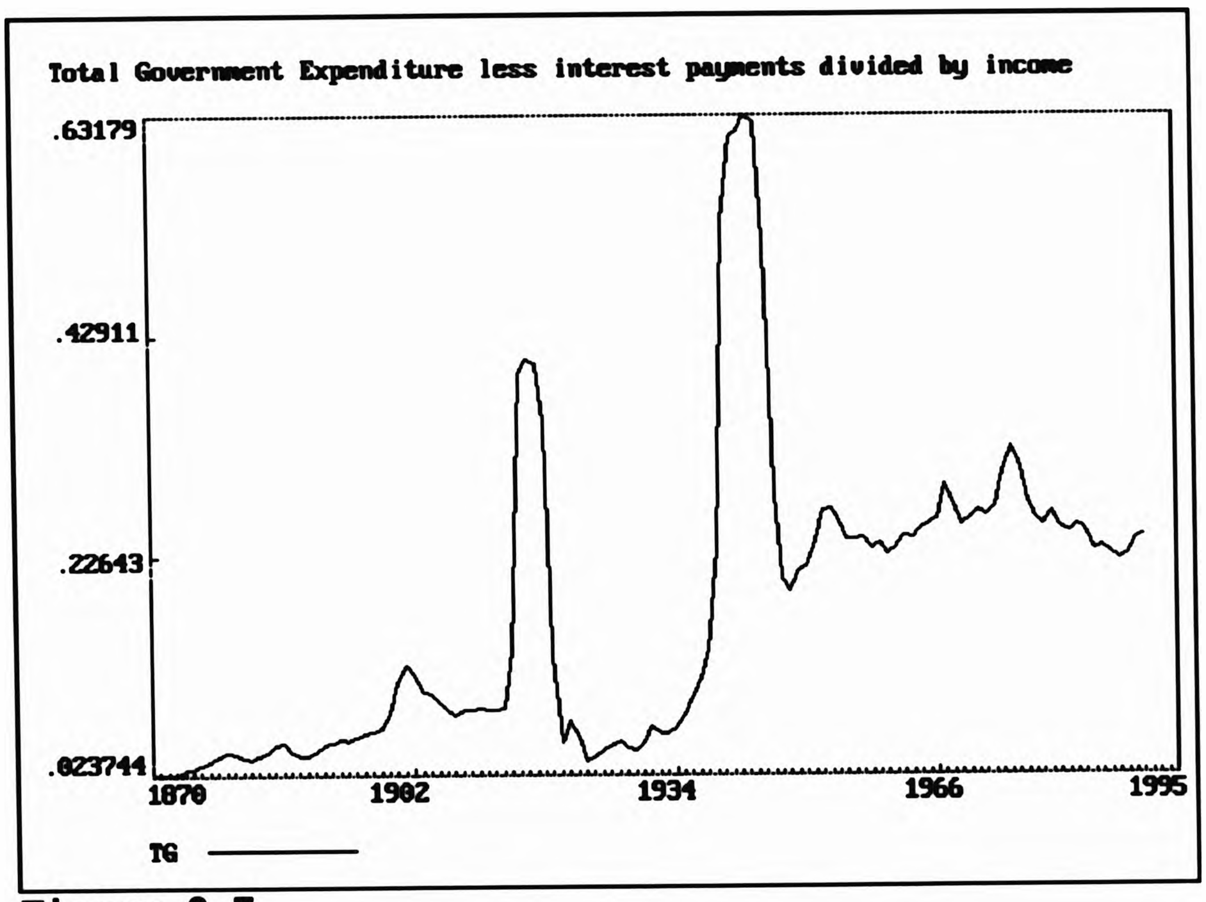

Figure 8.7

It can be argued that defence expenditure, especially during the two world wars, distorts this measure. In consequence Bordo and Jonung offer an alternative in the form of total government expenditure less interest payments on the national debt and defence expenditure, divided by net national income. The resulting variable (TGDEF) is illustrated in figure 8.8.

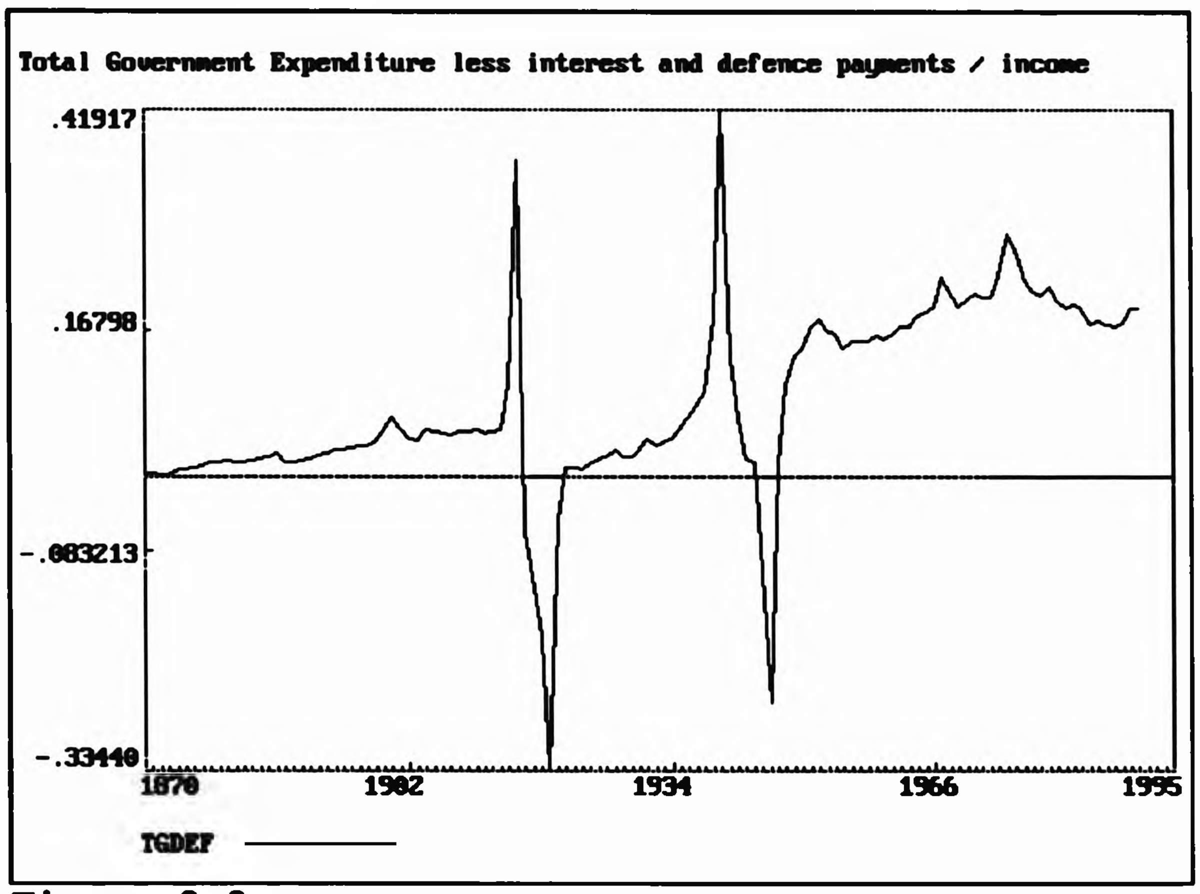

Figure 8.8

Capie and Wood (1986) offer a similar but more precise definition in the form of the percentage of GDP spent on social services, defined as education, health, social security and unemployment benefits (SSG). This is shown in figure 8.9. Apart from the Second World War and the late 1980's, this variable has risen almost continuously.

One would expect a positive relationship between TG, TGDEF, SSG and velocity. However, the majority of empirical work has found that while significantly different from zero, the parameter is of a negative sign. A possible explanation is that these variables move counter cyclically to velocity, reflecting the stabilizing role played by many governments. (see Bordo and Jonung, 1987, p.42). Another explanation, is that increased government expenditure which is funded by the PSBR may lead to an increase in the money supply before the impact is felt on nominal income. This would lower velocity, at least initially.

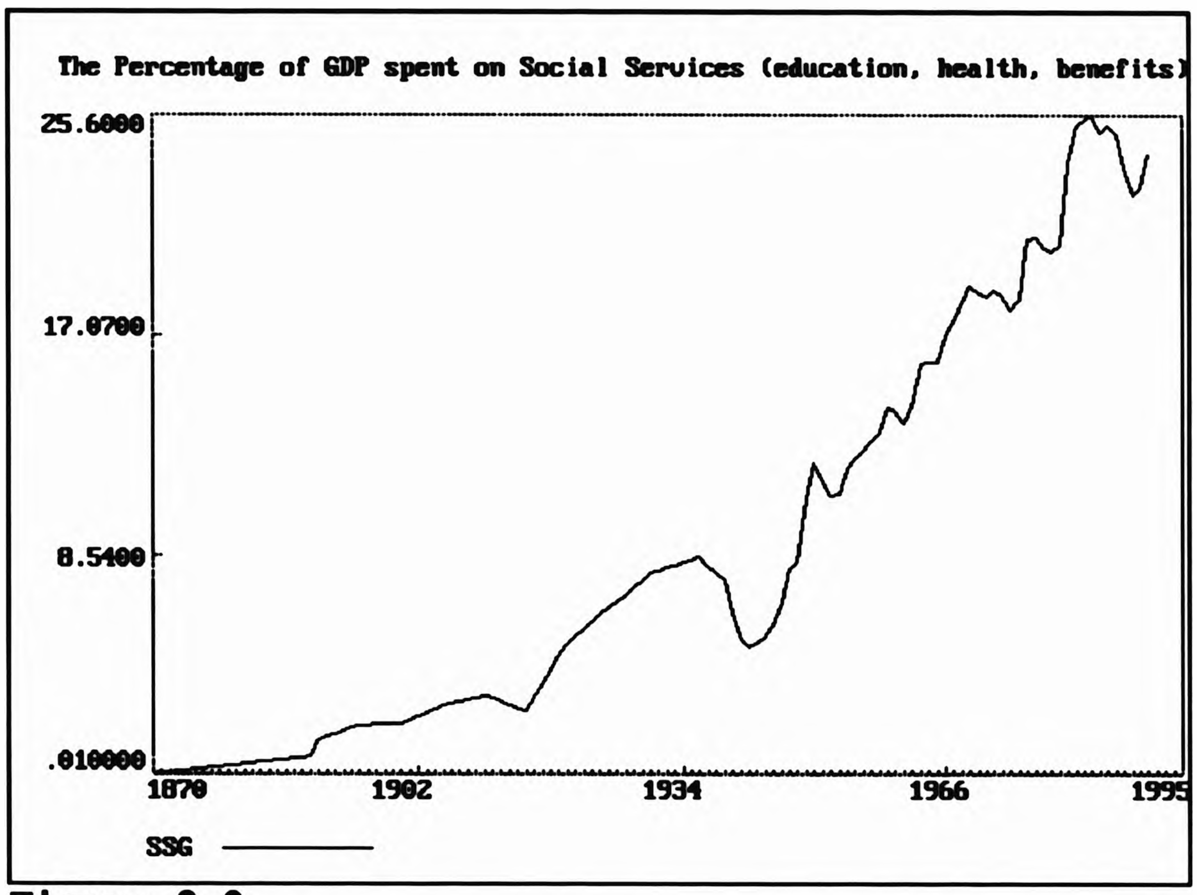

Figure 8.9

8.7 Income and Monetary Shocks

Another area of concern in accounting for short run behaviour, are the exogenous shocks to the velocity ratio, either to the numerator, nominal income, or denominator, the demand for money balances. Tatom (1983) suggests that labour strikes affect at least temporarily, reducing both production and spending. This is measured using the ratio of working days lost by strikes to labour force employed, as shown by STL in figure 8.10. The majority of working days lost through strike action took place in the first half of this century. The graph is dominated by the peak caused by the "General Strike". The other notable feature are the small peaks caused by a variety of coal miners strikes during the mid 1970s and early 1980s.

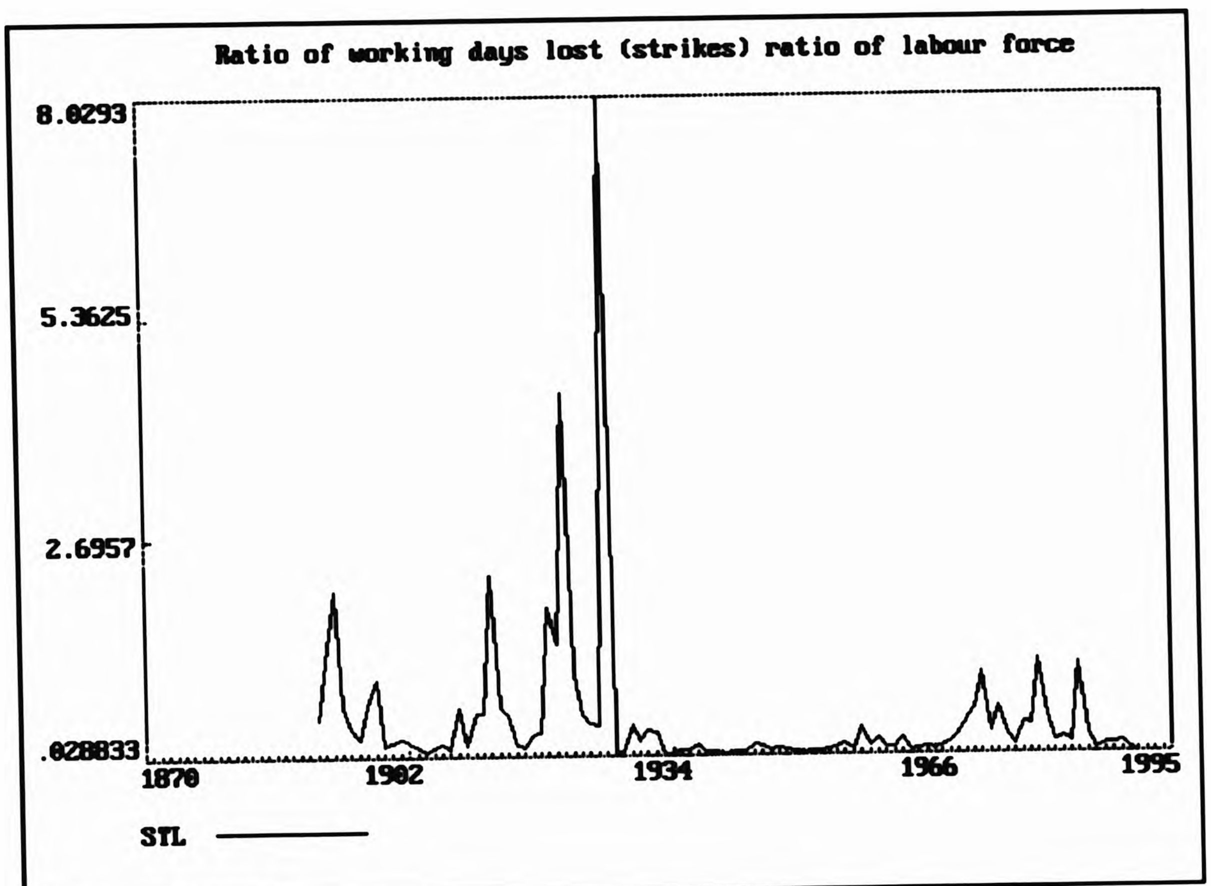

Figure 8.10

As discussed in chapter three, there are two components of G.D.P. whose unexpected variation may cause changes in velocity, these are inventories and imports. To measure this influence two additional variables are introduced. INVR, real inventories and work in progress, and MR, real imports, illustrated in figures 8.11 and 8.12 respectively. Real inventory and work in progress is dominated by the major trough in 1916, while real imports, for the most part, follow an upward trend, especially after the Second World War.

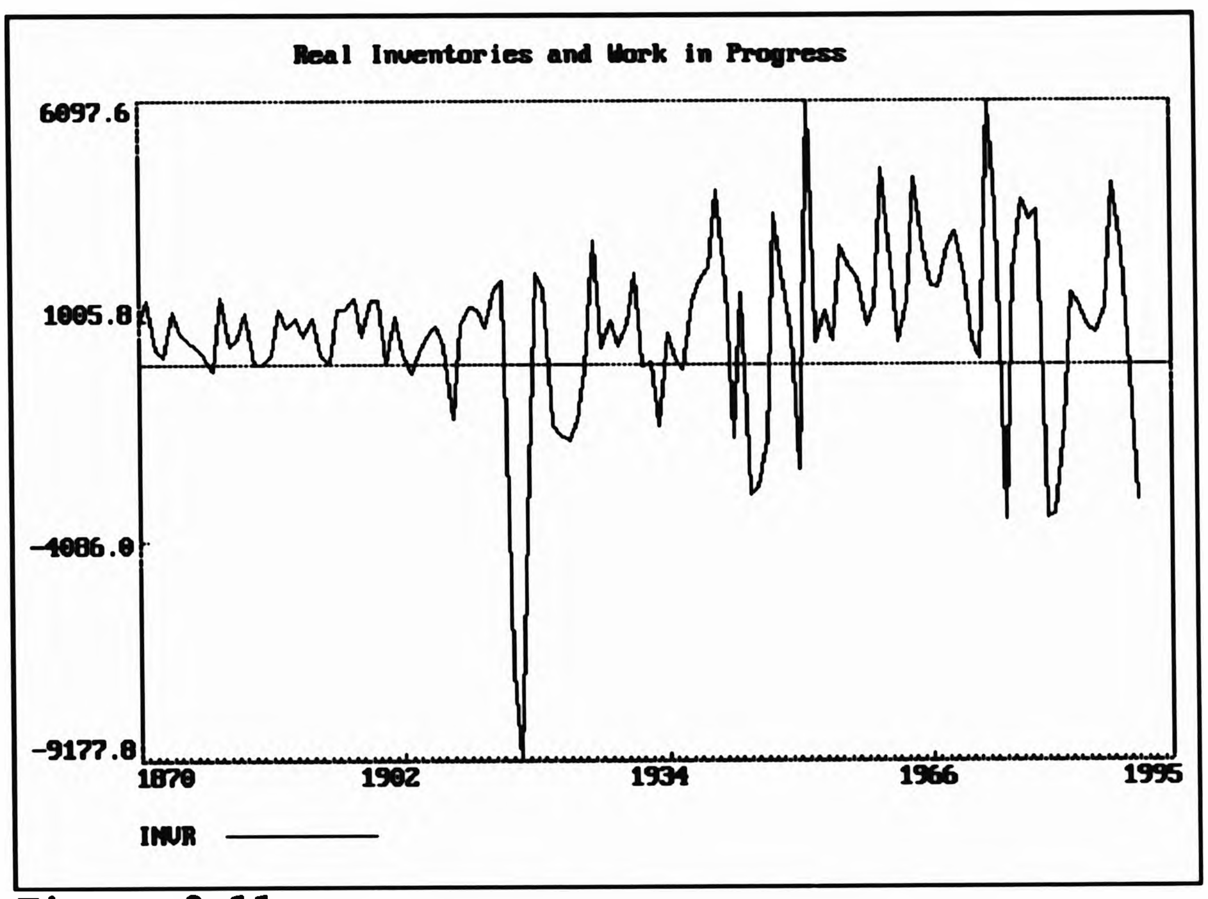

Figure 8.11

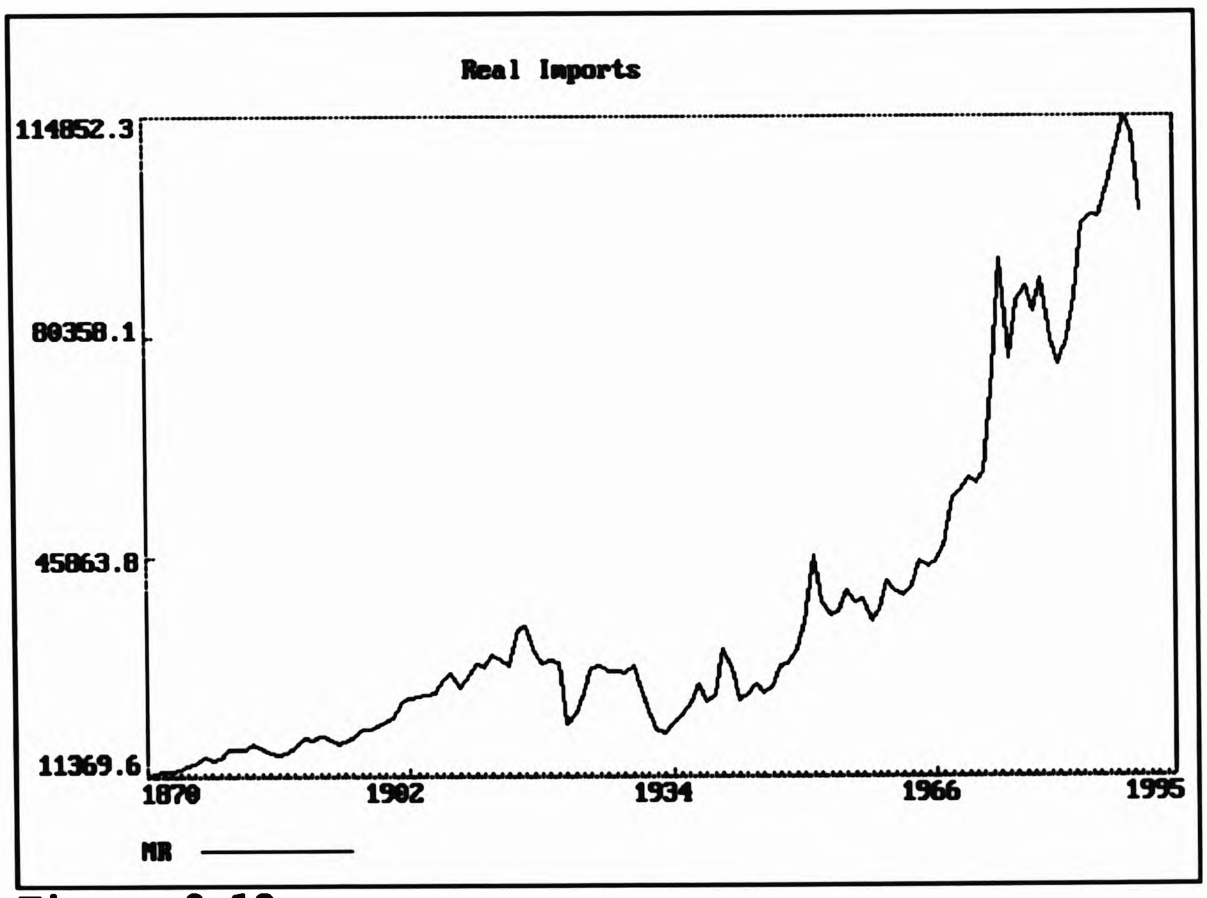

Figure 8.12

A reduction in direct taxation, ceteris paribus, will lead to an increase in consumption, which in turn causes a rise in the demand for transaction balances. Accordingly in the short run a reduction in direct taxes results in a decline in the velocity of money. The basic rate of income tax is illustrated in figure 8.13.

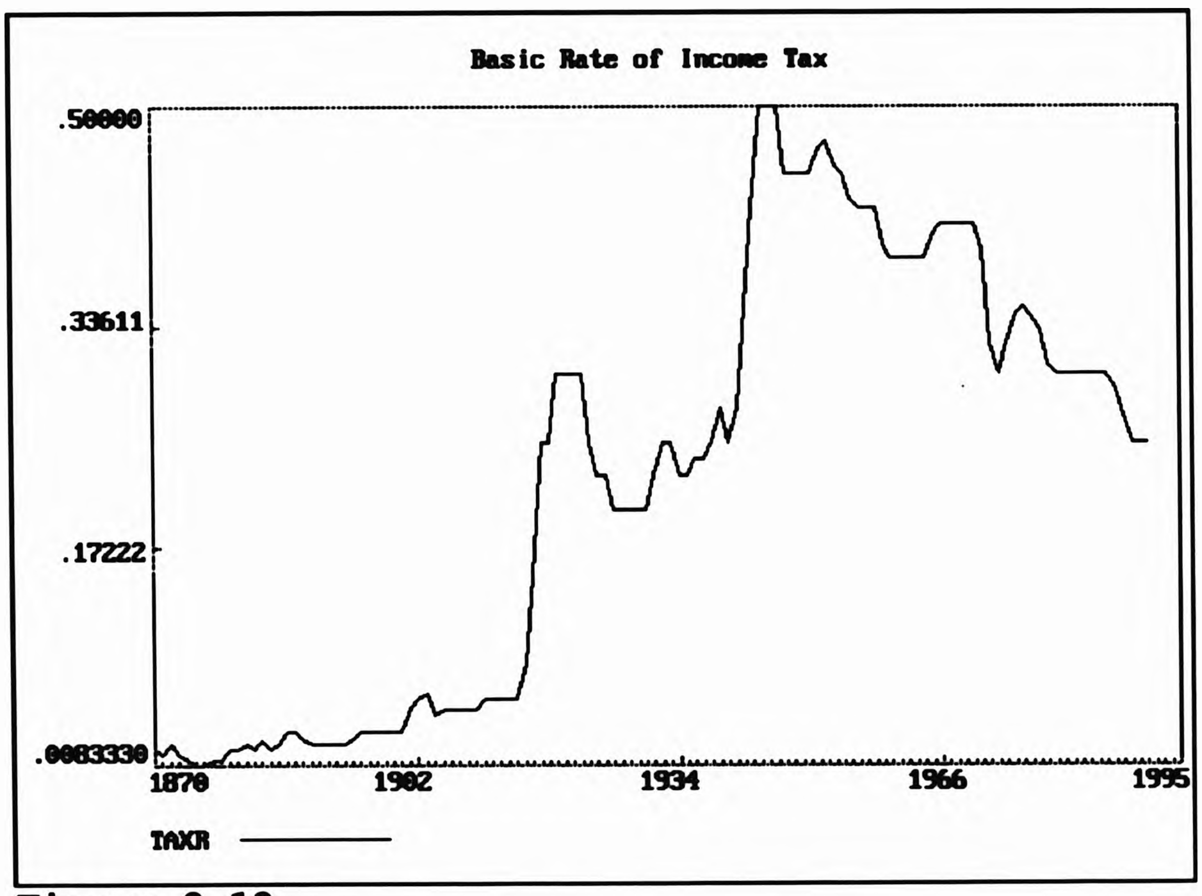

Figure 8.13

As discussed earlier, money balances serve as a shock absorber or buffer stock, which temporarily absorbs unexpected variations in income (transitory income), until the portfolio of securities and consumer durable goods can be adjusted. Together with the shock which may come from unexpected changes in the nominal money supply. In order to measure this phenomenon we introduce, following Chow (1966), the money shock absorber variable, that is the deviation between the nominal money stock (CWM3) and its long run trend level (M^*). Thus money deviation variable is measured as:

$$MDEV = \ln M_t - \ln M_t^* \tag{8.4}$$

This is illustrated in figure 8.14. Until the turn of the century, the ratio is positive. Between 1902 and 1972 except for a short period, MDEV is negative. In other words, the actual money supply is less than the overall trend. This is reversed after 1973.

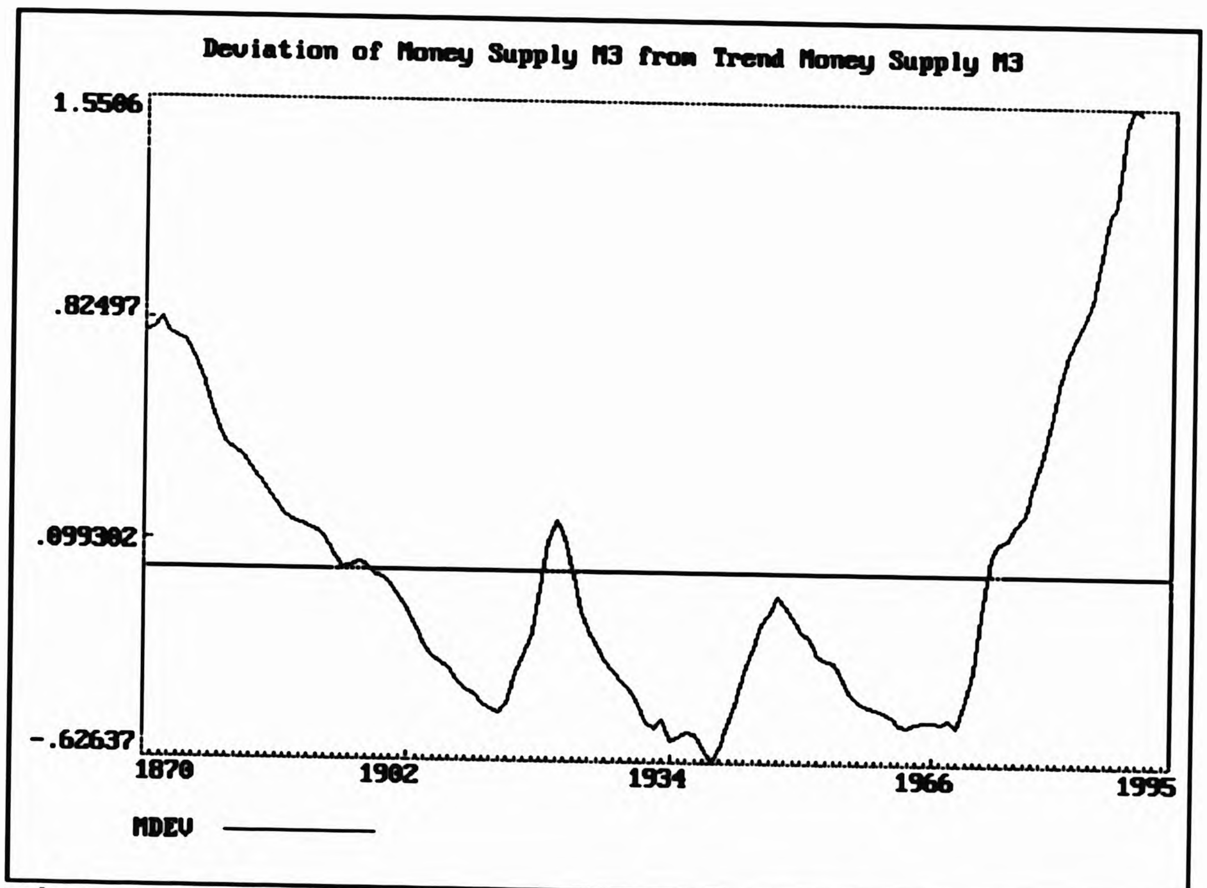

Figure 8.14

8.8 Price Expectations

The expected rate of change of price inflation reflects the opportunity cost of holding money. Early price expectations measurement used adaptive expectations, which were constructed using geometrically declining weights on the lagged values of past price inflation. However, by the early 1970s there was growing dissatisfaction with Friedman's adaptive expectations mechanism. Adaptive expectations implies that individuals will, regardless of what else happens, hold to a learning curve derived from an earlier period in time, although this may not reflect at all, what is happening in the economy at that moment. It is very unlikely, that this is actually what happens. More likely is the idea that people select from alternative learning rules, depending upon the circumstances they find themselves in at any particular time, and the information available to them. In other words expectations are rational. The Rational Expectations hypothesis was originally pronounced by Muth (1961), but its application to macroeconomics and policy issues was pioneered by Sargent, Lucas, and Wallace in particular. The basis of the hypothesis is the proposition that anticipations are formed "rationally" or consistently by individuals, as optimal predictions based on available information. Therefore, individuals will not make systematic errors in forming their expectations of inflation, as in the adaptive expectations mechanisms, as adjustment is continuous. Consequently, there will be only transitory and random deviations between the actual and expected rates of inflation. According to Tatom (1983) if inflation expectations are unbiased, they can be measured by changes in the GDP deflator (RPD), as illustrated in figure 8.15, and this is the main measure we will use in this analysis.

Tatom (1983) also suggests energy and other raw material prices will affect velocity at least temporarily. These are measured here by the rate of growth of import prices (RPQD) as shown in figure 8.16.

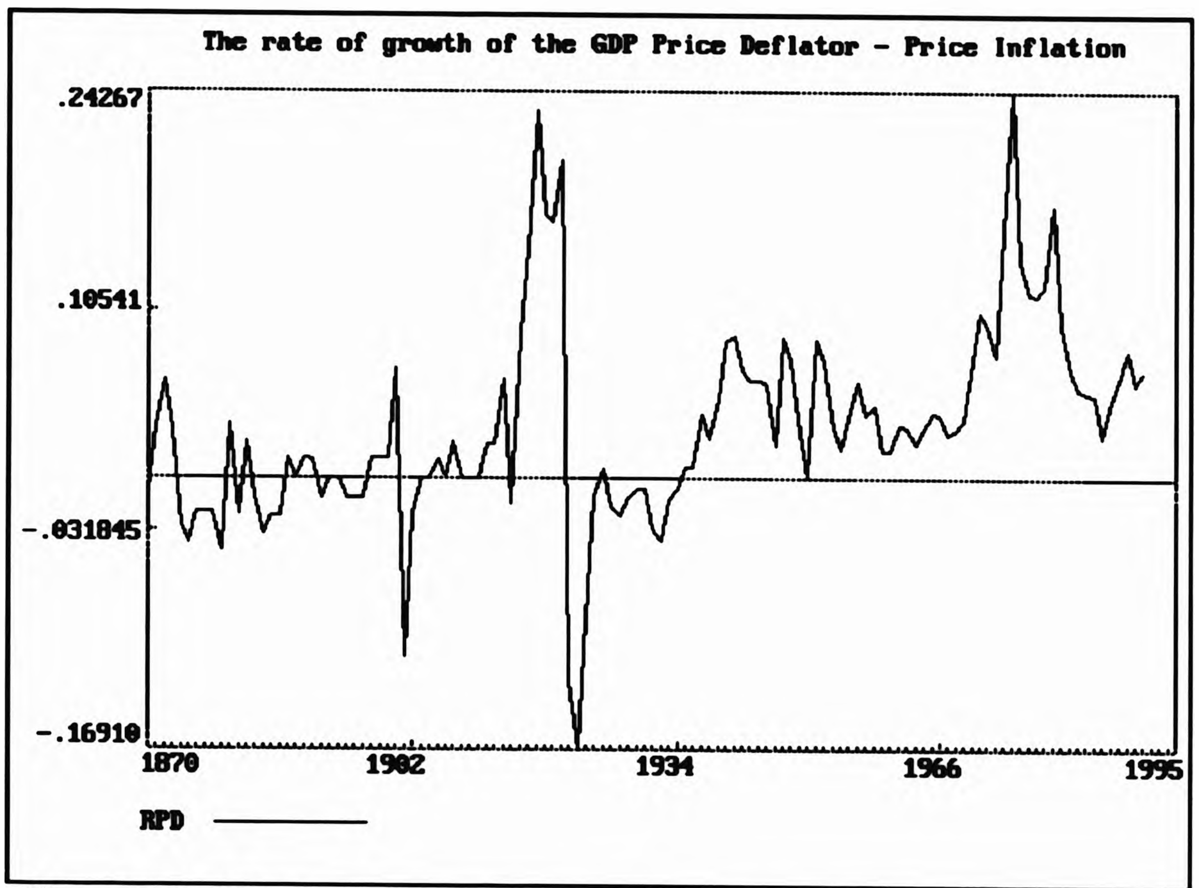

Figure 8.15

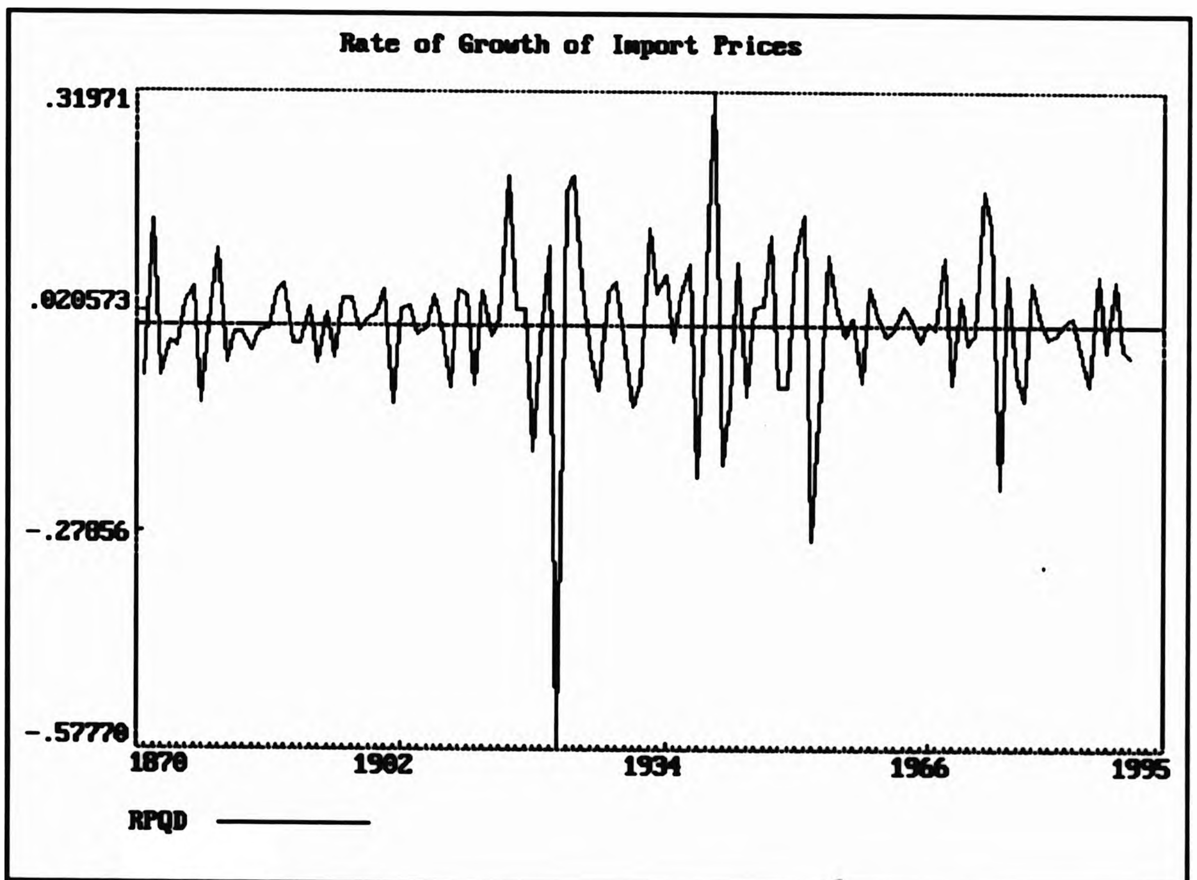

Figure 8.16

If we recall from chapter three, Karni (1974) suggested that real money holdings are positively related to the real value of time. This is due to the fact that individuals and firms wish to save time when conducting their exchange activities. Karni's hypothesis is stated in the form of an inventory model of the demand for money, by assuming that cash withdrawal involves a cost in terms of goods and time, that is forgone earnings. He suggests that the elasticity of the demand for money with respect to real hourly earnings is larger than the elasticity of the demand for money with respect to property income or per capita hours worked. In order to consider this argument, we introduce the variable, WP, which is a real wage measure, the index of average weekly wage rates (W) to the price deflator (PD). This is illustrated in figure 8.17.

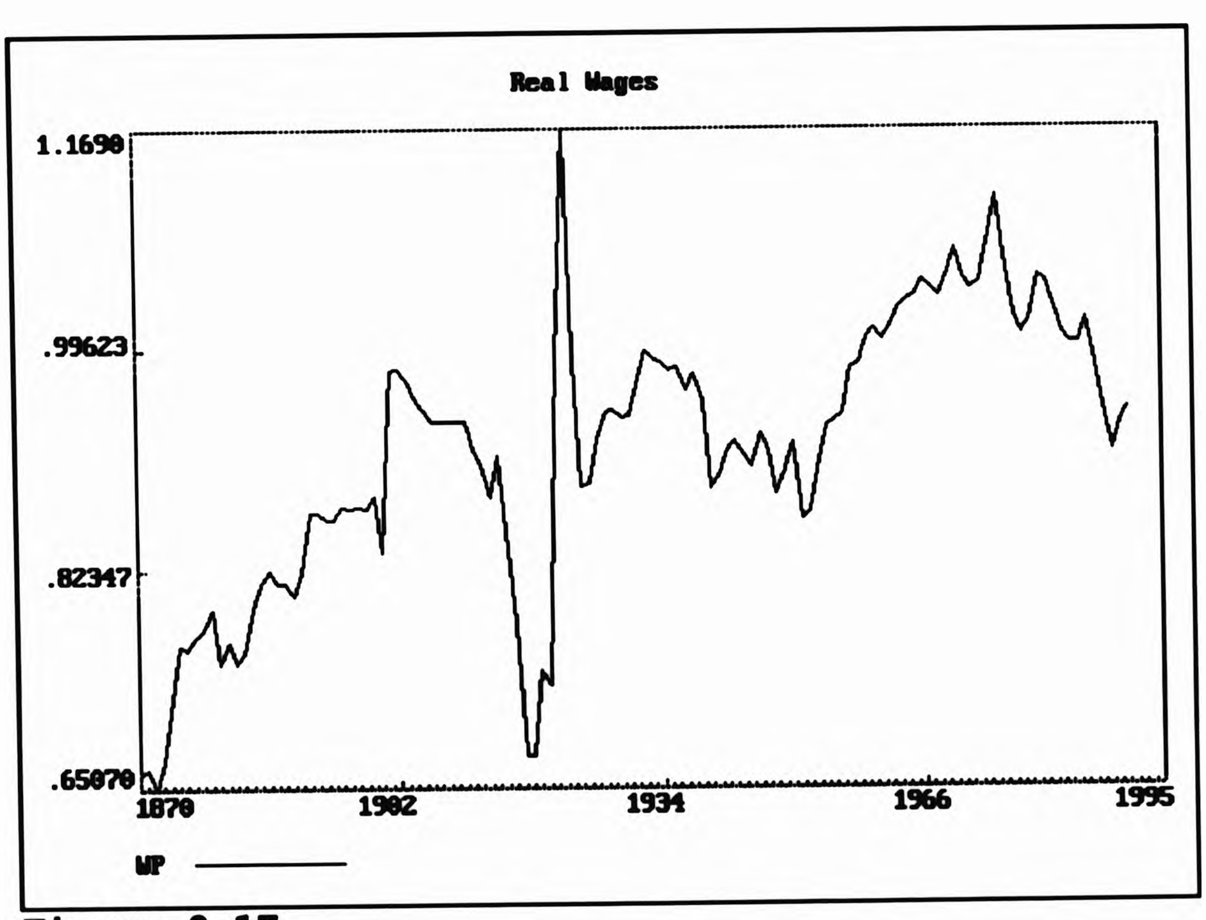

Figure 8.17

8.9 Financial Innovation

The final sub set of independent variables are those associated with financial innovation. By their very nature the sample size for these variables is very limited, although it has been possible to construct series for the post Second World War period. The first of these variables is the number of automatic teller machines (ATM) as illustrated in figure 8.18. The first ATM was introduced in the mid 1960s. After an initial period of steady growth, the late 1970s were characterised by a steady number of machines. However, after the introduction of the second generation machines in the early 1980s growth was very rapid.

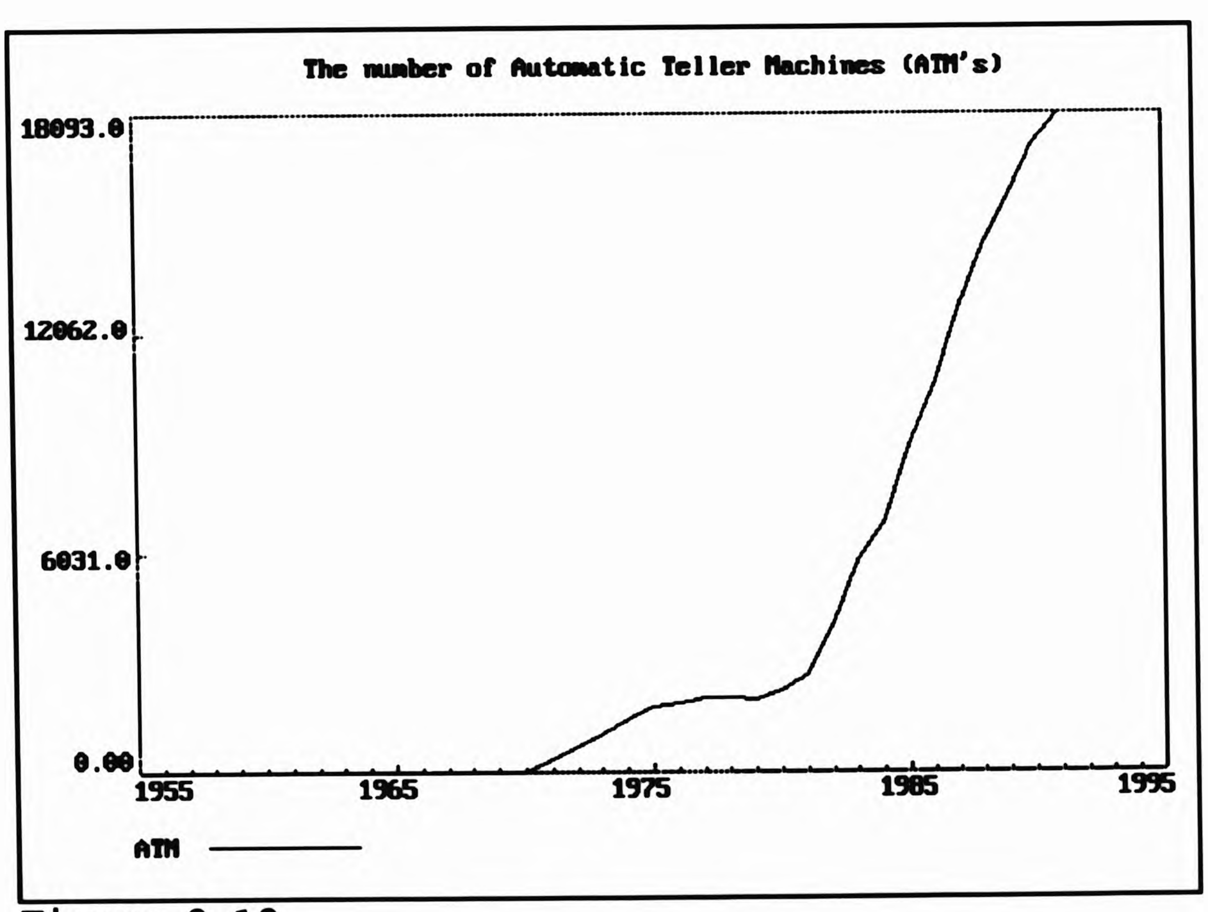

Figure 8.18

The second financial innovation variable is the number of credit cards issued (CCARD) as shown in figure 8.19. These have risen rapidly since their introduction, apart from a slight decline in the early 1990s following the introduction of an annual charge.

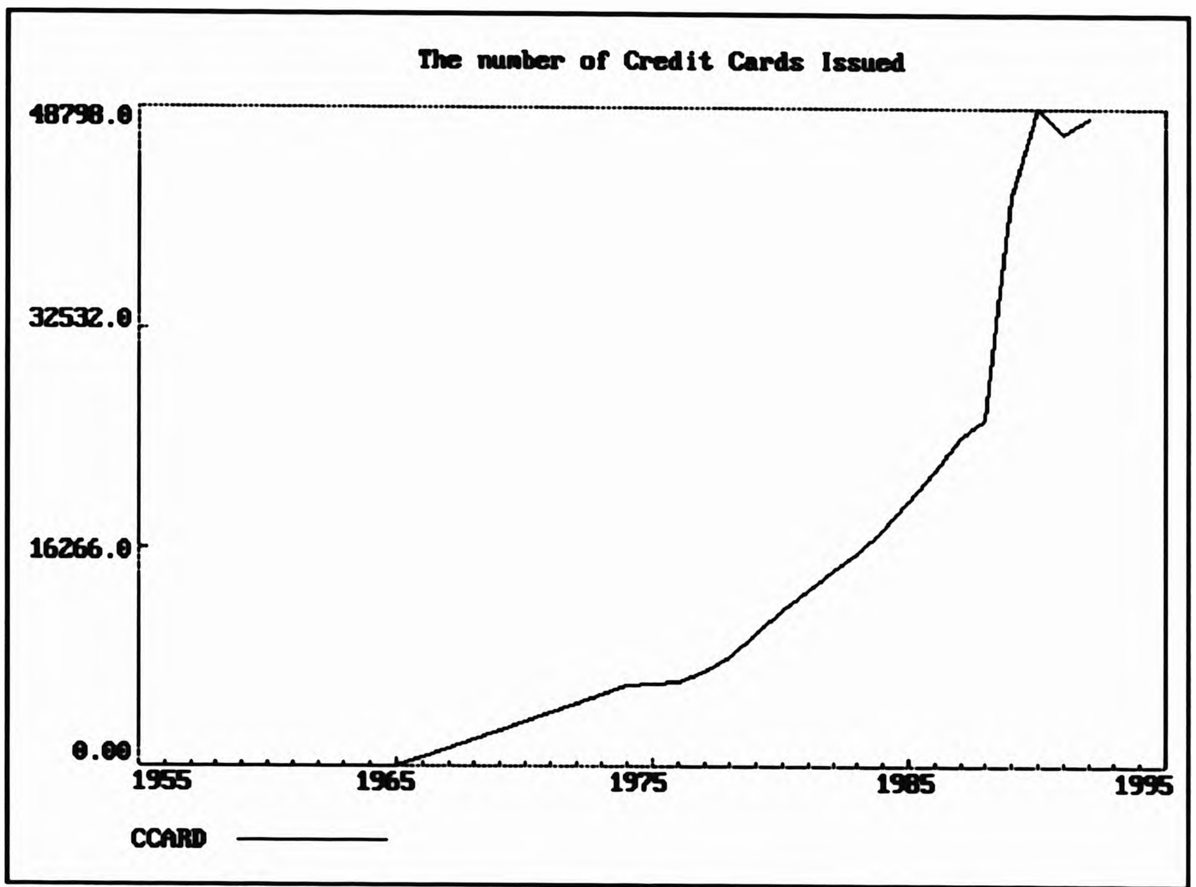

Figure 8.19

The third financial innovation variable is the number of Building Society Share accounts per capita (BSSAPN) as illustrated in figure 8.20. This ratio has risen steadily until 1987, when it fell, before stabilising at a new plateau. Another financial innovation variable is the previous peak of the short run rate of interest (RSMAX). This is introduced to simulate the ratchet hypothesis put forward by Goldfeld (1973). It is illustrated in figure 8.21. Between 1955 and 1967 it is constant at 6.43%. It moves to a new level in 1968, remaining at this rate until 1972. Another new rate is established in 1973, where it remains for the next five years. RSMAX's maximum rate is established in the late 1970s at 16.0740, where it remains until the end of the sample period in 1991.

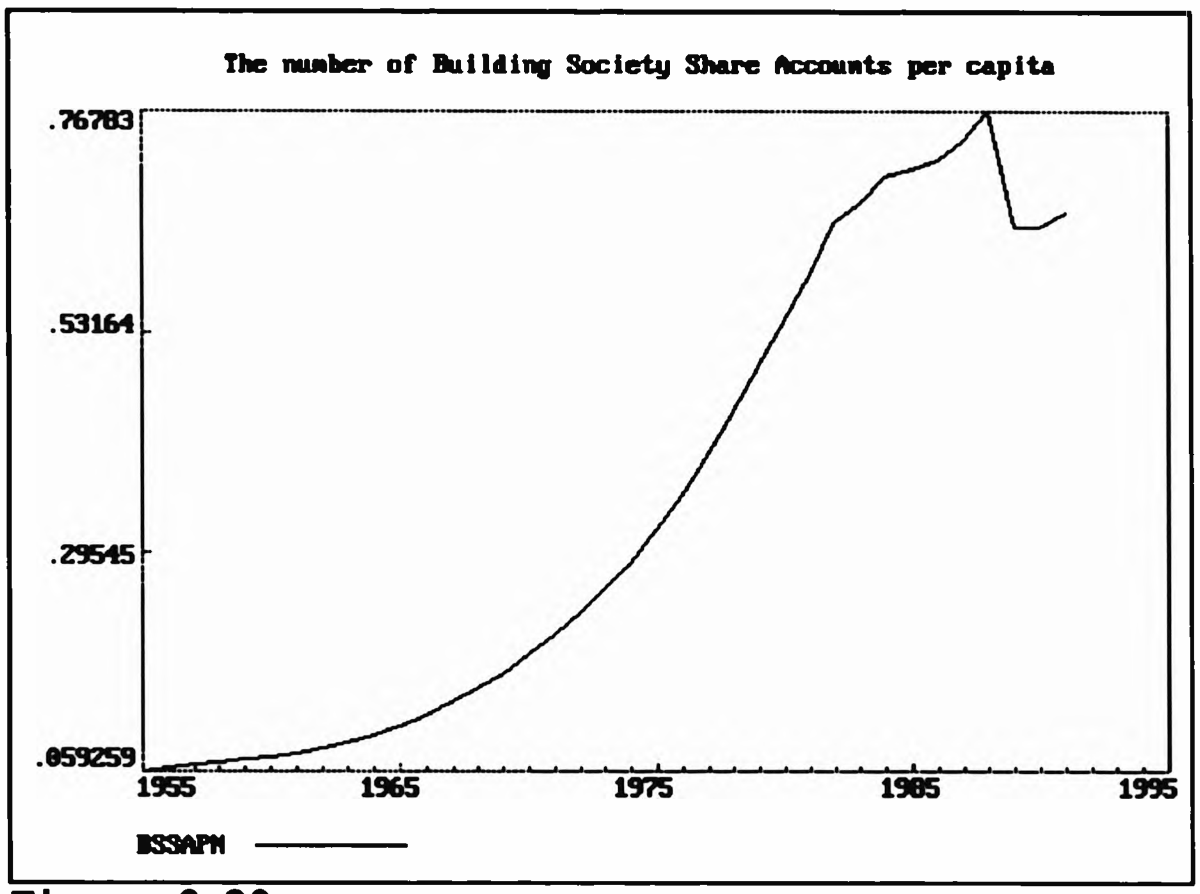

Figure 8.20

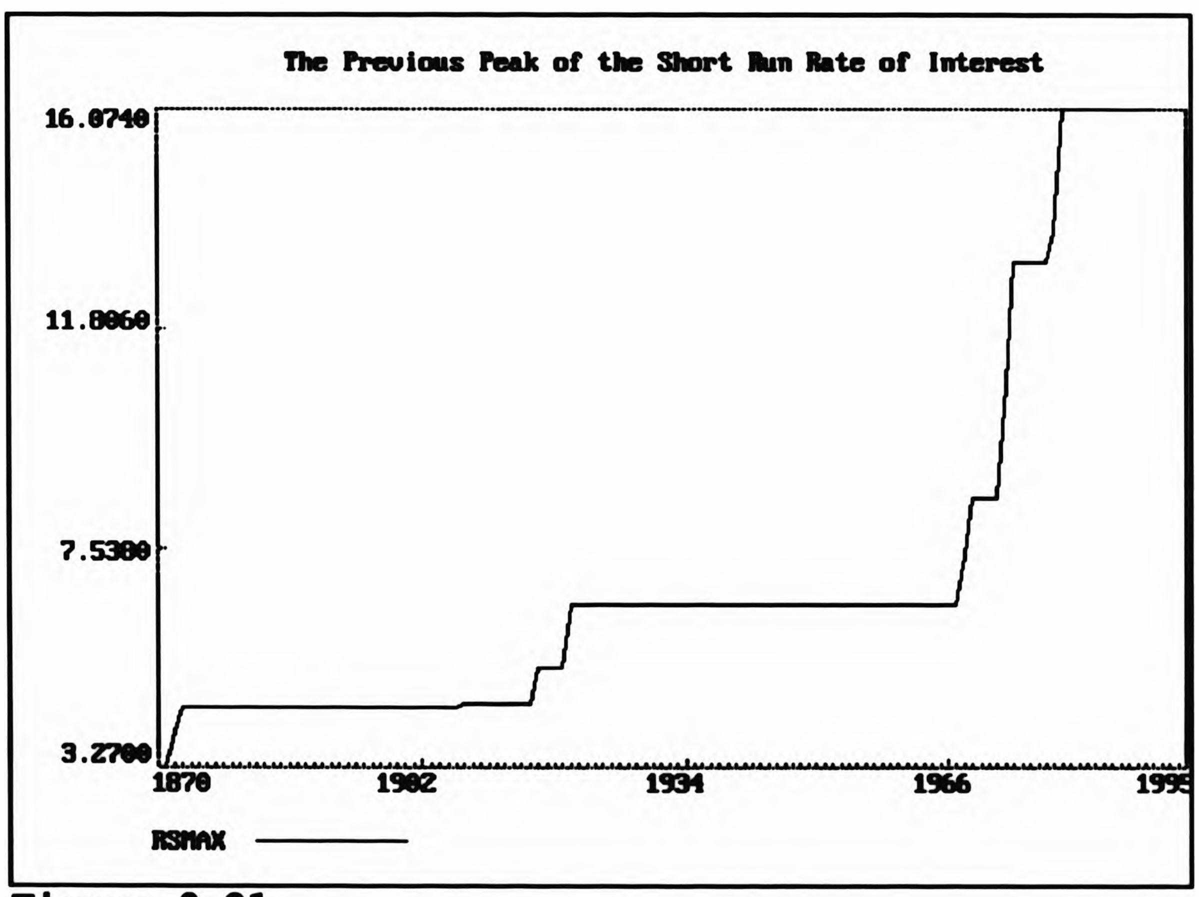

Figure 8.21

The final area concerns the financial innovations taking place in the stock market. These are measured in three forms, the real stock market price (RSMP), the Financial Times earnings yield (FTEY), and the ratio of short to long treasury bond yields (TLSR). The real stock market price is shown pictorially in figure 8.22. RSMP fell in the late 1950s, but recovered in the early 1960s, from whence it revolved around a constant mean until the early 1970s. A notable peak being in 1968. There was a dramatic fall in real stock market prices in 1973, and they remained at this low level until 1982, when a recovery began to take place. After 1987 RSMP was fairly constant until the end of the sample period.

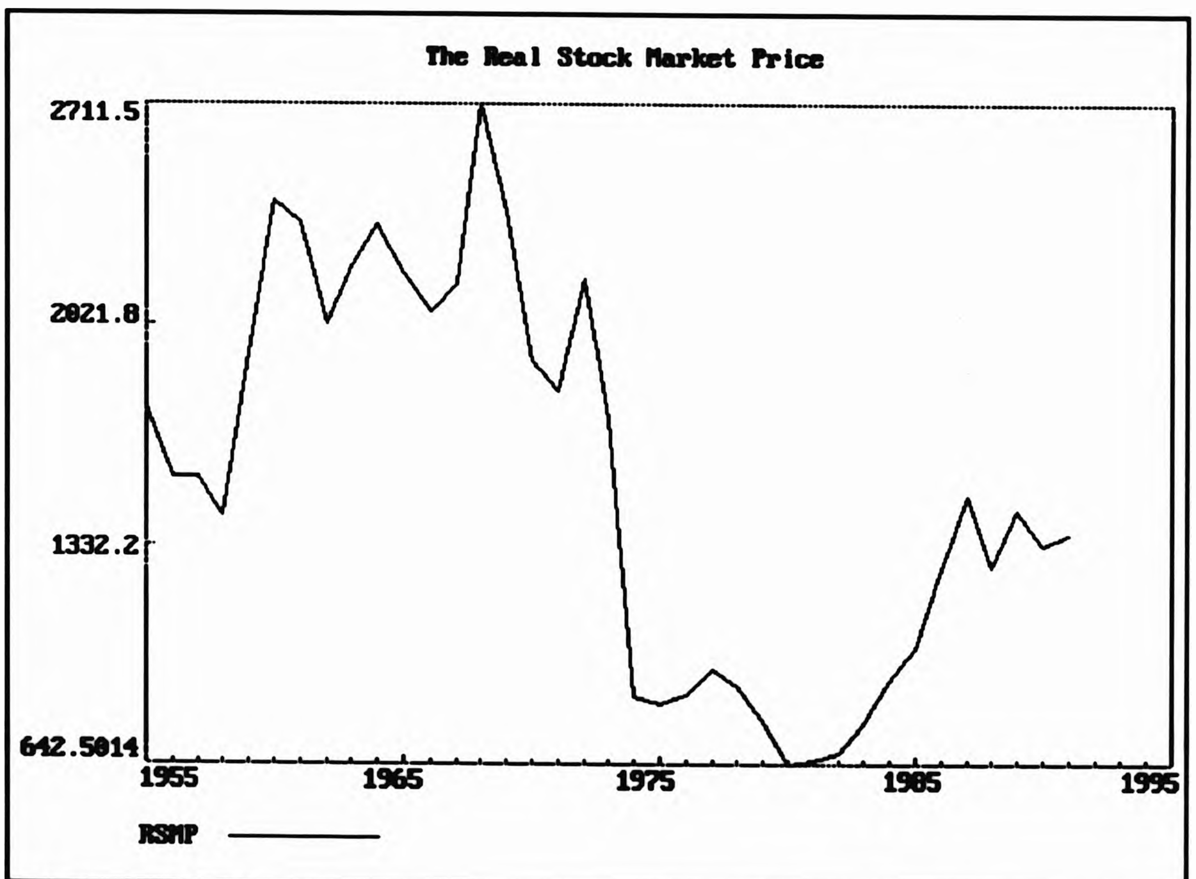

Figure 8.22

The Financial Times Earnings Yield (FTEY) is shown in figure 8.23. Throughout the 1950s and 1960s FTEY is characterised for the most part by a downward trend, reaching an all time low in 1972. This is dramatically reversed into a maximum peak of 21.47 in 1973. The Financial Times Earning Yield then falls back modestly to a fairly constant plateau in the late 1970s. However, FTEY falls again in the early 1980s stabilising around a new mean for the remaining part of the decade. The ratio of long to short Treasury Bill yields (TLSR), is shown in figure 8.24. This variable peaks in the late 1950s, followed by a trough in the 1960's. A major peak is to be found in 1971 followed almost immediately by a trough in 1973. There are two further peaks in the mid 1970s, after which a decline takes place. TLSR is fairly stable in the 1980s, except for a trough in 1989.

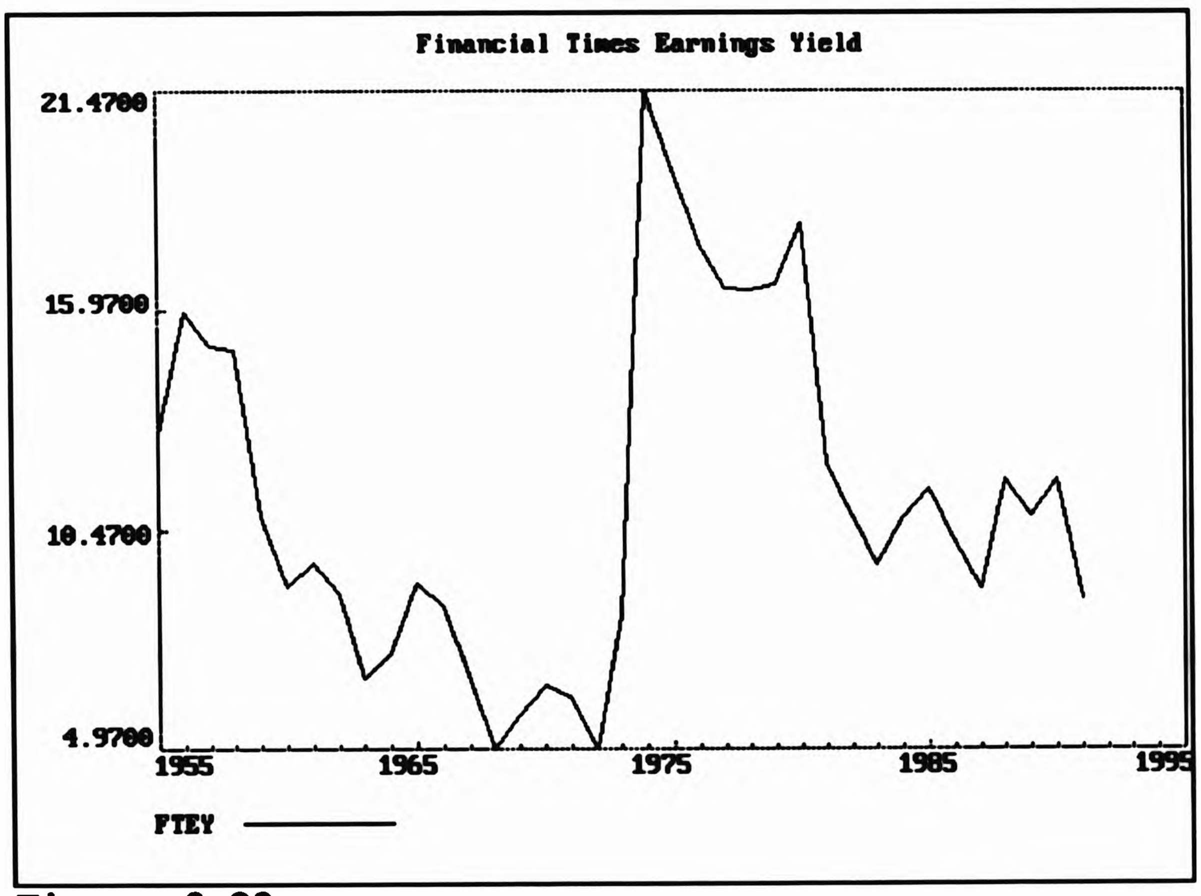

Figure 8.23

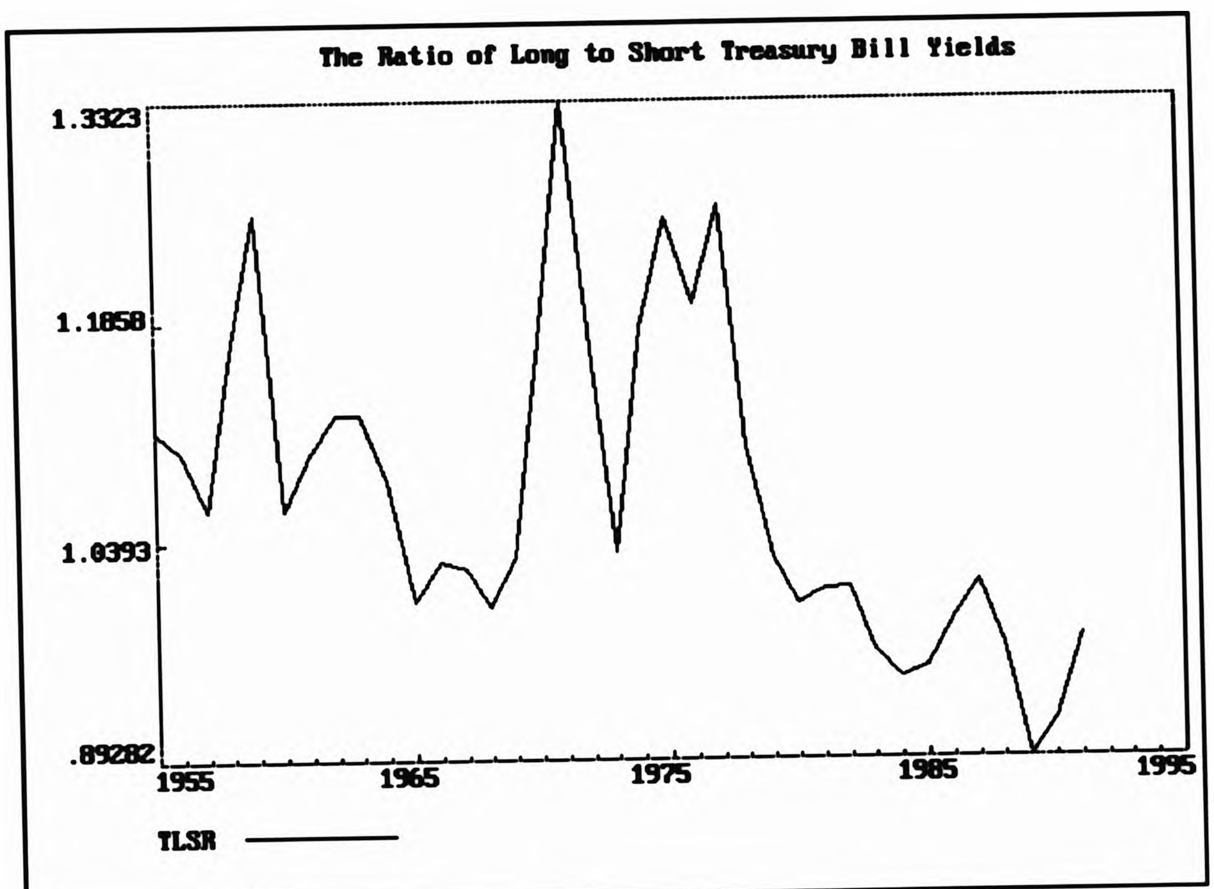

Figure 8.24

8.10 The Theoretical Short Run Dynamic Model

The completion of the review of proposed regressors gives the opportunity to state the full short run model, including those long run regressors which also, it is believed, play a role in the short term. It can be stated in the following functional form.

$$
\begin{aligned}
V = f(&\underbrace{RL,\ RS,\ ROWN,\ RFORG}_{\text{interest rates}},\ \underbrace{(Y/PN)^{P},\ CYCLE,\ YRGAP}_{\text{wealth}},\\
&\underbrace{(TNBFA/TFA)}_{\text{financial sophistication}},\ \underbrace{(LNA/L),\ POMPT,\ (C/M)}_{\text{monetization}},\\
&\underbrace{YSD,\ TG,\ TGDEF,\ SSG}_{\text{economic stability}},\\
&\underbrace{STL,\ INVR,\ MR,\ TAXR,\ MDEV}_{\text{G.D.P. and monetary shocks}},\\
&\underbrace{RPD,\ RPQD,\ WP}_{\text{inflation and value of time}},\\
&\underbrace{ATM,\ CCARD,\ BSSAPN,\ RSMAX,\ RSMP,\ FTEY,\ TLSR}_{\text{financial innovation}})
\end{aligned}
$$

where V = velocity of circulation, RL = long term interest rate (consols (2.5%)), RS = short term interest rate (prime bank bill rate), ROWN = own rate of interest on money, RFORG = foreign portfolio term (German example), $(Y/PN)^{P}$ = permanent income, CYCLE = the ratio of measured per capita real income to permanent per capita real income, YRGAP = difference between potential real output and actual real output, (TNBFA/TFA) = ratio of total non bank financial assets to total financial assets, (LNA/L) = ratio of the number of people working in nonagricultural pursuits to the total number of people employed, POMPT = the proportion of population living in major towns and cities to total population, (C/M) = currency/money ratio, YSD = six year moving standard deviation of the percentage change in real income per head, TG = total government expenditure less interest payments on the national debt, divided by net national income, TGDEF = total government expenditure less interest payments on the national debt and defence expenditure, divided by net national income, SSG = percentage of GDP spent on social services, defined as education, health, social security, and unemployment benefits, STL = the ratio of working days lost by strikes to the labour force employed, INVR = real inventories and work in progress, MR = real imports, TAXR = the basic rate of income tax, MDEV = deviation between the nominal money supply (M3) and its long run trend, RPD = price inflation, RPQD = import price inflation, WP = real wages, ATM = the number of automatic teller machines, CCARD = the number of credit cards issued, BSSAPN = the number of building society share accounts per capita, RSMAX = the previous peak of the short run rate of interest, RSMP = the real stock market price, FTEY = Financial Times earnings yield, and TLSR = the ratio of short to long term treasury bond yields.

The last chapter established a long term relationship between velocity and a small number of explanatory variables. This chapter has been concerned with the construction of a short run dynamic model for use in the second step of the cointegration process. In undertaking this task, a number of possible additional determinants have been identified, and their definition, measurement, and economic behaviour in the United Kingdom has been discussed. The next task is to test this theoretical model with empirical work.

The list of explanatory variables is obviously based on earlier theorising to be found in the relevant literature and is intended to cover many considerations: price effects (rates of interest, inflation, value of time); quantity effects (permanent income, cyclical phase); velocity mismeasurement effects (measured versus permanent income); economic instability/uncertainty effects (income volatility); real and monetary shocks (strikes, tax change, unanticipated changes in money supply); structural effects (urbanisation, monetisation) and financial innovation. It is inevitable that in this process ad hoc theorising and approximate measurements cannot be avoided. The underlying individual optimising process takes place in a shifting environment where institutional, structural and technological developments play a role and may even affect the definition and thus measurement of the key variable, that is money.

Chapter 9

The Short Run Dynamic Relationship - Empirical Work

9.1 Introduction

With the theoretical short run dynamic model at hand, the next task is to test it using empirical work. Here both income and transactions velocity will be considered. First for the complete sample period 1870-1991 and later using two sub periods, that is 1870-1946, when velocity was falling, and 1950-1991, a period when velocity was rising. In estimating each relationship, the methodology suggested by Hendry, Pagan, and Sargan (1984) will be used, that is from the general to the specific. In other words, the starting point is the theoretical short term model with a generous lag structure, which is then simplified with the help of statistical tests, until an acceptable specific (parsimonious) model is derived. The main instrument in carrying out these tests is MICROFIT 3.0, with additional statistical computation using P.C. GIVE 6.0, and TSP, where necessary.

9.2 Additional Unit Root Tests

The theoretical short run dynamic model introduced additional variables that economic theory suggests affects the short term behaviour of velocity. In the strictest sense these variables should be the first differences of other I(1) variables which do not enter the cointegration regression. Therefore it is necessary to consider the time series properties of the proposed short run variables, and check their order of integration. A comprehensive diagnosis of all variables is found in appendix F. Here we concentrate on those variables which are not I(1).

Table 9.1 Proposed Short Run Relationship Variables which are **not** I(1)

Variable	Φ_1	Φ_2	Φ_3	t_{α} (constant)	t_{time}	type	I(0)	I(1)	I(2)	I(3)	k
ln CYCLE	0.58174 (4.71)	18.2004 (4.88)	27.2608 (6.49)	-4.7210 (1.96)	0.76272 (1.96)	non trended	-7.3575 (-2.8855)				1
ln PQD	3.9989 (4.71)	13.6095 (4.88)	20.4123 (6.49)	6.38917 (1.96)	1.9997 (1.96)	trended	-6.3836 (-3.4475)				1
ln (W/P)	8.9403 (4.71)	7.3555 (4.88)	10.8587 (6.49)	-3.3955 (1.96)	2.9900 (1.96)	trended	-4.5909 (-3.4475)				1
ln STL	1.3622 (4.71)	5.1642 (4.88)	7.6161 (6.49)	-1.3544 (1.96)	-1.1671 (1.96)	non trended	-3.7172 (-2.8906)				1
INVR	0.048926 (4.71)	0.019925 (4.88)	7.12703 (6.49)	-0.16822 (1.96)	0.22119 (1.96)	non trended	-7.6557 (-2.8855)				1
ln(INA/L)	6.1457 (4.71)	9.6947 (4.88)	7.5561 (6.49)	-2.3315 (1.96)	2.4791 (1.96)	trended	-3.0522 (-3.4478)	-3.1865 (-3.4478)	-10.7449 (-3.4481)		1
ln TGDEF	10.7650 (4.71)	8.5958 (4.88)	12.7328 (6.49)	4.3590 (1.96)	3.2810 (1.96)	trended	-3.6835 (-3.4478)				1
ln ATM (1970-1991)	0.09491 (4.86)	3.0607 (5.13)	3.1260 (6.73)	0.34681 (1.96)	0.30812 (1.96)	non trended	-0.20378 (-2.9202)	-2.8800 (-2.9202)	-5.8738 (-2.9215)		1
ln BSSAPN (1945-1991)	1.2317 (4.86)	4.0243 (5.13)	5.9616 (6.73)	-1.2880 (1.96)	1.1098 (1.96)	trended	-1.7947 (-2.92256)	0.99433 (-3.5088)	-3.4615 (-2.9271)		3

The Augmented Dickey Fuller statistics are reported in Table 9.1. Let us begin with the ratio of measured per captia real income to permanent per capita real income (CYCLE). The computed Φ_3 is greater than the corresponding critical value, so that the null hypothesis implying that the series contains a unit root cannot be accepted. The next step is to test $\rho = 1$ using critical values from the standard normal tables. In this case the null is rejected and we use a conventional t statistic to decide whether to take β to zero or not. Here we accept the null hypothesis that the series is stationary with no linear trend, but possibly with an intercept. We test the hypothesis using α in a conventional manner. In this case an intercept is present. Thus we can conclude that ln CYCLE is an I(0) variable.

A similar series of tests concludes that ln STL, and INVR are stationary series with no linear trend and no intercept. While ln PQD, ln(W/P), and ln TGDEF are stationary series with a linear trend and an intercept. All these series being clearly I(0). The financial innovation variables ln ATM and ln BSSAPN contain a unit root, and require differencing twice to achieve stationarity. The ln(LNA/L) series as discussed earlier in chapter seven, is a random walk about a non linear time trend and I(2). Consequently all of the variables contained in Table 9.1 were dropped from the proposed short term model, which becomes:

$$V = f(\underbrace{RL,\ RS,\ ROWN,\ RFORG,}_{\text{interest rates}}\ \underbrace{(Y/PN)^{P},\ YRGAP,}_{\text{wealth}}$$

$$\underbrace{(TNBFA/TFA)}_{\text{financial sophistication}},\quad \underbrace{POMPT,\ (C/M),}_{\text{monetization}}$$

$$\underbrace{YSD,\ TG,\ SSG,}_{\text{economic stability}}\quad \underbrace{MR,\ TAXR,\ MDEV,}_{\text{G.D.P. and monetary shocks}}$$

$$\underbrace{RPD}_{\text{inflation}}\quad \underbrace{CCARD,\ RSMAX,\ RSMP,\ FTEY,\ TLSR}_{\text{financial innovation}}$$

With the short run model established, the next task is estimation. As discussed earlier, the econometric methodology suggested by Hendry is used. The general theoretical model outlined above is adopted with a general lag structure, which is simplified with the help of statistical tests, until an acceptable or best possible model is derived.

9.3 The Full Sample Period 1870-1991

Initially we are concerned with income velocity for the whole period 1870-1991, the final specification is reported in equation (9.1).

Ordinary Least Squares

1874-1991

$$\Delta V1_t = \underset{(1.9793)}{-0.10309} + \underset{(3.4641)}{0.51482}\ \Delta(Y/PN)^P_t + \underset{(1.9920)}{1.0054}\ \Delta(TNBFA/TFA)_{t-3}$$

$$+ \underset{(2.8397)}{0.18459}\ \Delta RL_{t-1} + \underset{(2.0651)}{0.20583}\ \Delta RS_t - \underset{(2.0195)}{0.20118}\ \Delta ROWN_t$$

$$- \underset{(2.7268)}{0.045818}\ \Delta TG_t + \underset{(1.8420)}{0.12796}\ \Delta PD_t + \underset{(5.4968)}{0.50772}\ \Delta(C/M)_t$$

$$- \underset{(2.2249)}{0.039508}\ \Delta YSD_t - \underset{(1.8183)}{0.028459}\ RES_{t-1} \qquad (9.1)$$

$R^2 = 0.44382$ s.e. $= 0.044051$
$n = 118$
$k = 10$
D.W.$= 1.7132$ $[d_L = 1.335\ d_U = 1.765\ (4-d_U) = 2.235]$
$t_{90} = [1.658]$
$t_{95} = [1.980]$

$F_1(1,106) = 3.0456$ [3.94]
$F_2(1,106) = 7.2932$ [3.94]
$\chi^2 = 4.0343$ [5.991]
$F_3(1,116) = 3.5817$ [3.92]

Interest rates are represented by the long term rate lagged one period, and the contemporaneous values of short term and own rate of interest of on money. Wealth is portrayed by permanent income. Financial sophistication is symbolized by total non bank financial assets to total financial assets lagged three years. Monetization is depicted by the currency money ratio. Economic stability is represented by the six year moving standard deviation of the percentage change in real per capita income, and the ratio of total government expenditure, less interest payments on the national debt divided by net national income. Price expectations are depicted by the rate of growth of the GDP price deflator. Finally, the lagged residuals from the long term model are introduced as an error correction mechanism. Coefficients are of the correct sign.[1] All parameters are significantly different from zero at the 95% confidence level, except, ΔPD_t, and RES_{t-1}, which are accepted at the 90% confidence level. It is interesting to note that the coefficients on ΔRS_t and $\Delta ROWN_t$ are almost equal but of the opposite sign. The Durbin Watson statistic suggests no autocorrelation, and this is confirmed by the Lagrange multiplier test of residual serial correlation, (F_1). Jarrque - Bera's test of the normality of regression residuals (χ^2), indicates that this is not a problem. F_3, the test for heteroscedasticity, is computed as 3.5817, less than the critical value of 3.92. This suggests that the residuals are homoscedastic. However, the estimated equation fails Ramsey's RESET test of functional form (F_2), which suggests misspecification. Another test for misspecification is the differencing test suggested by Plosser, Schwert and White (1982). Breusch and Godfrey (1986) have shown that this can be calculated as a variable addition test. The supplementary variables being constructed from the existing regressors by adding the observation lagged one period to the observation lead forward one period. The test then amounts to an F test for the joint significance of the additional regressors. In this case the differencing test is calculated as $F(11,91) = 8.8407$, and with a corresponding critical value of 1.89, the early suggestion of misspecification is maintained. The more sophisticated and detailed RESET tests computed by P.C. GIVE 6.0 suggest that ΔTG_t and ΔPD_t are the two candidates which cause the misspecification problem.[2] However, as will be revealed later in our discussion, this is not the main problem with full sample dynamic equations.

An R^2 of 0.44382 suggests an average fit. Nonetheless, a plot of residuals and standard error bands, (figure 9.1), reveals a number of outliers.

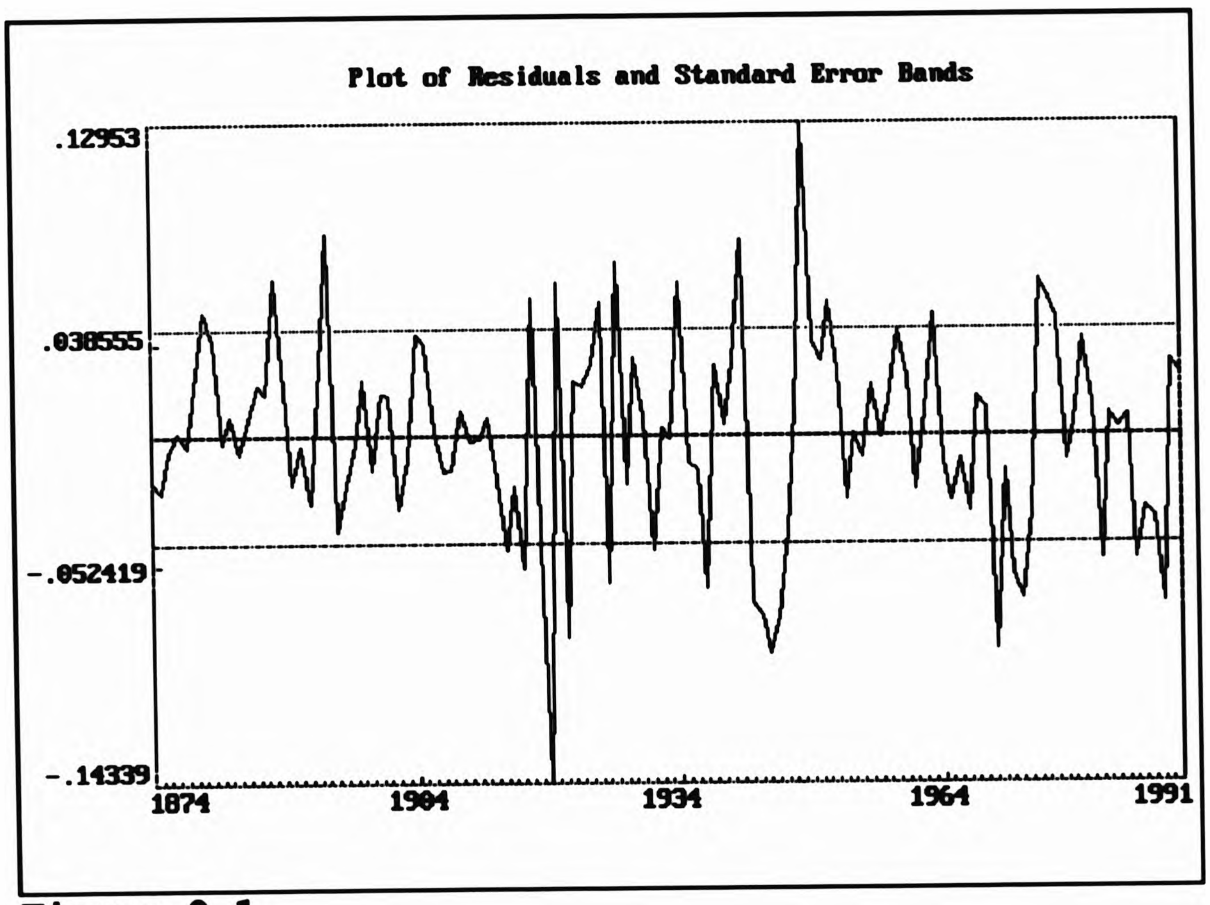

Figure 9.1

The most notable being as follows; 1919 and 1921 a little after the end of the First World War, when income velocity declined rapidly and a period of major disinflation took place; 1948 soon after cessation of hostilities after the Second World War and the beginning of reconstruction; 1970 and 1975, a period of rapid inflation; 1988, a period of rapid financial innovative change. In an attempt to account for these outliers, dummy variables were introduced, the revised empirical results are shown in equation (9.2).

Ordinary Least Squares

1874-1991

$$\Delta V1_t = \underset{(1.8927)}{-0.086417} + \underset{(3.2663)}{0.43948}\,\Delta(Y/PN)^P_t + \underset{(2.1722)}{0.94463}\,\Delta(TNBFA/TFA)_{t-3}$$

$$+ \underset{(2.6449)}{0.16177}\,\Delta RL_{t-1} + \underset{(3.0461)}{0.52949}\,\Delta RS_t - \underset{(2.9969)}{0.51751}\,\Delta ROWN_t$$

$$- \underset{(3.6287)}{0.053795}\,\Delta TG_t + \underset{(1.7064)}{0.112233}\,\Delta PD_t + \underset{(3.0180)}{0.34376}\,\Delta(C/M)_t$$

$$- \underset{(0.42883)}{0.0068728}\,\Delta YSD_t - \underset{(4.3637)}{0.18526}\,D19 - \underset{(2.0877)}{0.089843}\,D21$$

$$+ \underset{(3.1877)}{0.12385}\,D48 - \underset{(2.1832)}{0.085302}\,D70 + \underset{(1.8688)}{0.082548}\,D75$$

$$- \underset{(2.0638)}{0.16370}\,D88 - \underset{(1.7992)}{0.024617}\,RES_{t-1} \qquad (9.2)$$

$R^2 = 0.60511$ s.e. $= 0.037118$
$n = 115$
$k = 16$
D.W.$= 1.5053$ [$d_L = 1.203$ $d_U = 1.922$]
$t_{90} =$ [1.658]
$t_{95} =$ [1.980]

$F_1(1,100) = 9.0252$ [3.94]
$F_2(1,100) = 5.2955$ [3.94]
$\chi^2(2) = 1.5604$ [5.991]
$F_3(1,116) = 1.7567$ [3.93]

While all the dummies are significantly different from zero at the 90% confidence level, their introduction leads to serial correlation, and the parameter on ΔYSD_t becomes insignificant. It could be argued that the debut of dummy variables picks up exogenous occurrences, which would have been explained by the unknown omitted variables, although this of course, could suggest mis-specification in the first place.

Finally, returning to the original equation, consideration is made of parameter stability. A plot of the cumulative sum of recursive residuals statistic is shown in figure 9.2.

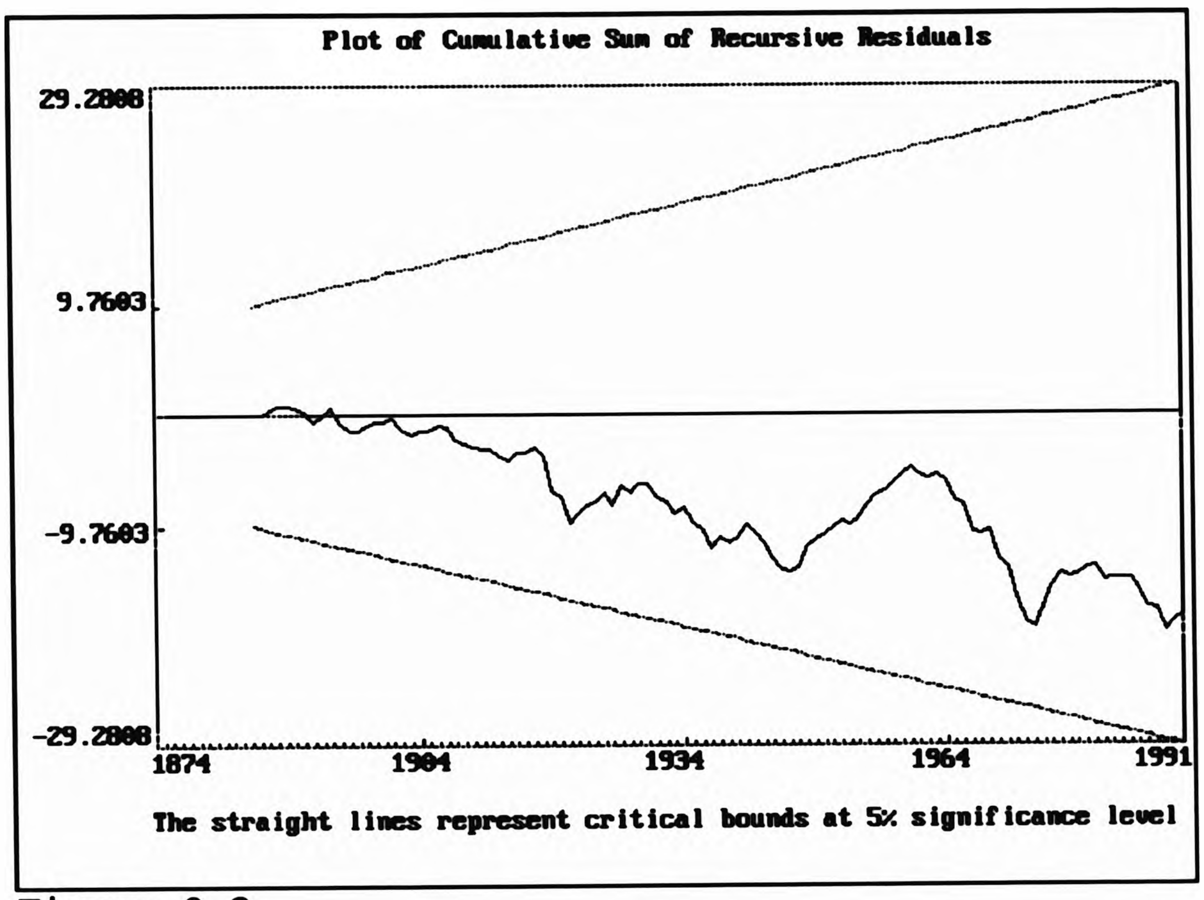

Figure 9.2

Neither of the critical boundaries is crossed, and the null hypothesis that the regression model is correctly specified is accepted. This suggests that there are no systematic changes in the regression coefficients. A plot of cumulative sum of squares of recursive residuals, together with a pair of straight lines representing the 5% critical values is illustrated in figure 9.3. Here, the critical boundary is violated just after the First World War, and again in 1964. Thus the null hypothesis is rejected, and we accept that there is a sudden departure from constancy of the estimated regression coefficients. In order to locate the problem, we examine recursive parameter and t statistic plots.

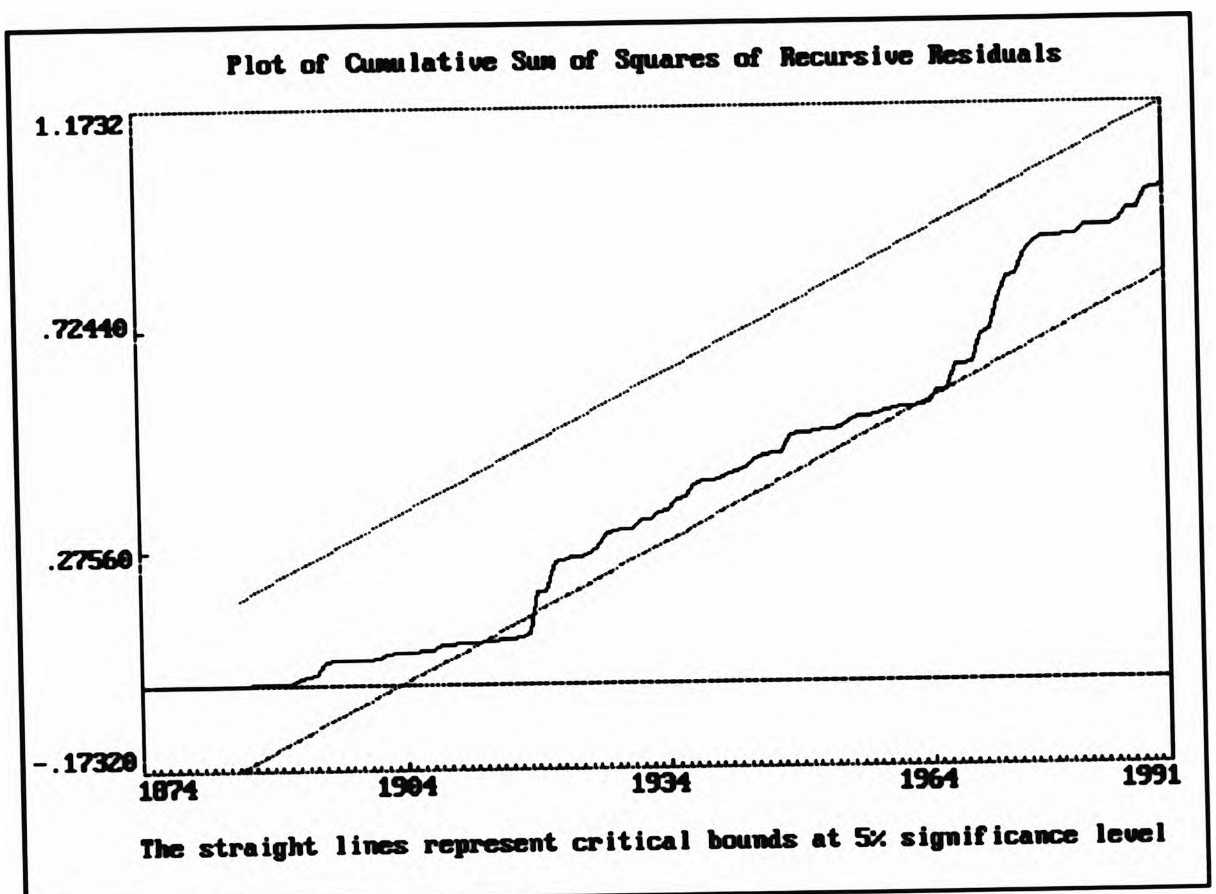

Figure 9.3

First, consider the plot of the coefficient on $\Delta(Y/PN)^{P}_{t}$, figure 9.4.

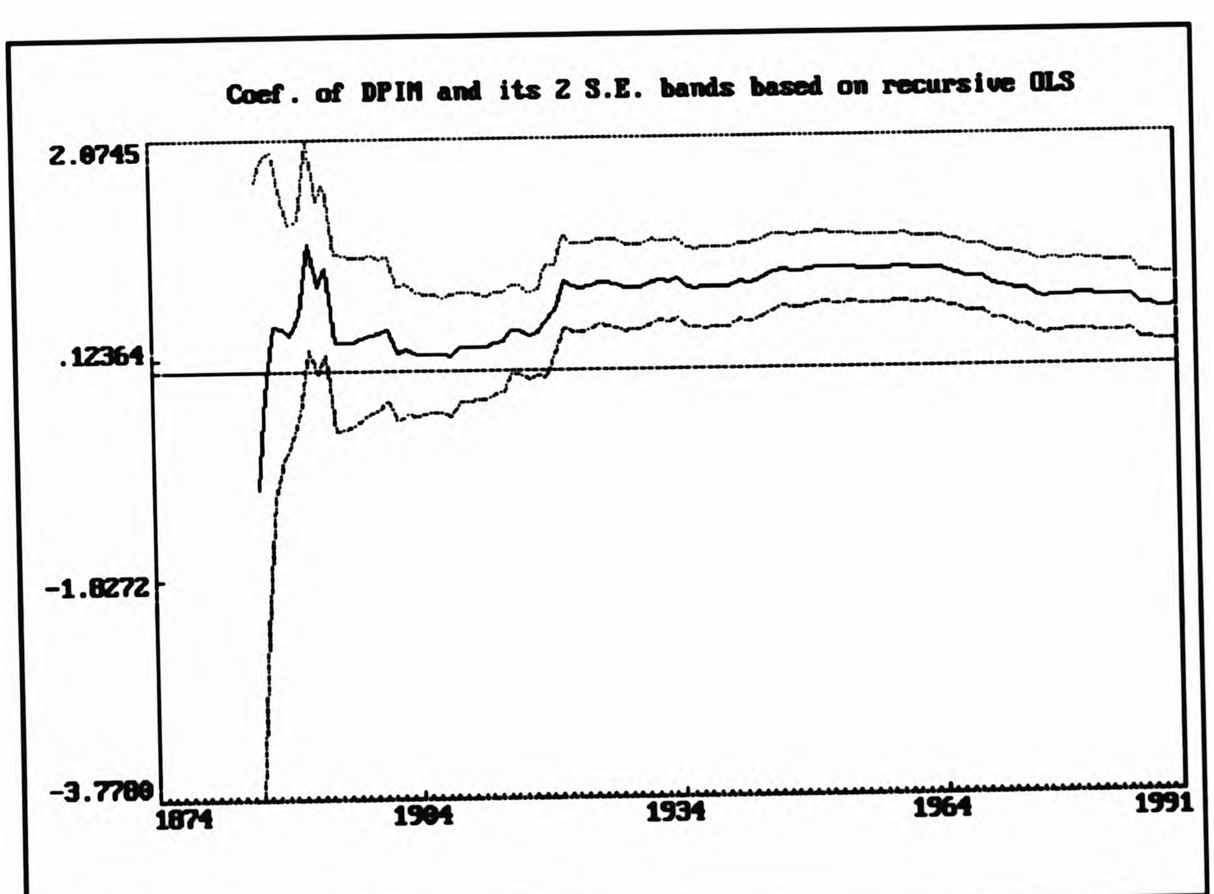

Figure 9.4

This clearly shows parameter instability in 1921, if one recalls, the time of the structural break discussed earlier. The associated recursive t statistic is shown in figure 9.5. This suggests that the permanent income parameter was not significantly different from zero before the point of fluctuation. The variation in the t statistic after this point should also be noted.

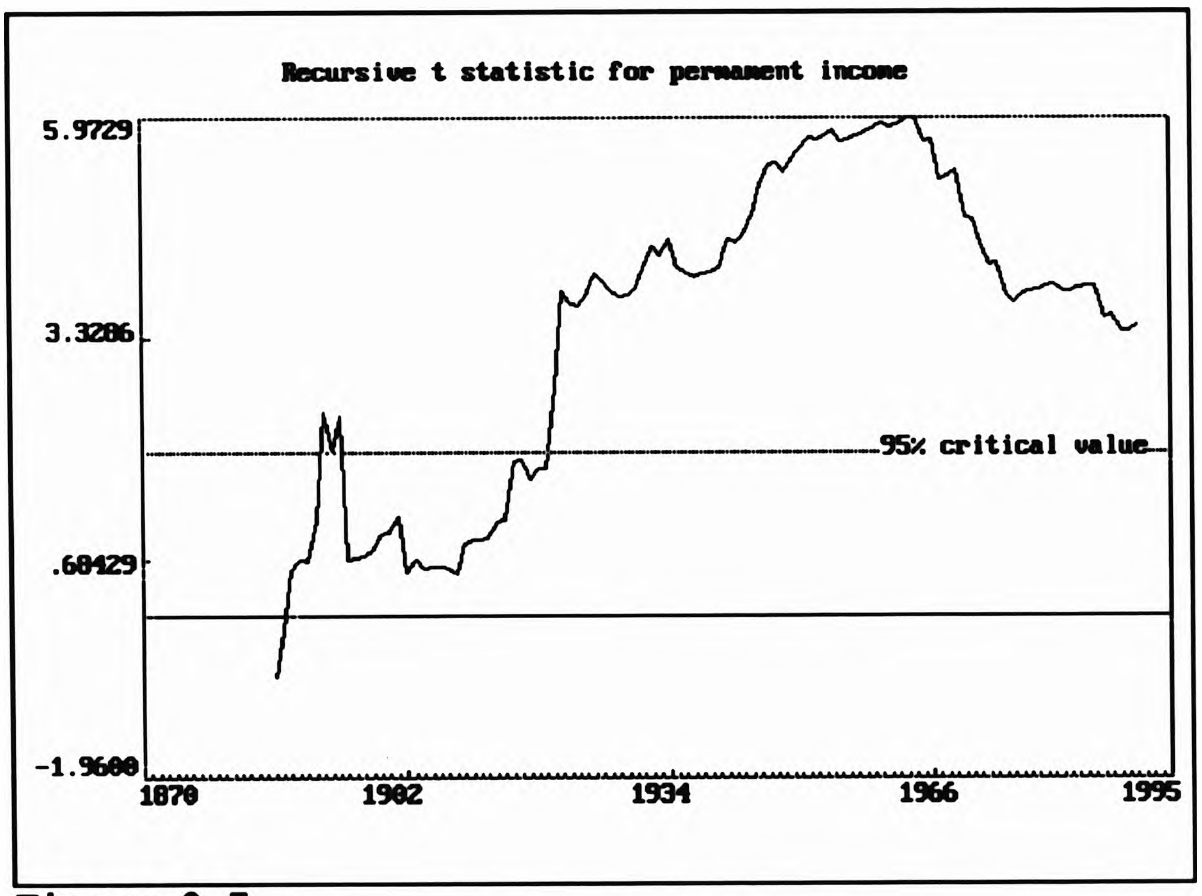

Figure 9.5

As well as parameter fluctuation in 1921, the parameter on the ratio of total non bank financial assets to total financial assets, lagged three periods, also shows instability in 1939 and 1967, as illustrated in figure 9.6.

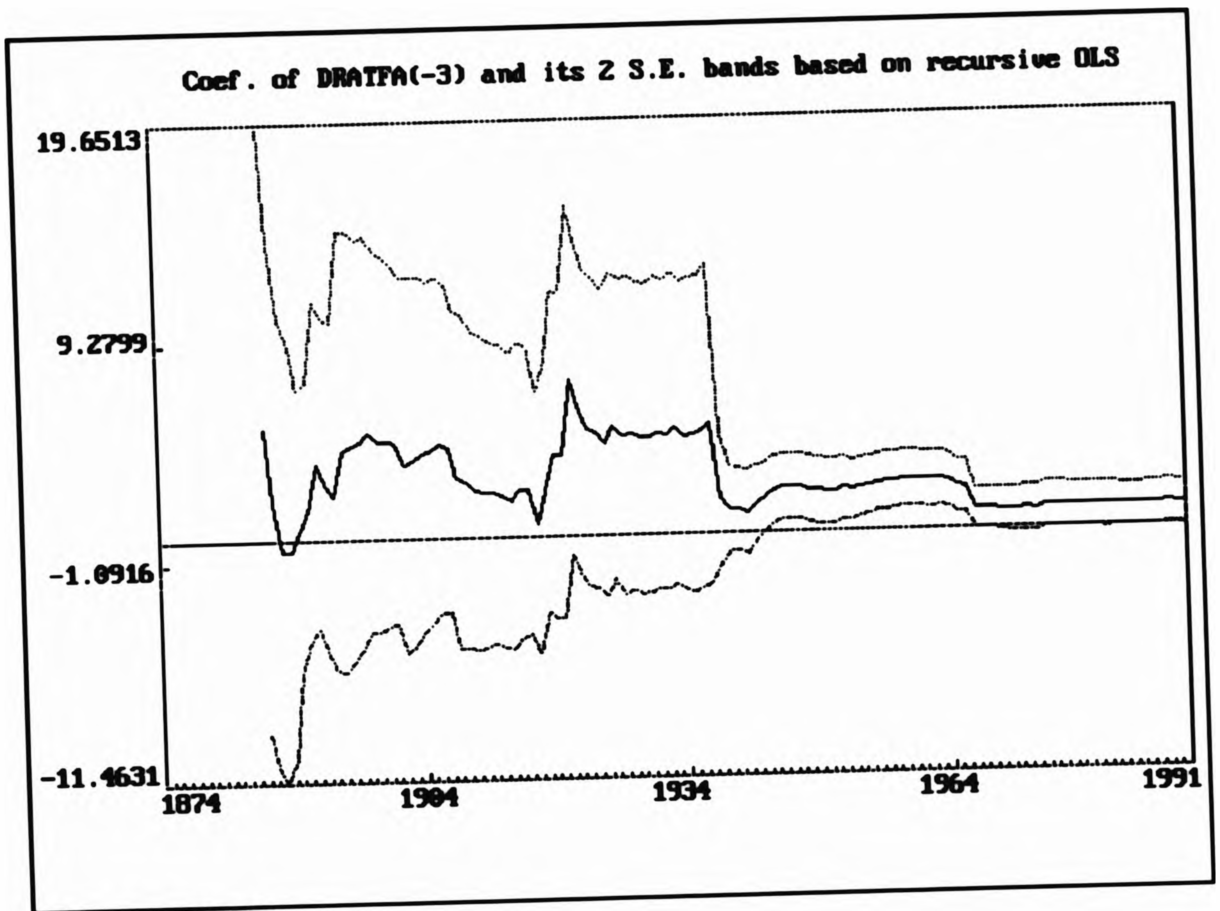

Figure 9.6

The corresponding recursive t statistic, figure 9.7, is interesting because it suggests that the parameter on $\Delta(TNBFA/TFA)_{t-3}$ is only significantly different from zero at the 95% confidence level between 1939 and 1964, together with a small period at the end of the sample. Although for the most part, the null is rejected at the 90% significance level between 1965 and 1989.

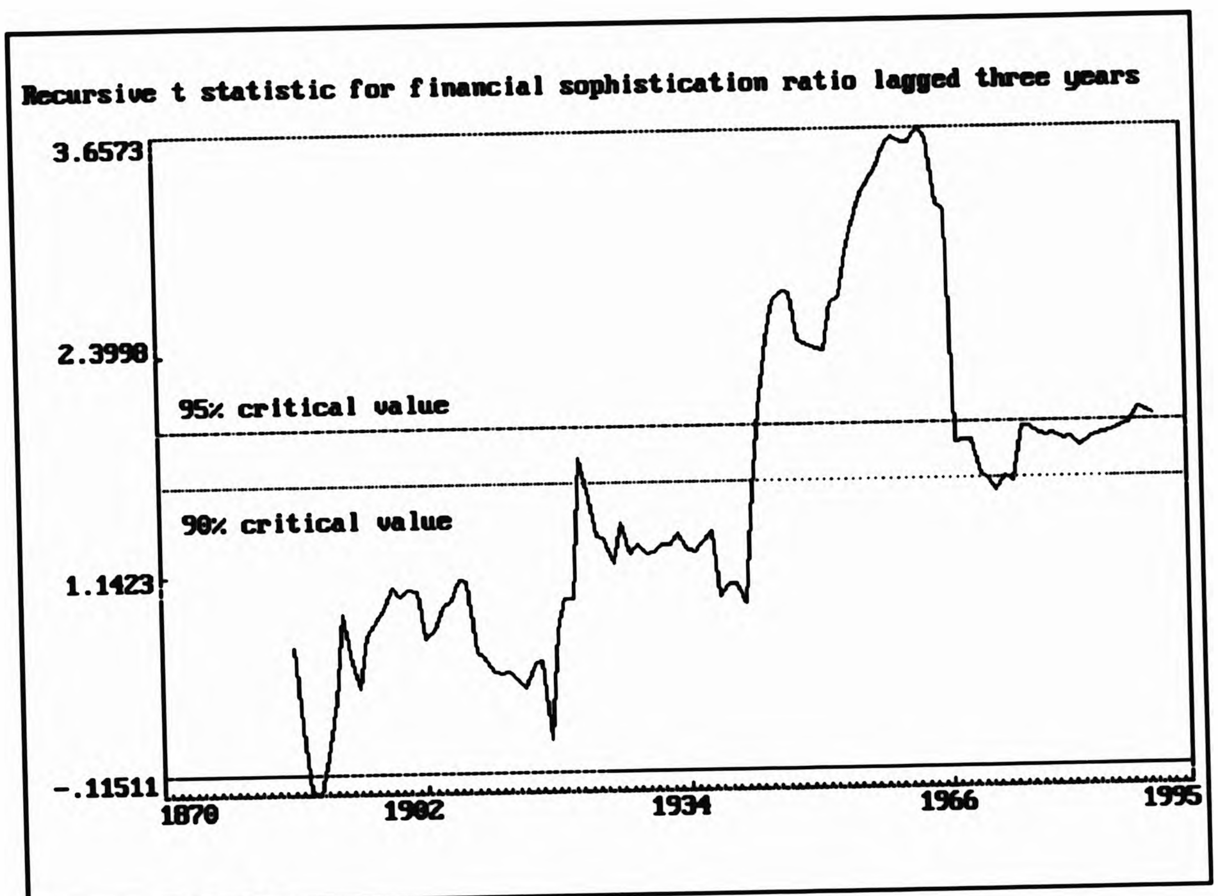

Figure 9.7

Apart from the structural break in 1921, the parameter on ΔRL_{t-1} is relatively stable. This is not true, however, of the short term and own rate of money interest rates, whose coefficients follow a similar pattern, see figures 9.8 and 9.9. Parameter instability being found in 1919, 1934, 1947, and 1987. Another issue which is alarming, is the fact that these parameters are of the incorrect sign between 1919 and 1986. Further anxiety is caused by the fact that the coefficients are only significantly different from zero, at any acceptable confidence level, after 1986, (see figures 9.10 and 9.11).

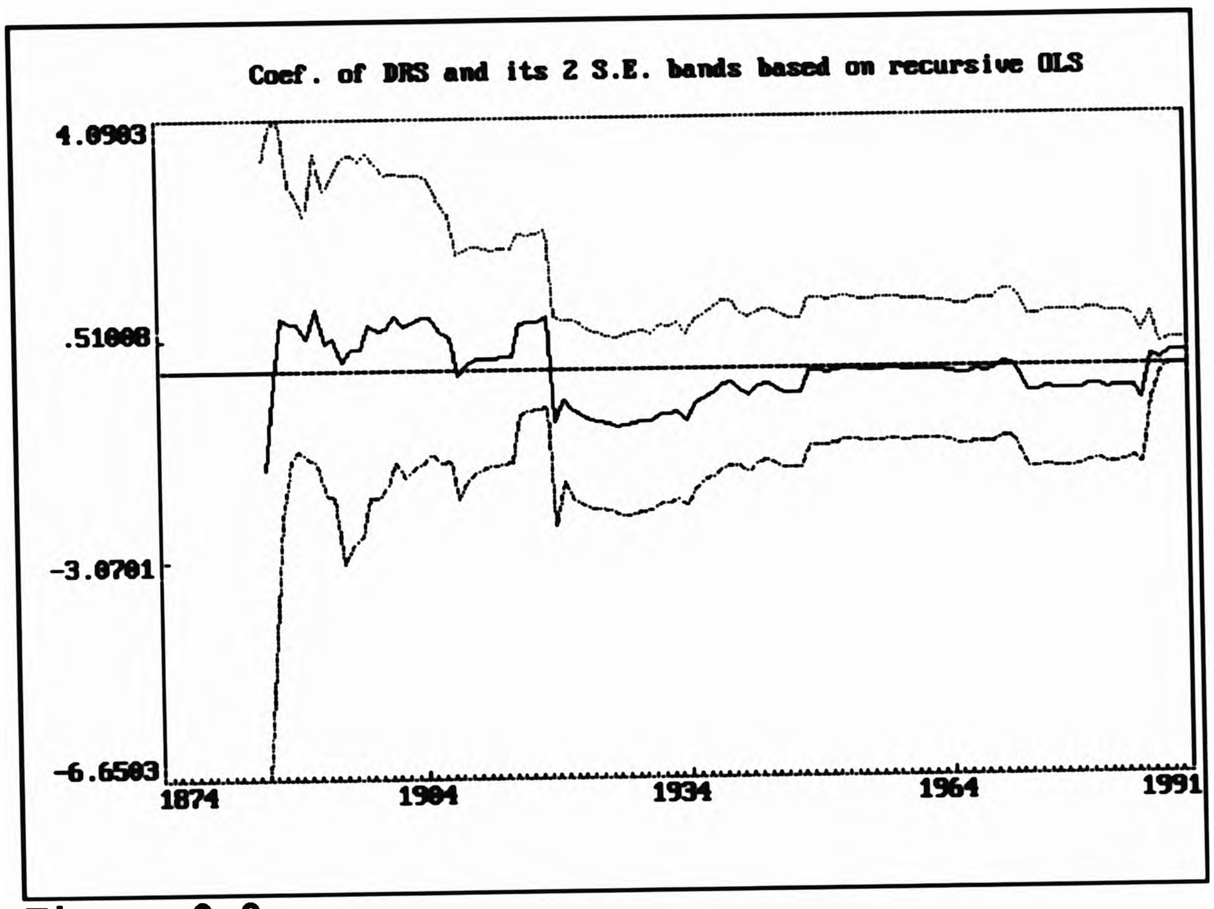

Figure 9.8

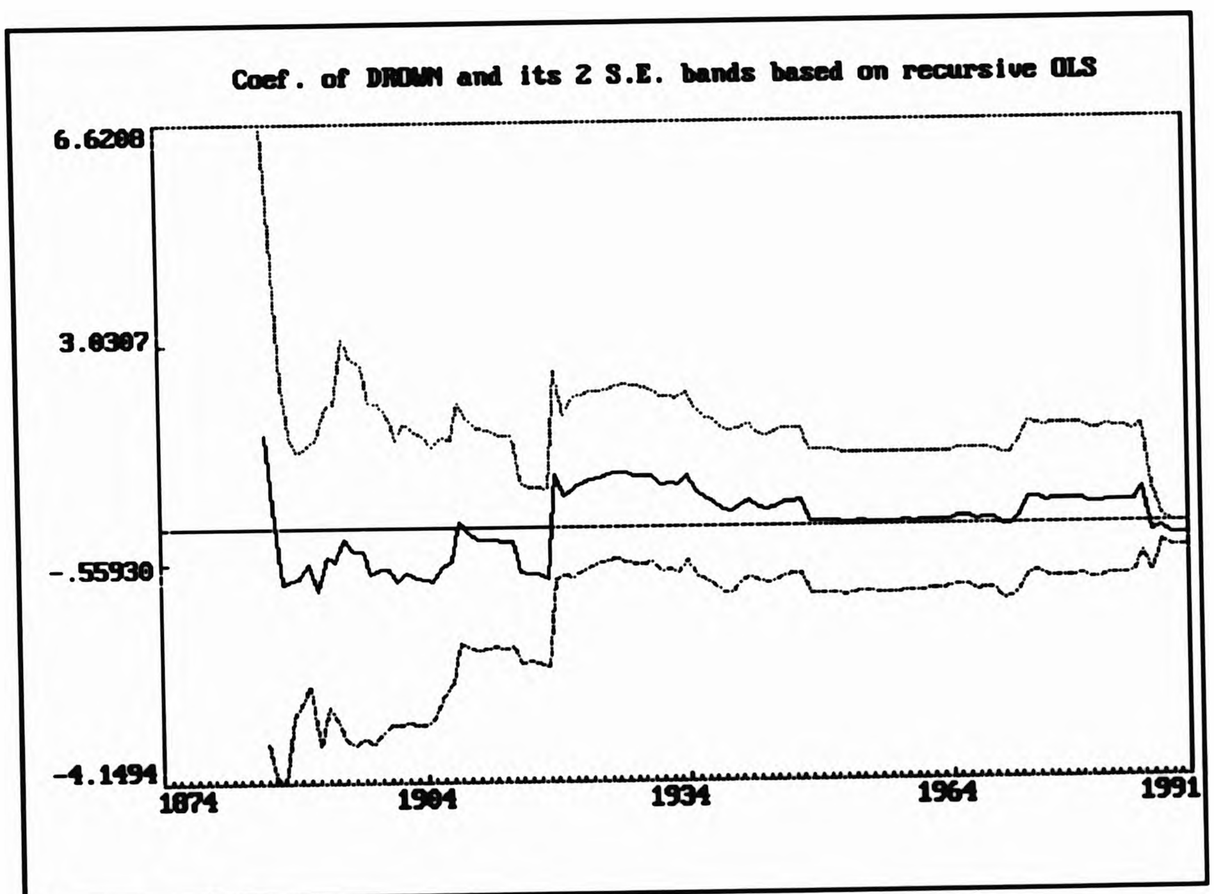

Figure 9.9

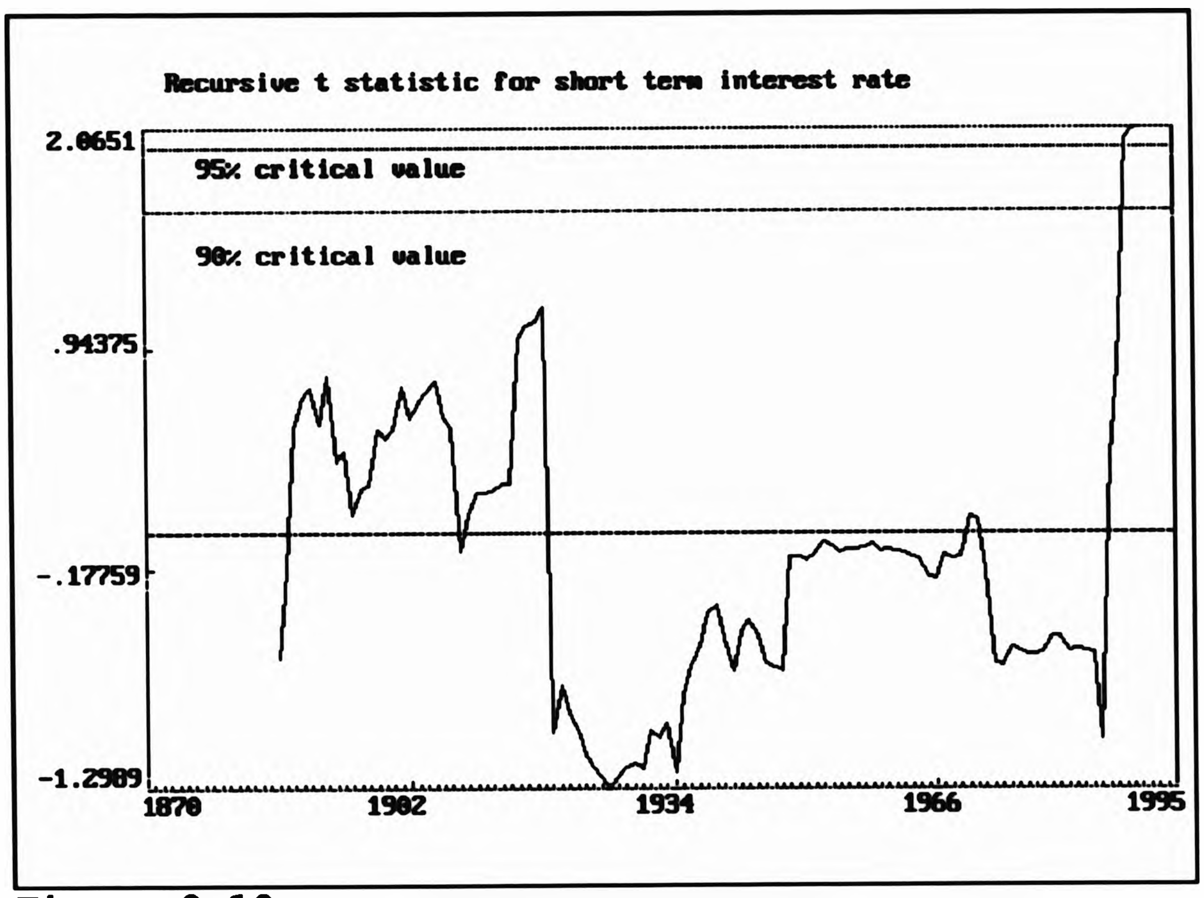

Figure 9.10

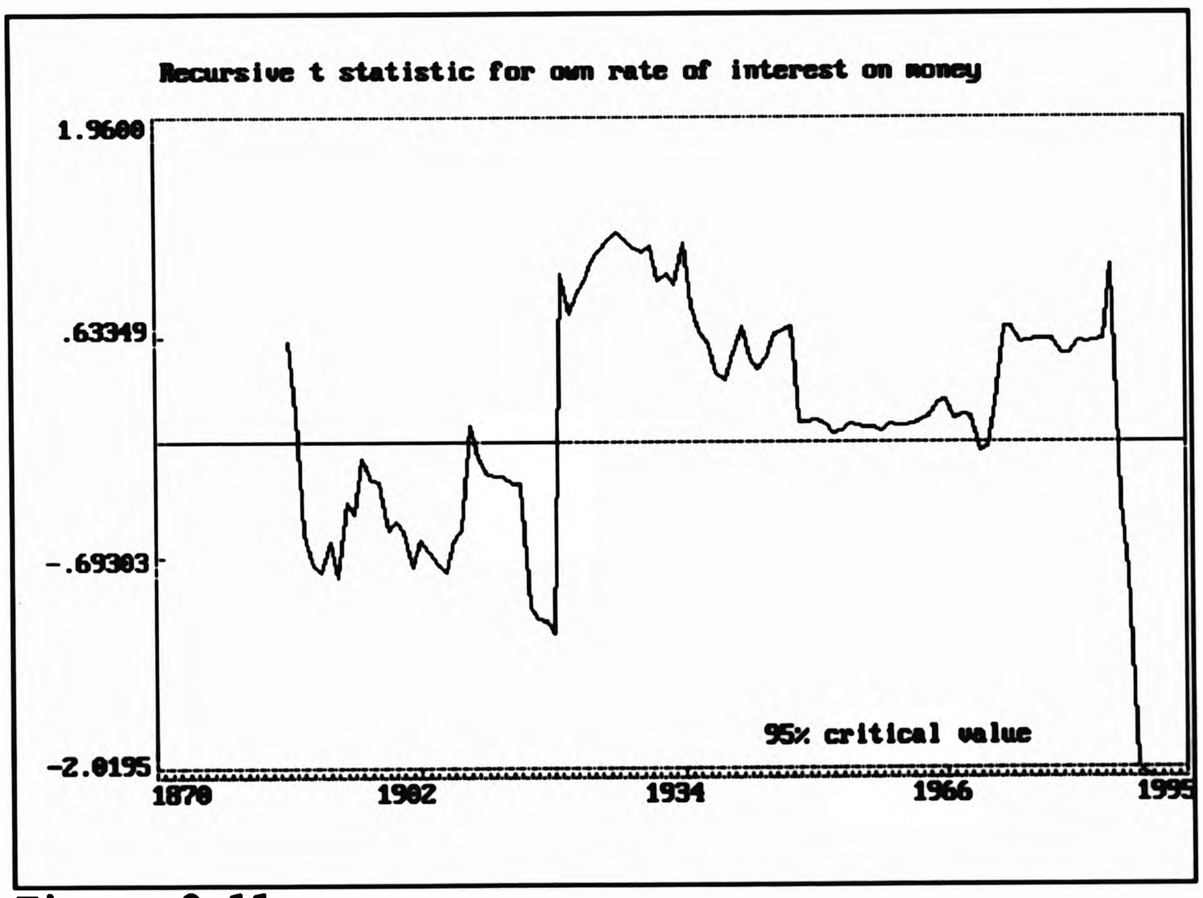

Figure 9.11

After the First World War, the parameter on ΔTG_t is comparatively constant. However, this shrouds its significance, exceeding t_{95} for two short periods, 1914-1919, 1984-1991, and t_{90} in three minor periods, 1896-1900, 1905-1913, and 1951-1963, (see figure 9.12).

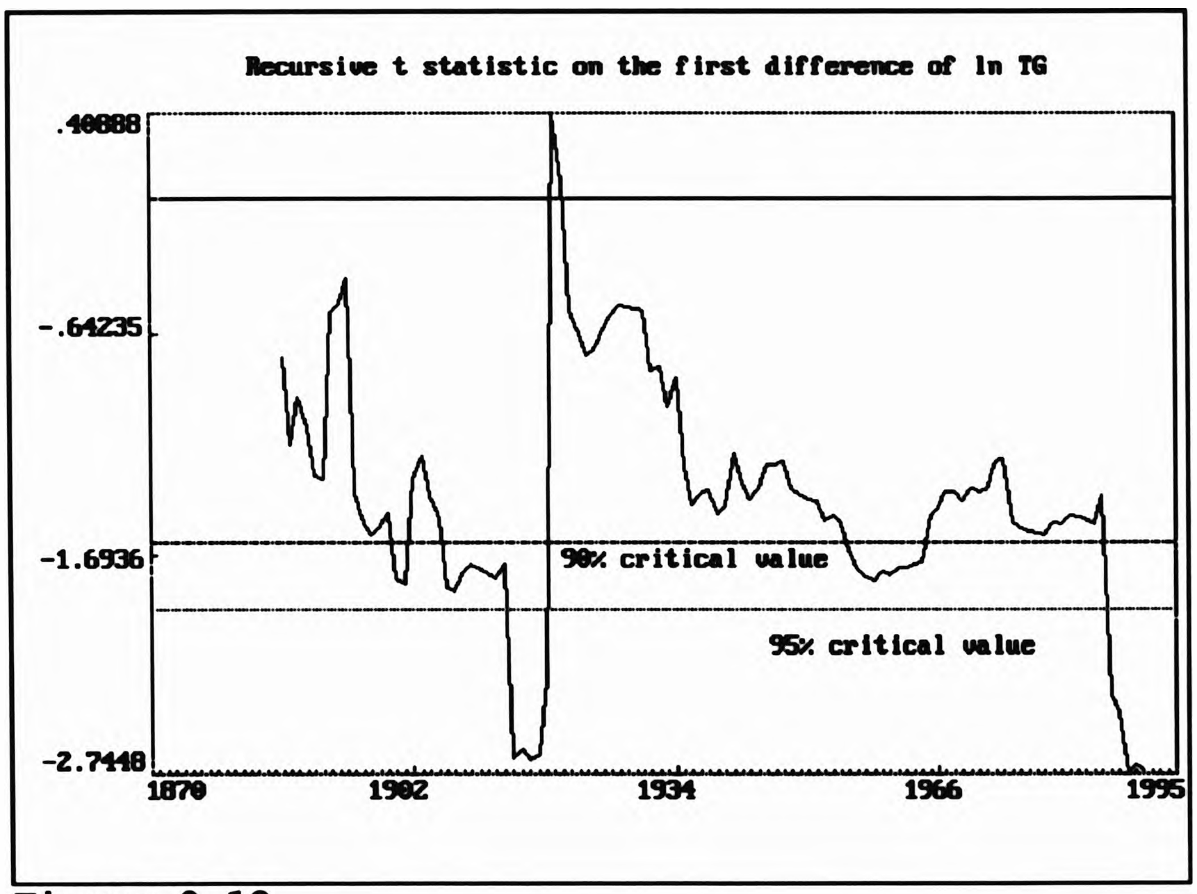

Figure 9.12

The price inflation parameter shows marked instability in 1919-1921 (disinflation) and 1972-1977 (rapid inflation), as illustrated in figure 9.13. For most of the sample period, the associated parameter is significantly different from zero at the 90% confidence level, as shown by a plot of the recursive t statistic in figure 9.14. However, there are notable exceptions, 1888-1898, 1911-1914, 1919-1920, 1933-1946, 1969-1978.

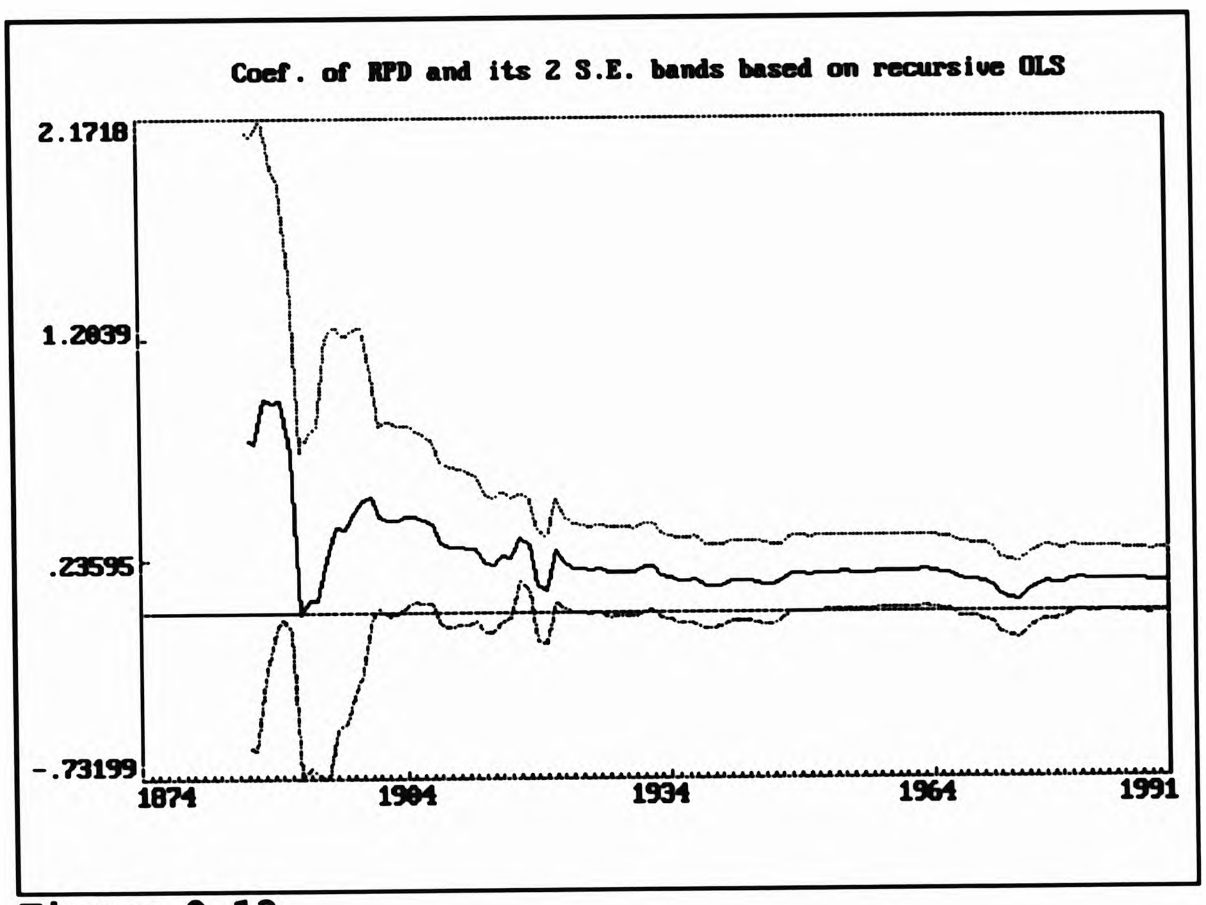

Figure 9.13

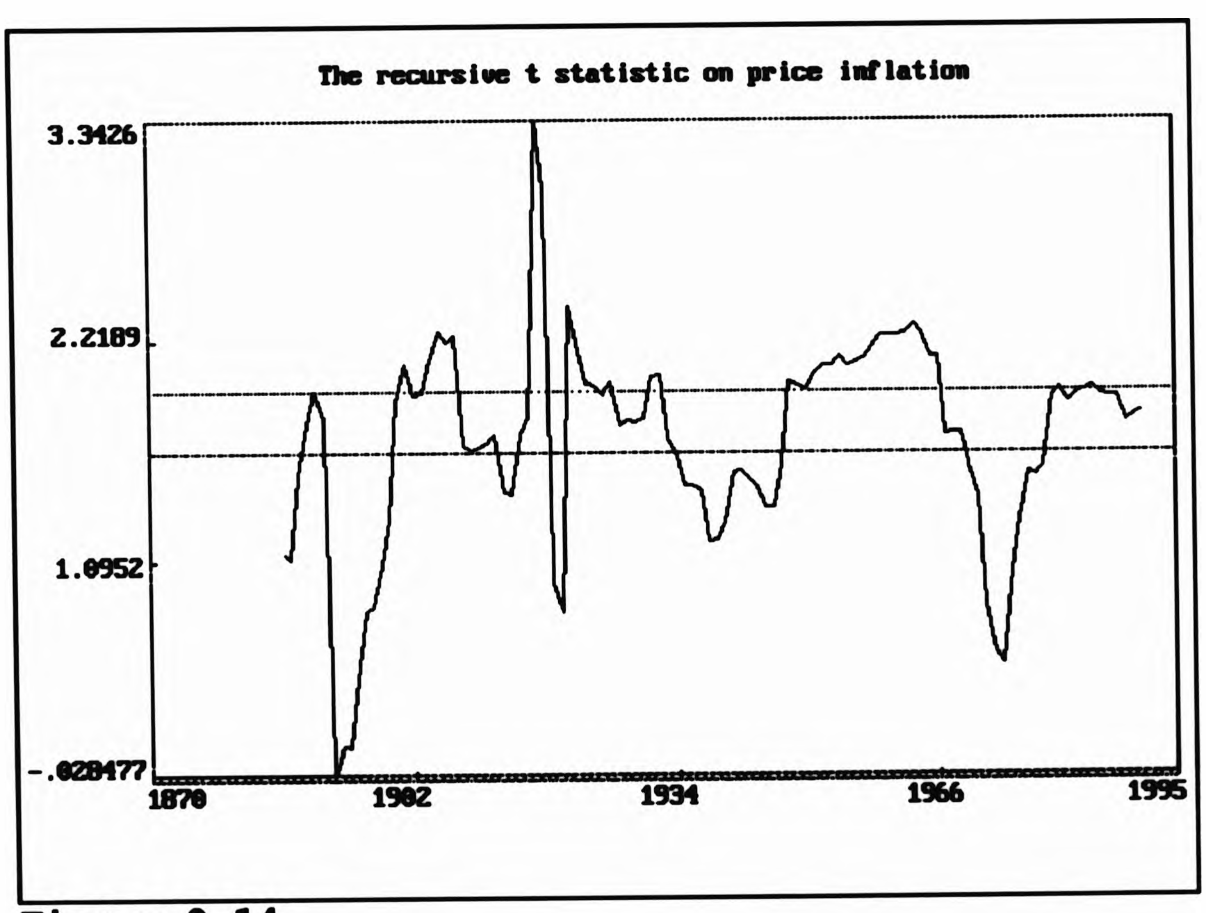

Figure 9.14

One of the most volatile coefficients is that on $\Delta(C/M)_t$, a plot of which is shown in figure 9.15. However, it is with dismay, that we find that this parameter is only significantly different from zero after 1973 (figure 9.16).

The parameter on the economic on the economic stability variable ΔYSD_t is fairly stable, apart from the 1921 structural break. Once again it is only significant for two short periods 1921-1923 and 1973-1991. This point being illustrated in figure 9.17.

Finally, consider the coefficient on the error correction mechanism term, RES_{t-1}, figure 9.18. This shows wide fluctuations, the parameter is significant with two periods of exception, 1890-1905, and 1970-1980.

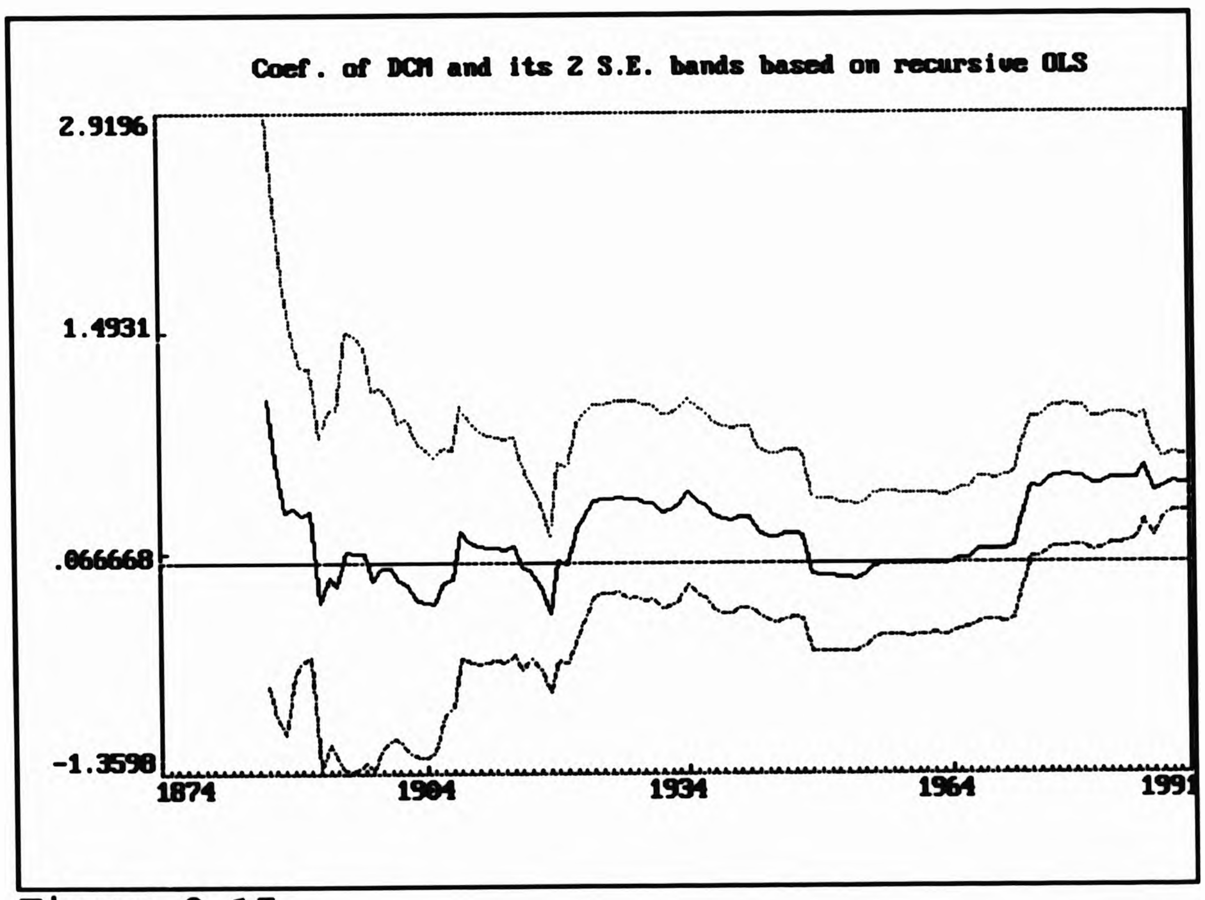

Figure 9.15

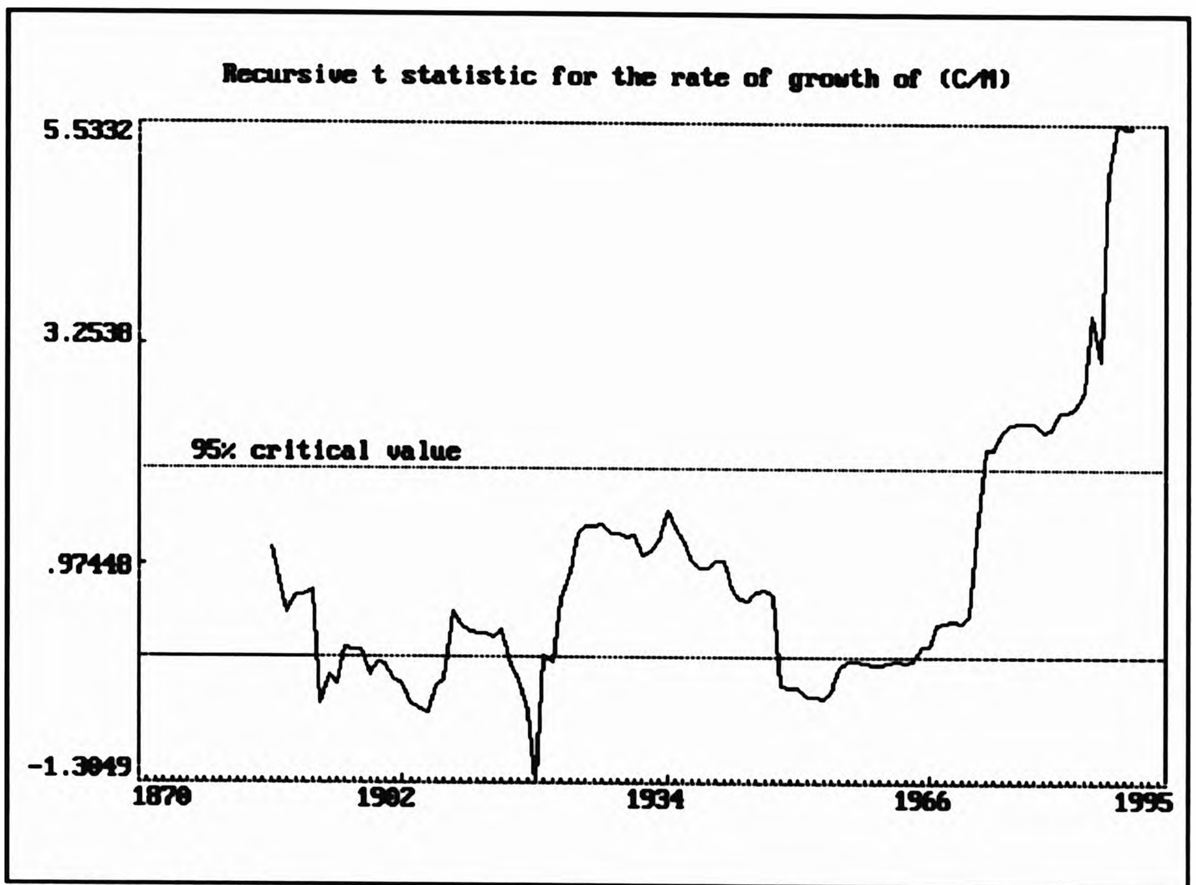

Figure 9.16

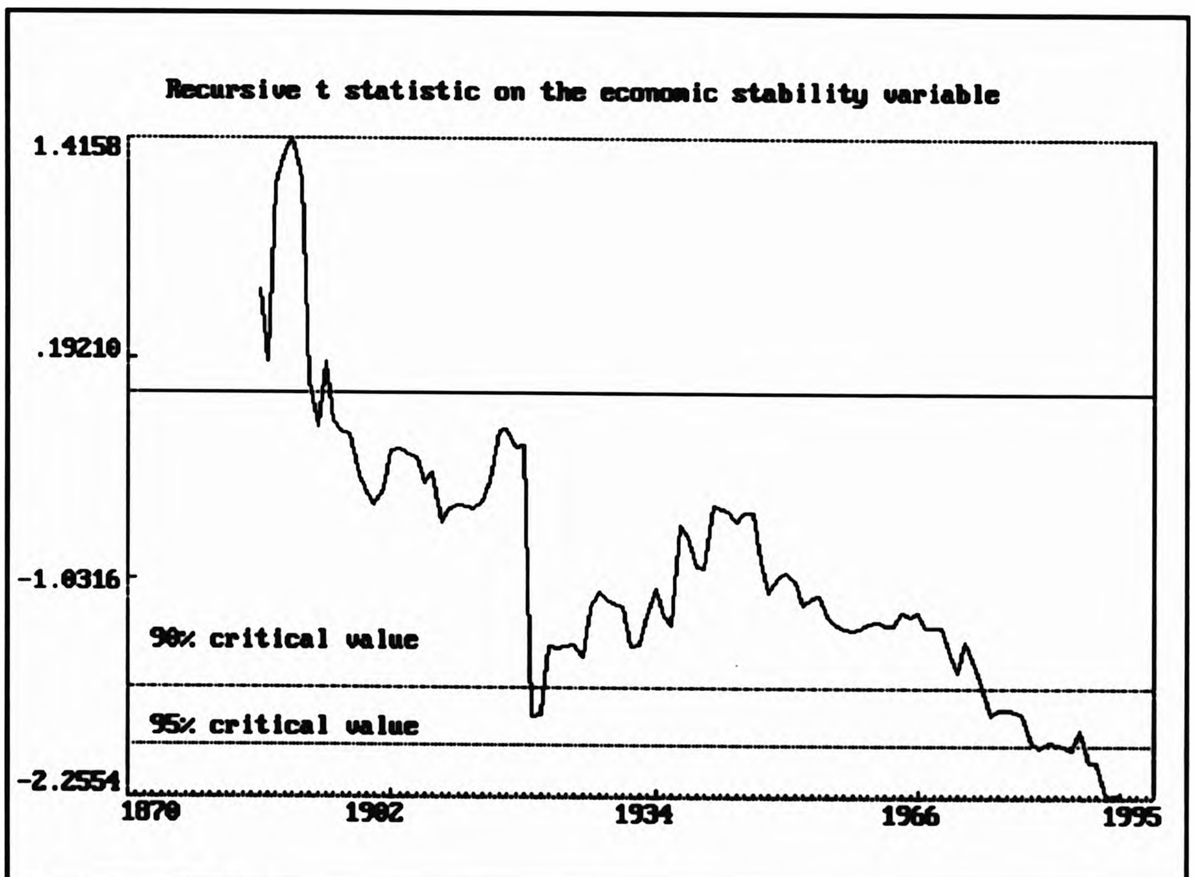

Figure 9.17

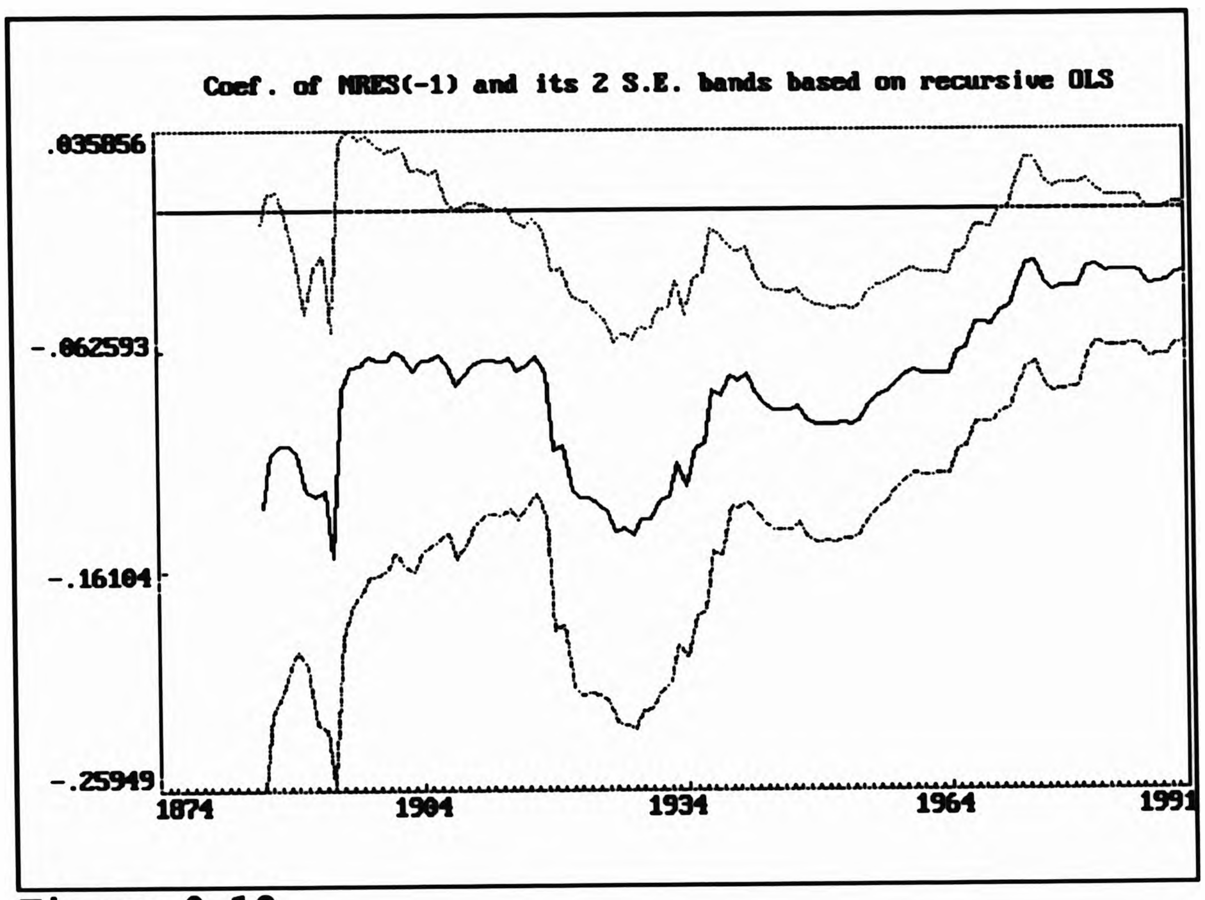

Figure 9.18

The detailed investigation of each parameter revealed that most were unstable, and often not significantly different from zero when considered on a cumulative basis. It also disclosed two possible structural breaks 1921 and 1964. Indeed, a plot of the regression standard errors of the recursive estimation, figure 9.19, shows these breaks clearly, together with the fact that the equation's descriptive power diminishes over time.

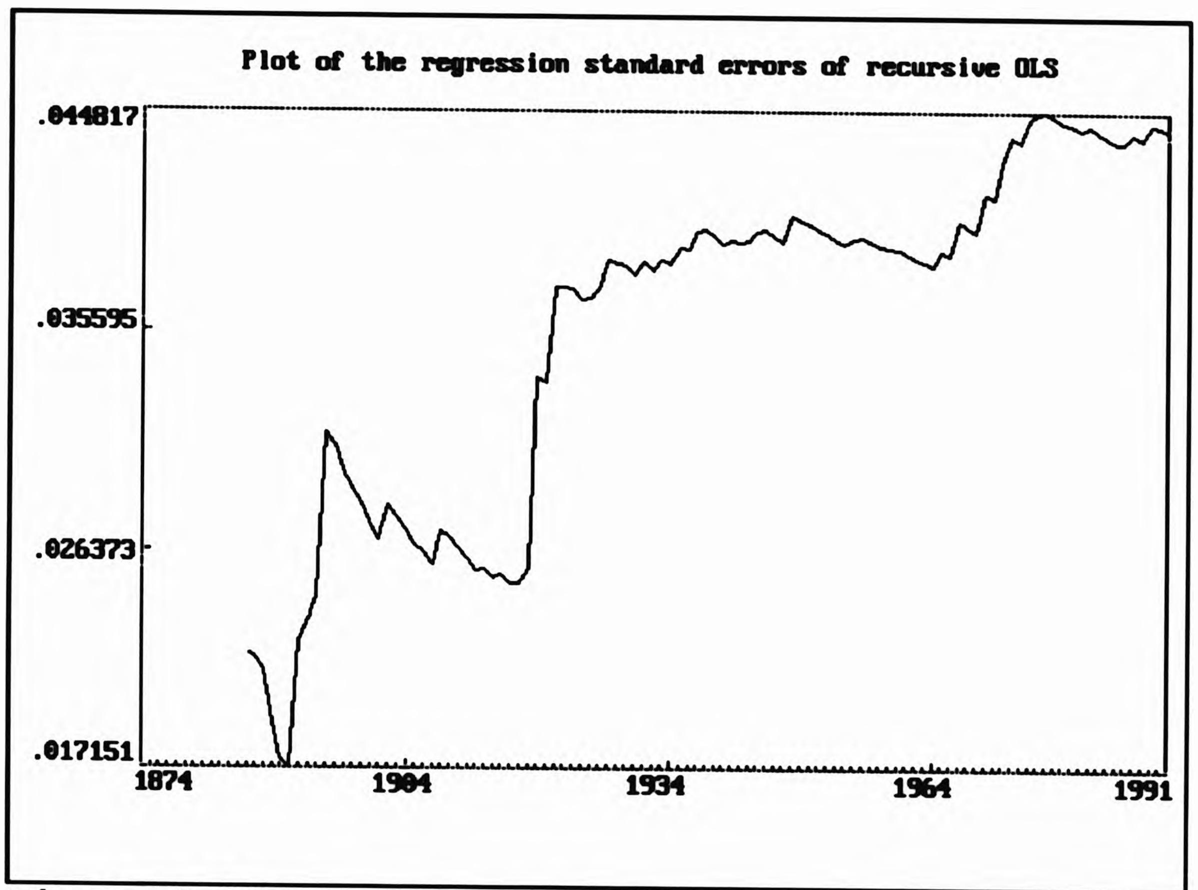

Figure 9.19

However, there may be a general explanation to this problem. If one recalls, the specific model reported in equation (9.1) is derived from a general model, which is revised using Hendry's methodology. Nevertheless, this is for a specific sample period 1870-1991. Let us suppose for a moment that Keynes's view that velocity behaviour depends on the structure of banking, industrial practices, social habits, the distribution of income, and the effective cost of holding idle balances is correct. Assume also that these influences alter and change over time. In consequence, the selection of variables from the general model will depend upon the sample period chosen. This does not affect the long term relationship described in chapter seven, this remains intact, it is the more volatile short run fluctuations in velocity whose structure changes. Later, we will return to this issue, and attempt to construct a more robust relationship for a shorter sample period.

First, we must turn our attention to the alternative dependent variable, transactions velocity, and compare and contrast this with the results for income velocity. Once again, the initial starting point was the general model, which was revised using Hendry's methodology until an acceptable model was derived.

Ordinary Least Squares

1874-1991

$$\Delta V2_t = \underset{(2.6744)}{0.09038} + \underset{(2.2596)}{0.40617}\,\Delta(Y/PN)^P_t + \underset{(3.7663)}{2.2910}\,\Delta(TNBFA/TFA)_{t-3}$$

$$+ \underset{(2.1892)}{0.15947}\,\Delta RL_{t-1} + \underset{(3.5836)}{0.36969}\,\Delta(C/M)_t - \underset{(2.7441)}{0.12118}\,RES_{t-1} \qquad (9.3)$$

$R^2 = 0.28030$ s.e. $= 0.053096$
$n = 118$
$k = 5$
D.W.$= 1.6589$ $[d_L = 1.441\ d_U = 1.647\ (4-d_U) = 2.353]$
$t_{90} = [1.658]$
$t_{95} = [1.980]$

$F_1(1,106) = 3.9037$ [3.94]
$F_2(1,106) = 1.2299$ [3.94]
$\chi^2(2) = 81.7324$ [5.991]
$F_3(1,116) = 5.2230$ [3.92]

This is a much simpler model than its income velocity counterpart. It consists of just permanent income, the total non-bank financial assets to total financial assets ratio lagged three years, the long term interest rate lagged on year, the currency money ratio, and the error correction term.

Unfortunately, there is one major problem with this equation, which was also a conundrum for all full sample transactions velocity equations considered. The Jarque - Bera's test of the normality of regression residuals fails. The consequence of this one problem, is that it is not possible to assess the statistical reliability of the classical tests reported above, because they are based on normal distributions. A plot of residuals and standard error bands, figure 9.20, traces the normality problem to the major outliers in 1987 and 1989. A problem caused by major fluctuations in the transactions velocity variable itself, at the end of the sample period.

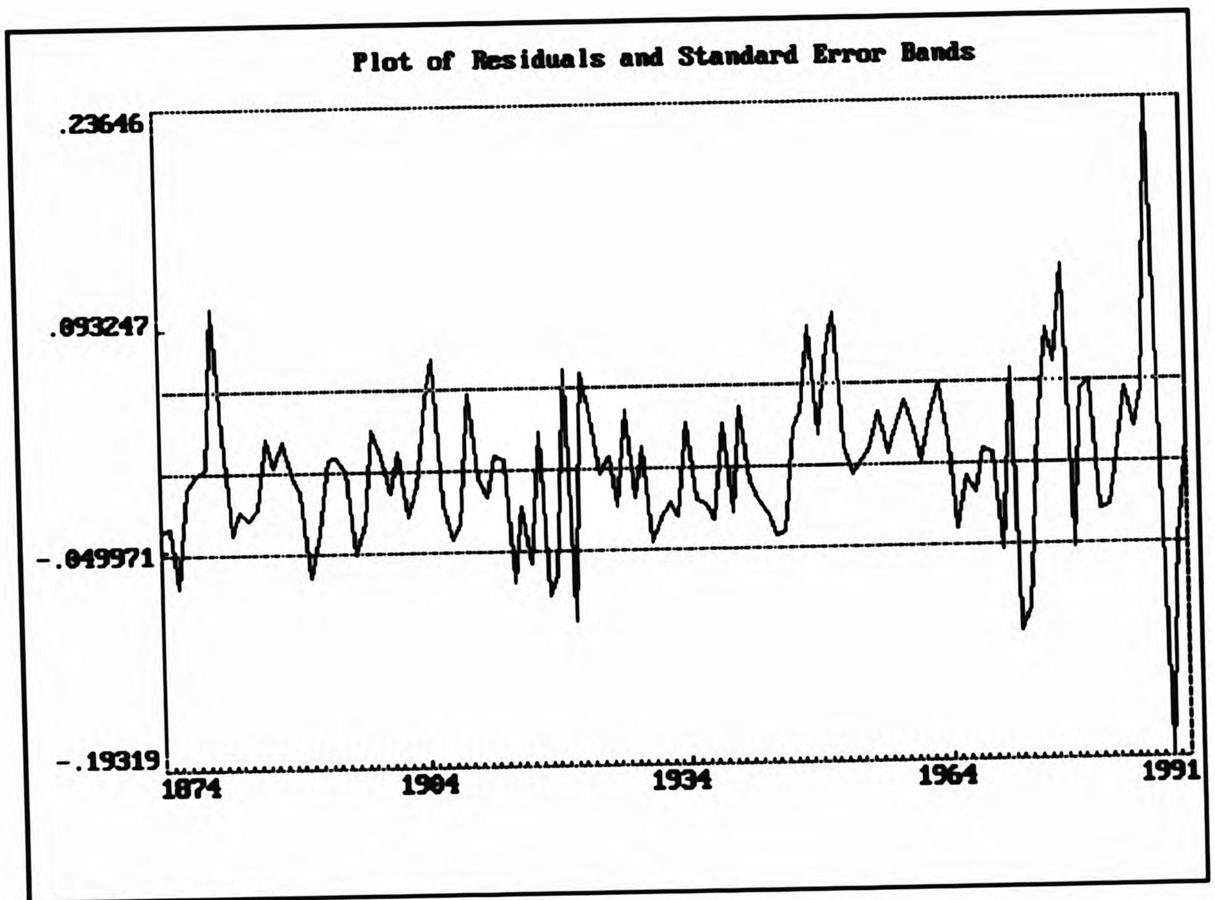

Figure 9.20

One solution to the problem, is the introduction of dummy variables for 1987 and 1989, which gives the following results.

Ordinary Least Squares
1874-1991

$$\Delta V2_t = \underset{(2.7983)}{0.080297} + \underset{(2.2714)}{0.34782}\,\Delta(Y/PN)^P_t + \underset{(4.2414)}{2.1824}\,\Delta(TNBFA/TFA)_{t-3}$$

$$+ \underset{(2.8178)}{0.17362}\,\Delta RL_{t-1} + \underset{(3.7802)}{0.36111}\,\Delta(C/M)_t + \underset{(5.0382)}{0.23772}\,D87$$

$$- \underset{(4.0500)}{0.19622}\,D89 - \underset{(2.8680)}{0.10748}\,RES_{t-1} \qquad (9.4)$$

$R^2 = 0.48564$ s.e. $= 0.044887$
$n = 118$
$k = 7$
D.W.= 1.7067 [$d_L = 1.400$ $d_U = 1.693$ $(4-d_U) = 2.307$]
t_{90} = [1.658]
t_{95} = [1.98]
$F_1(1,109) = 2.8362$ [3.94]
$F_2(1,109) = 0.0059706$ [3.94]
$\chi^2(2) = 0.91808$ [5.991]
$F_3(1,116) = 0.42609$ [3.93]

The introduction of the dummy variables solves the normality problem, and the other statistical tests do not reveal any further problems. Given the fact that the normality problem was due to outliers in the transactions velocity variable, it could be argued, following Arestis and Biefang-Frisancho Mariscal (1994, p.421), and Holden and Perman (1994, p.107), that these outliers should be captured by dummies in the Johansen procedure, when the long term vector was estimated. Attempts to carry out this procedure, in order to surpass the normality problem in the dynamic equation proved fruitless in this case.

While equation (9.4) proved to be an excellent specification, the entry of the dummy variables late in the sample period caused problems with the computation of the CUSUM and associated statistics. In order to solve this problem, and the original normality one, the equation less dummies was reestimated for the period 1870-1986.

Ordinary Least Squares

1874-1986

$$\Delta V2_t = \underset{(2.6017)}{0.076685} + \underset{(2.2465)}{0.34738}\ \Delta(Y/PN)^P_t + \underset{(4.1588)}{2.1602}\ \Delta(TNBFA/TFA)_{t-3}$$

$$+ \underset{(2.6878)}{0.17107}\ \Delta RL_{t-1} + \underset{(3.4133)}{0.34045}\ \Delta(C/M)_t - \underset{(2.6614)}{0.10247}\ RES_{t-1} \qquad (9.5)$$

$R^2 = 0.30095$ s.e. $= 0.045169$
$n = 113$
$k = 5$
D.W.$= 1.6918$ $[d_L = 1.441\ d_U = 1.647\ (4-d_U) = 2.353]$
$t_{90} = [1.658]$
$t_{95} = [1.980]$

$F_1(1,106) = 2.8676$ [3.94]
$F_2(1,106) = 0.003199$ [3.94]
$\chi^2(2) = 0.65012$ [5.991]
$F_3(1,111) = 0.48097$ [3.93]
$F_4(5,107) = 9.5529$ [2.30]

The overall predictive performance of this equation is poor, with an R^2 of 0.30095. Nevertheless, all statistical tests are acceptable, except Chow's predictive failure statistic (F_4), a test of the adequacy of predictions. This is not surprising given the discussion of outliers in the period 1987-1991.

However, a plot of cumulative sum of squares of recursive residuals, figure 9.21, shows that the lower critical boundary is crossed on two occasions. The breeches taking place between 1939-1951 and 1960-1970.

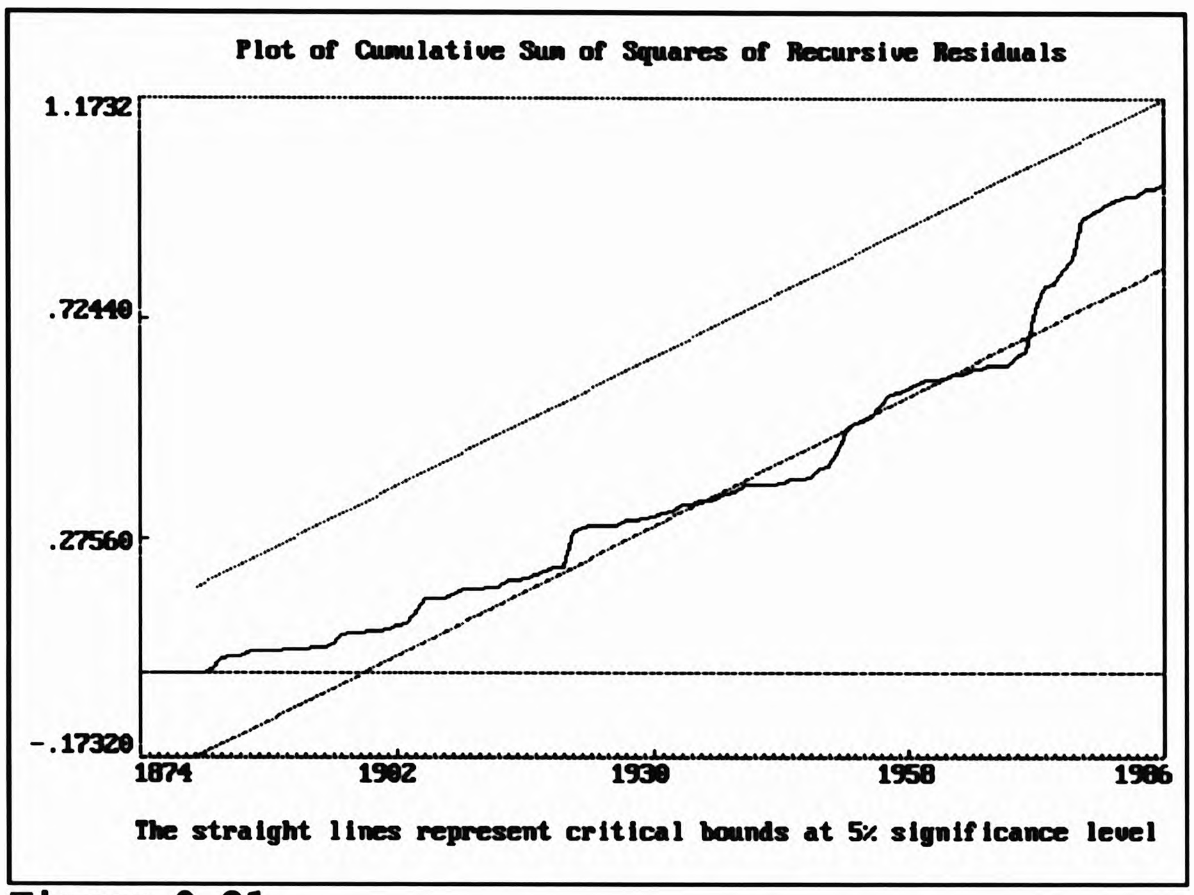

Figure 9.21

Consideration of each recursive coefficient reveals much parameter instability. Plots of corresponding recursive t statistics uncovers the fact that the majority of parameters are not significantly different from zero for the whole sample period.

The recursive coefficient on permanent income, figure 9.22, shows much variation. While its matching recursive t statistic reveals that it is only significant for a short period at the end of the nineteenth century and after 1920, figure 9.23.

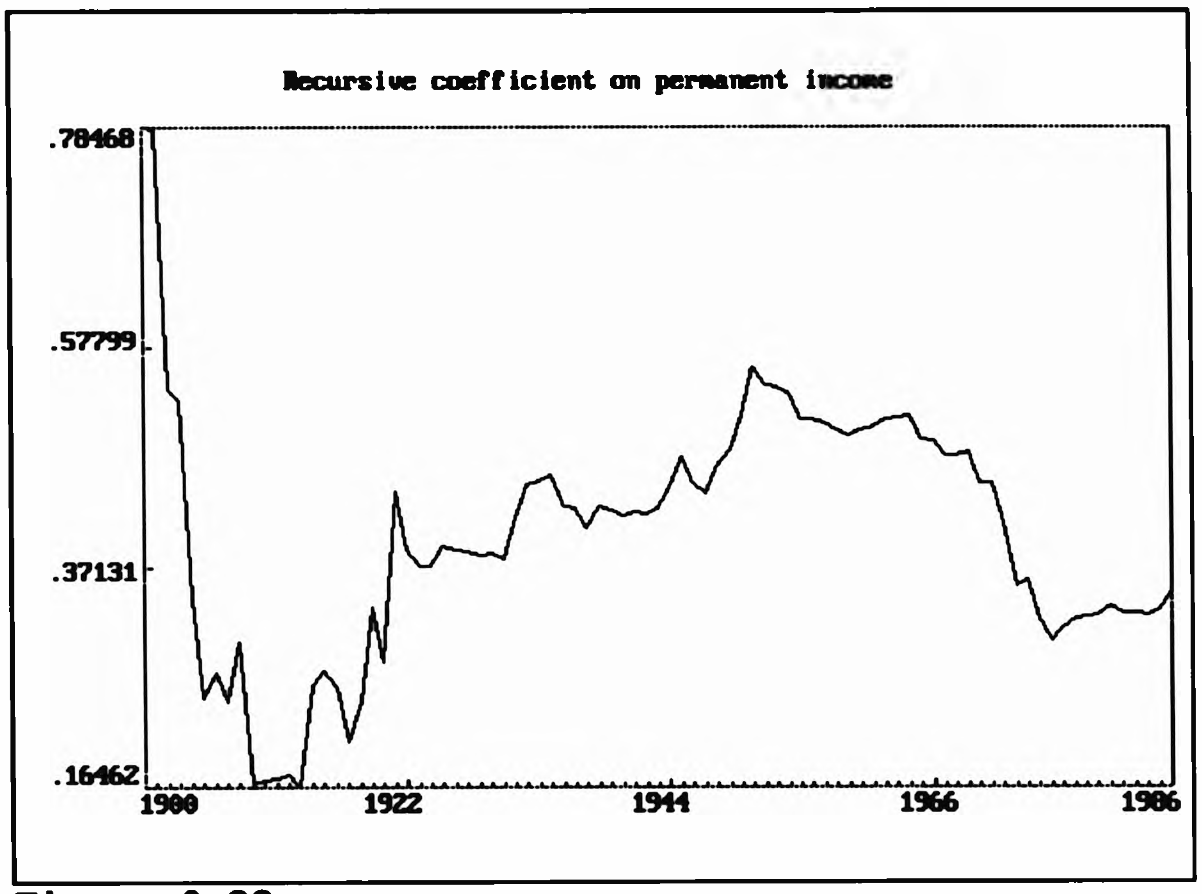

Figure 9.22

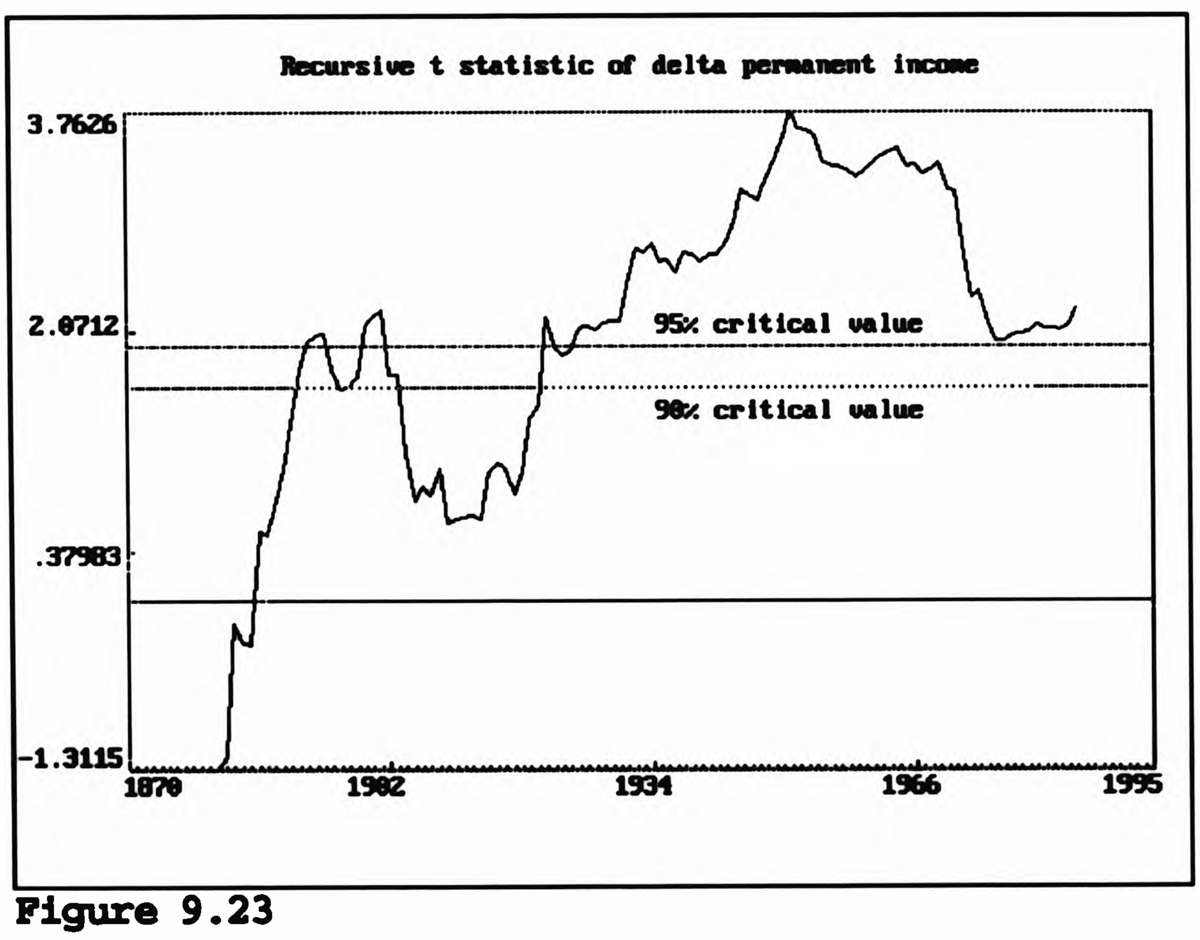

Figure 9.23

Prior to the end of the Second World War, much variation is found in the parameter on $\Delta(TNBFA/TFA)_{t-3}$, figure 9.24. The complementary recursive t statistic, figure 9.25, shows the parameter is not, for the most part, significant until after 1936. Before 1933 the recursive parameter on ΔRL_{t-1} is volatile, after which it is fairly stable, although some variation is present, figure 9.26. The correlative recursive t statistic, figure 9.27, suggests that the parameter is only significant between 1898-1904, 1919-1923, and 1936-1991. A plot of the recursive coefficient on $\Delta(C/M)_t$, figure 9.28, shows much variation until 1922. The following twenty years reveals some stability, which is followed by a trough, after which some constancy is restored. In 1970 there is a sharp increase in parameter size, succeeding mild variation. The recursive t statistic reveals that significance only occurs after 1970, figure 9.29. Finally, the recursive coefficient on the lagged error correction mechanism variable, figure 9.30, indicates little variation until the commencement of the Second World War, after which a steep fall takes place until 1970, when mild variation ensues. The associated recursive t statistic indicates significance for virtually the whole sample period, figure 9.31.

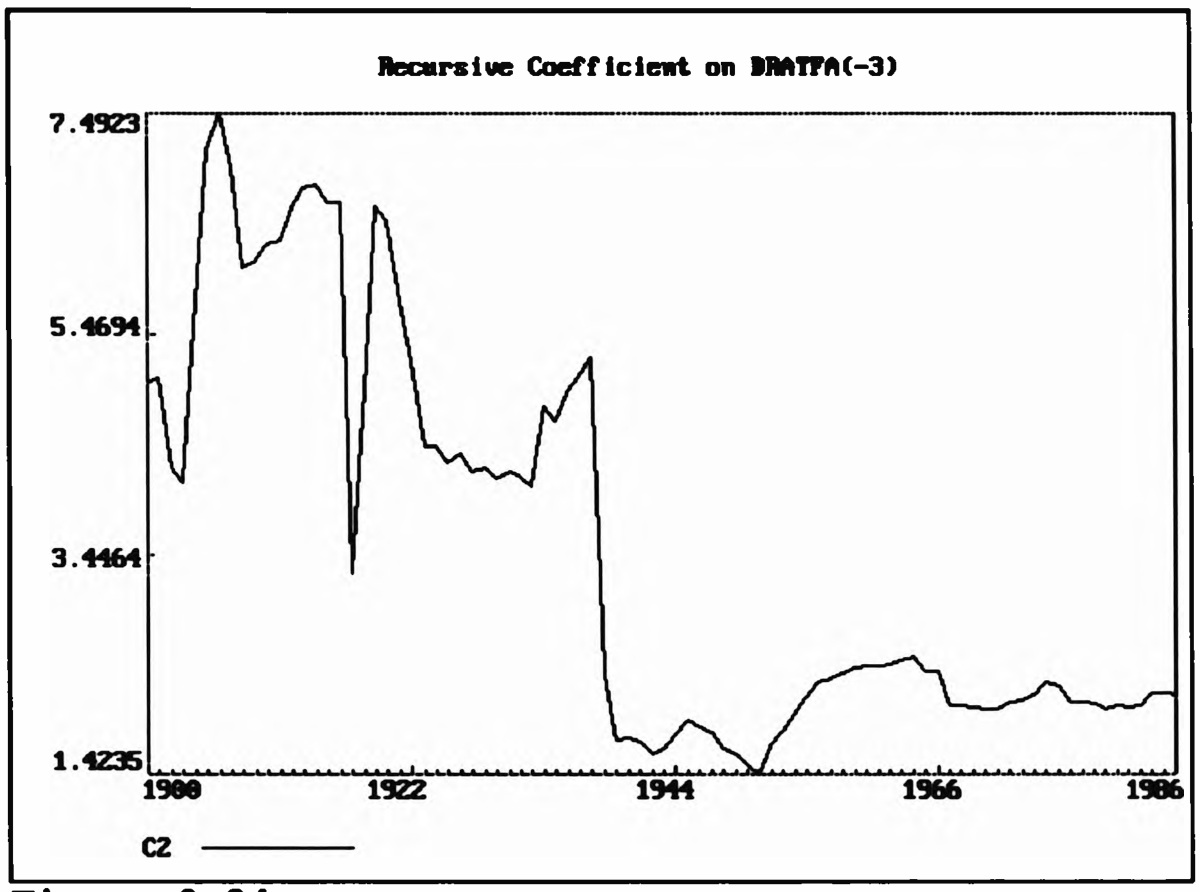

Figure 9.24

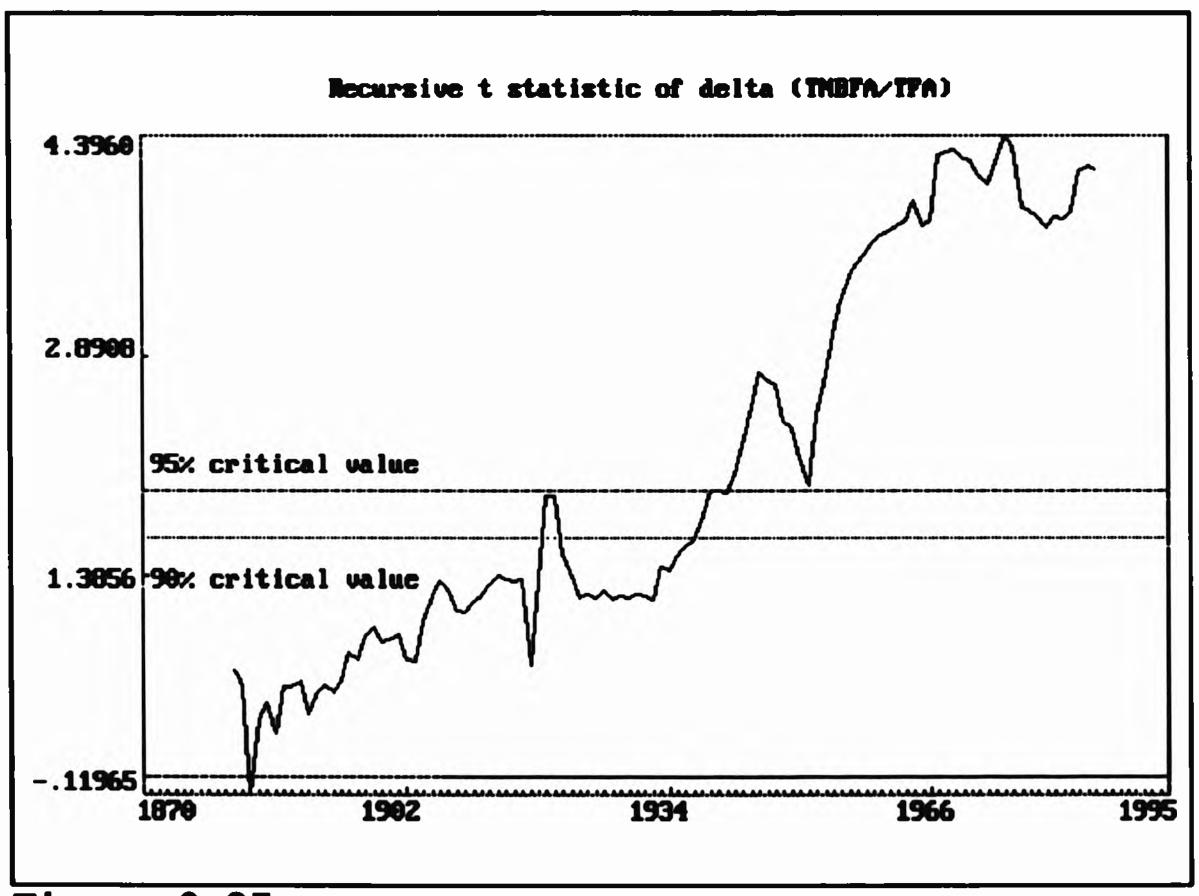

Figure 9.25

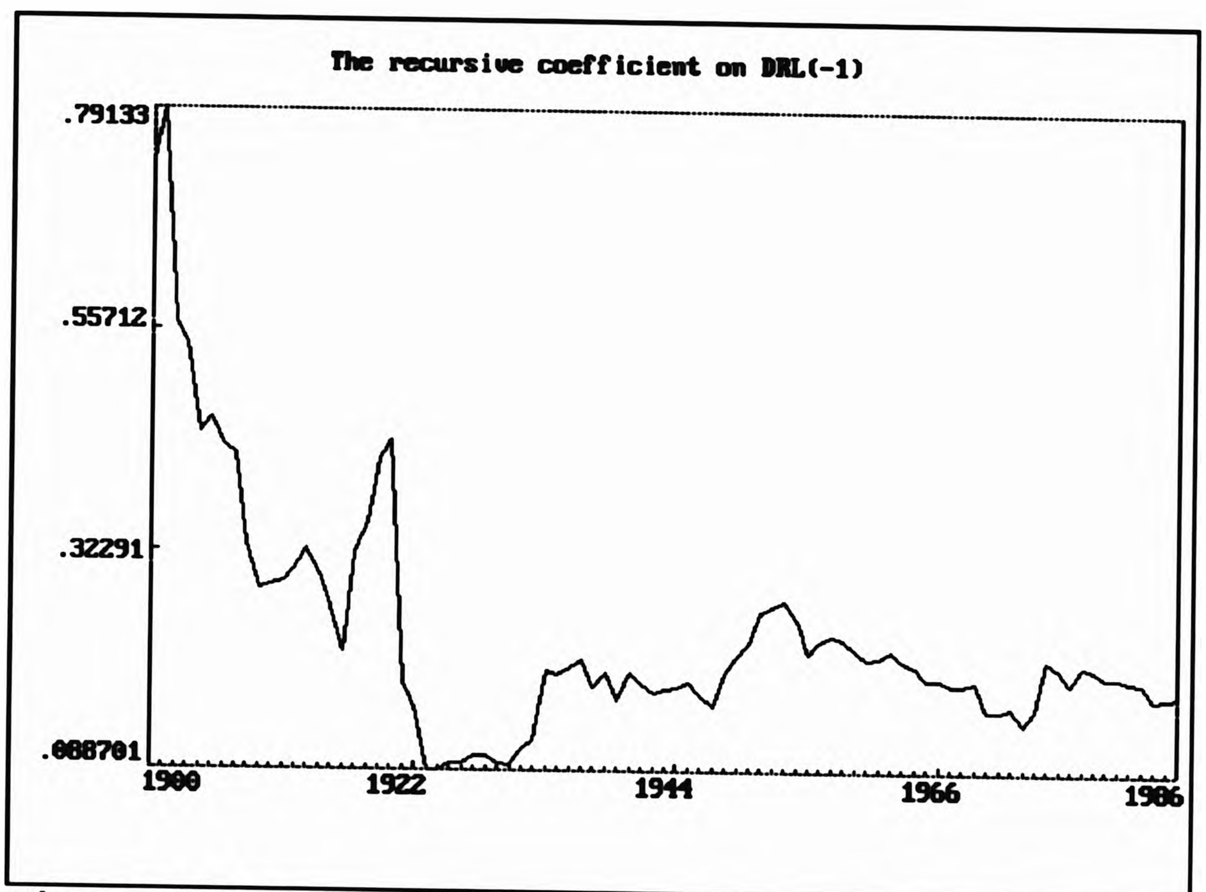

Figure 9.26

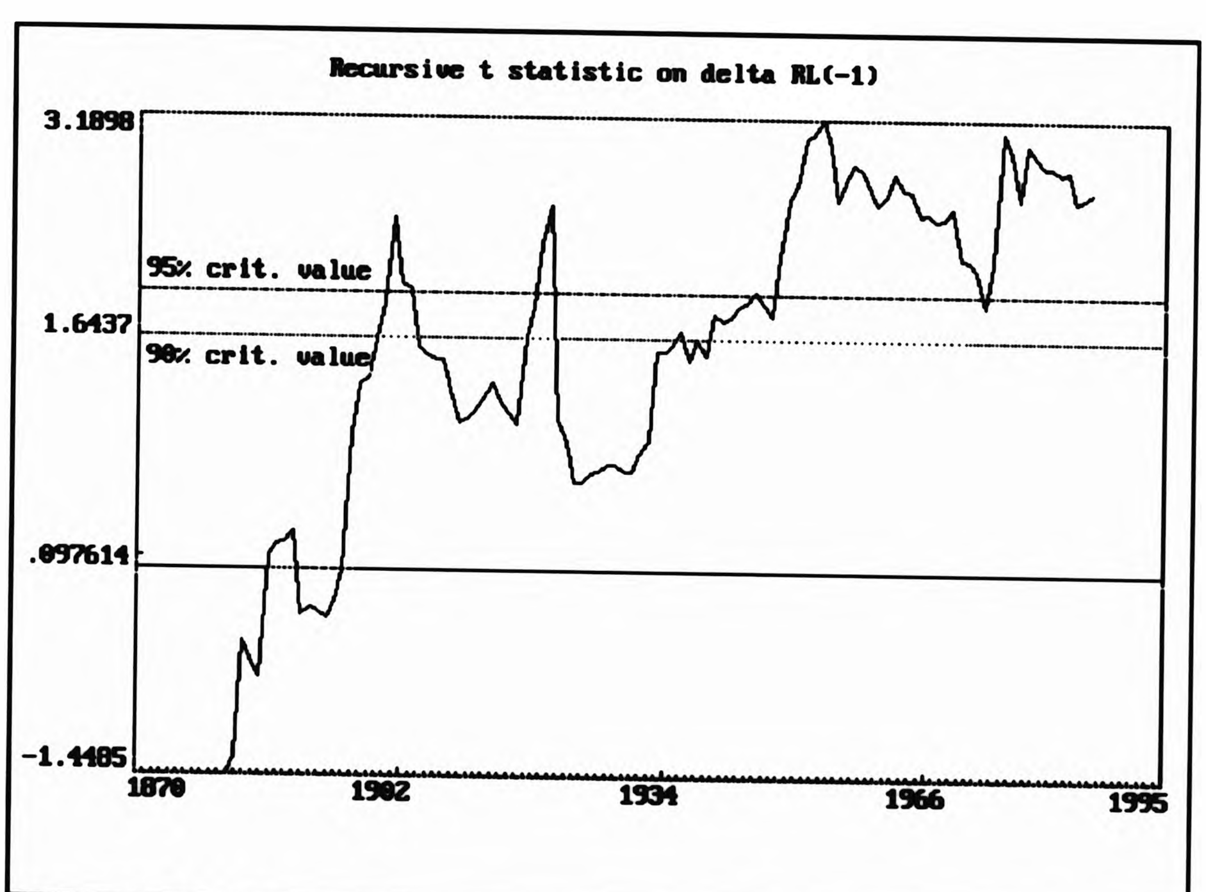

Figure 9.27

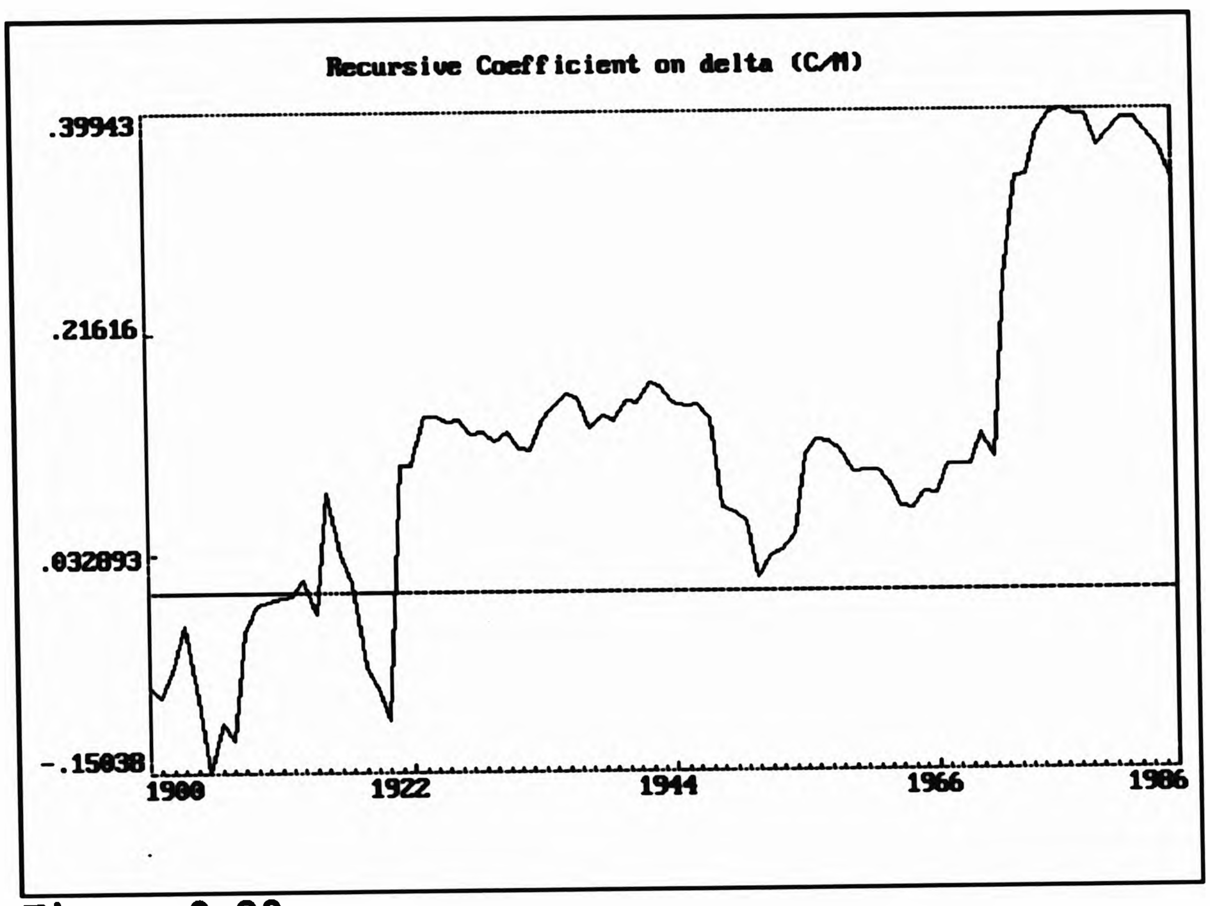

Figure 9.28

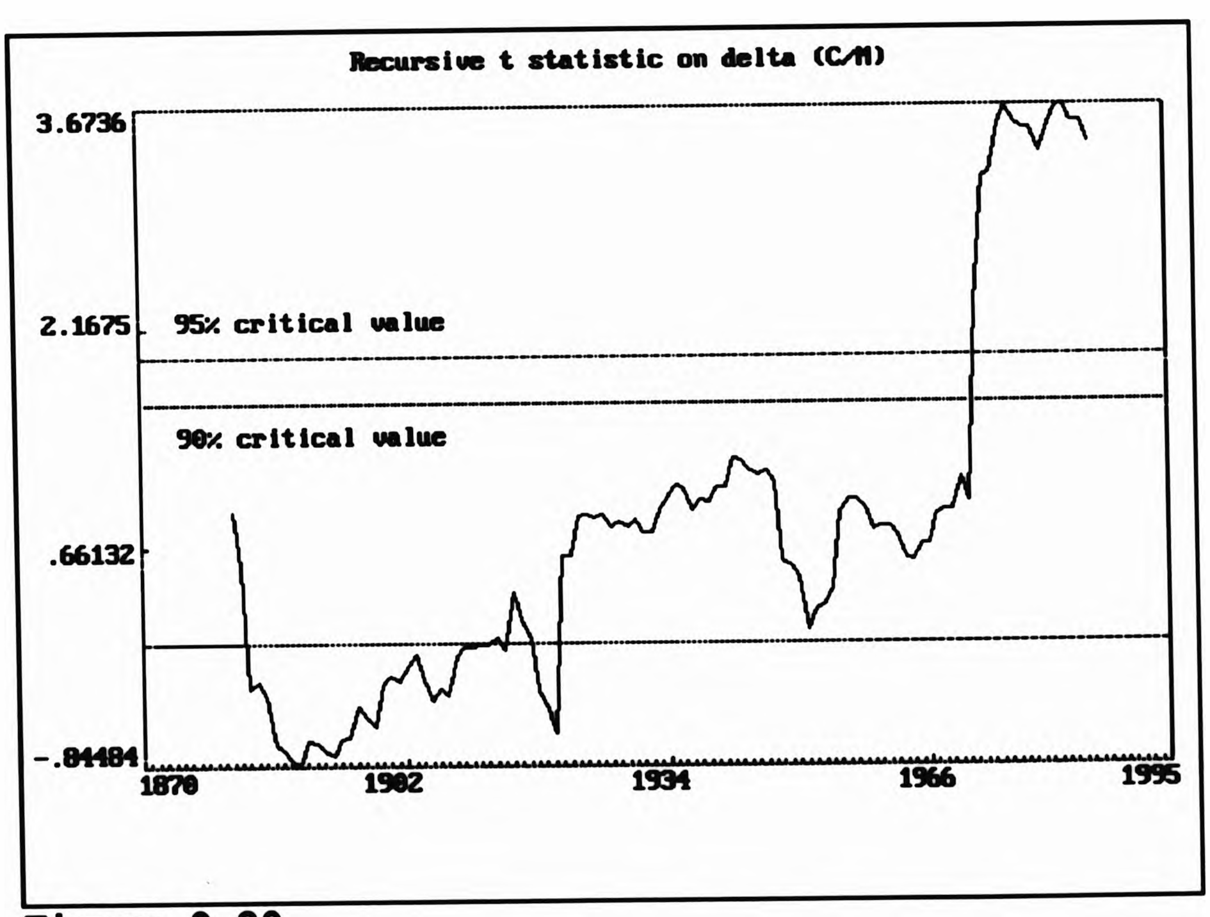

Figure 9.29

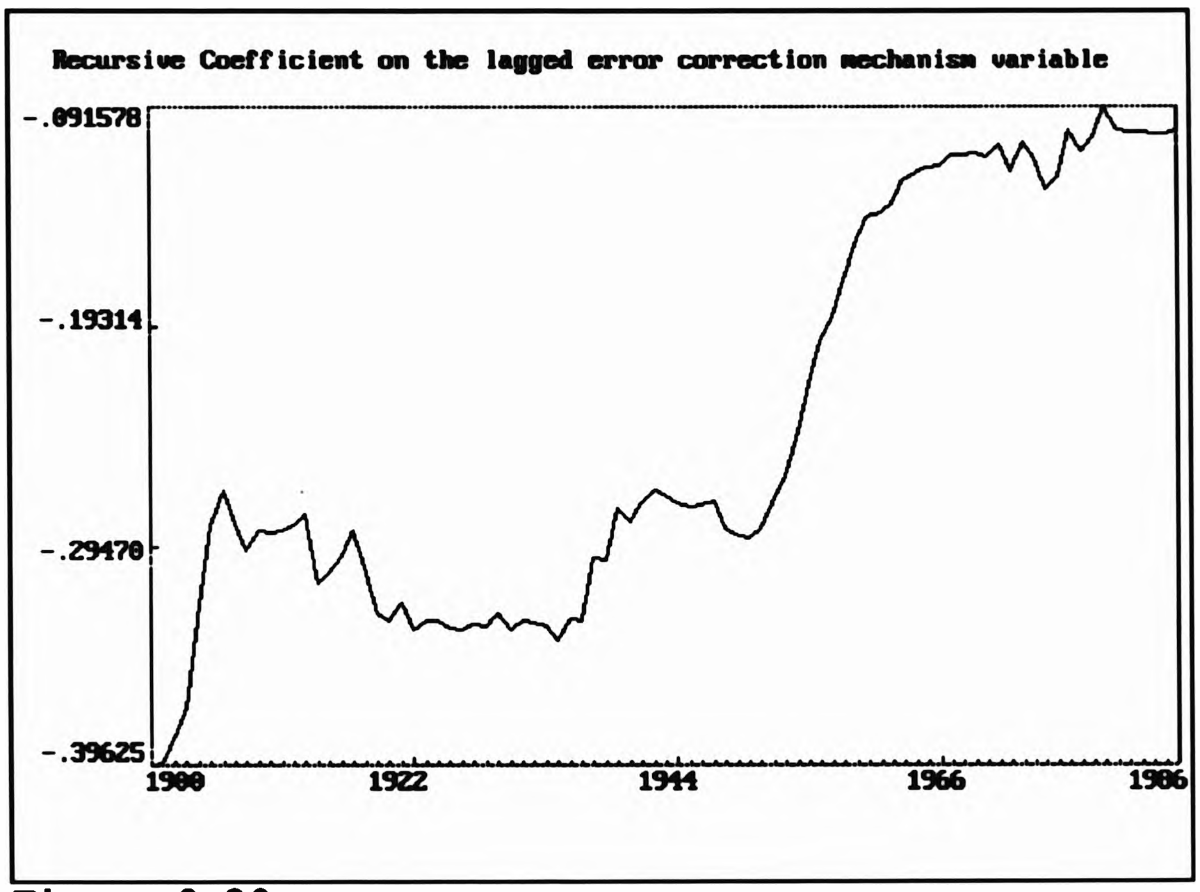

Figure 9.30

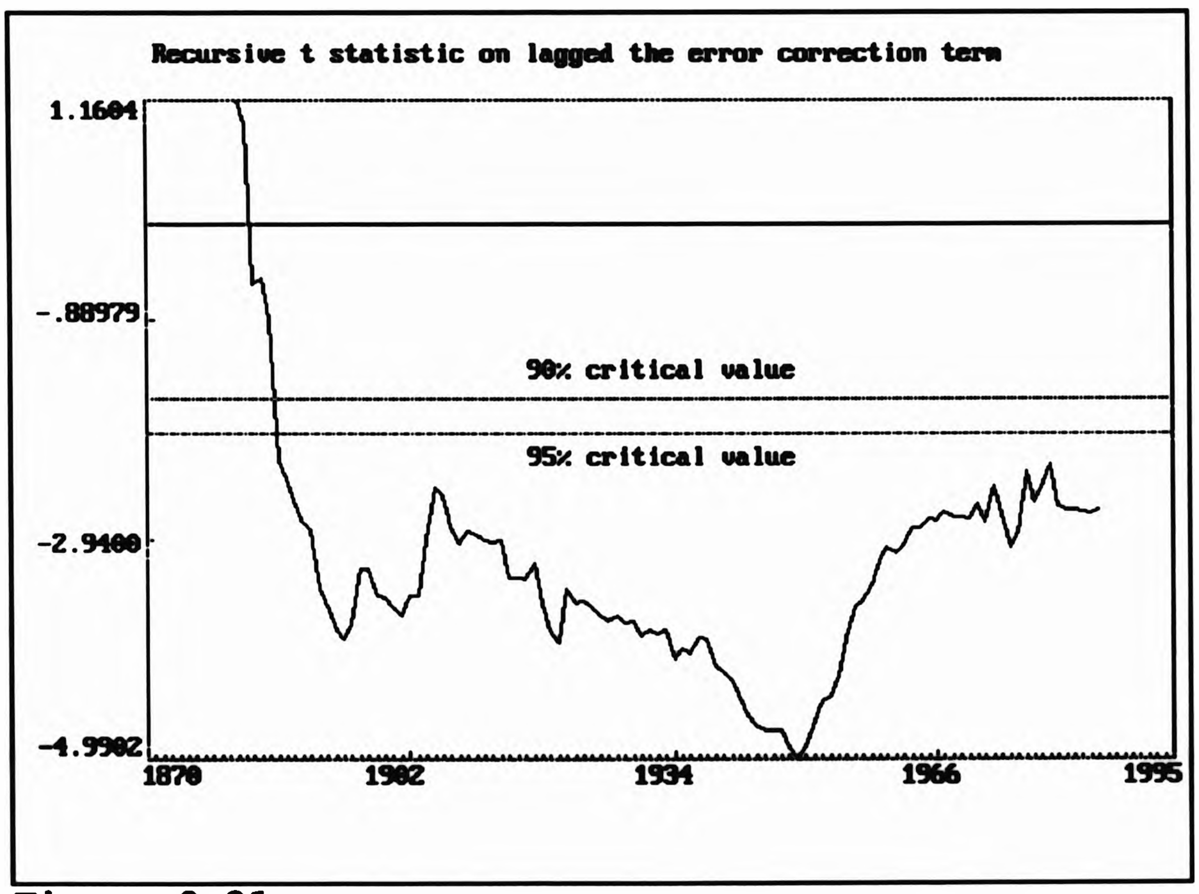

Figure 9.31

The overall fit of equation (9.5) is very poor. A plot of the regression standard errors of the recursive equation, figure 9.32, indicates that performance is fairly constant until the final thirty year period, when some deterioration takes place.

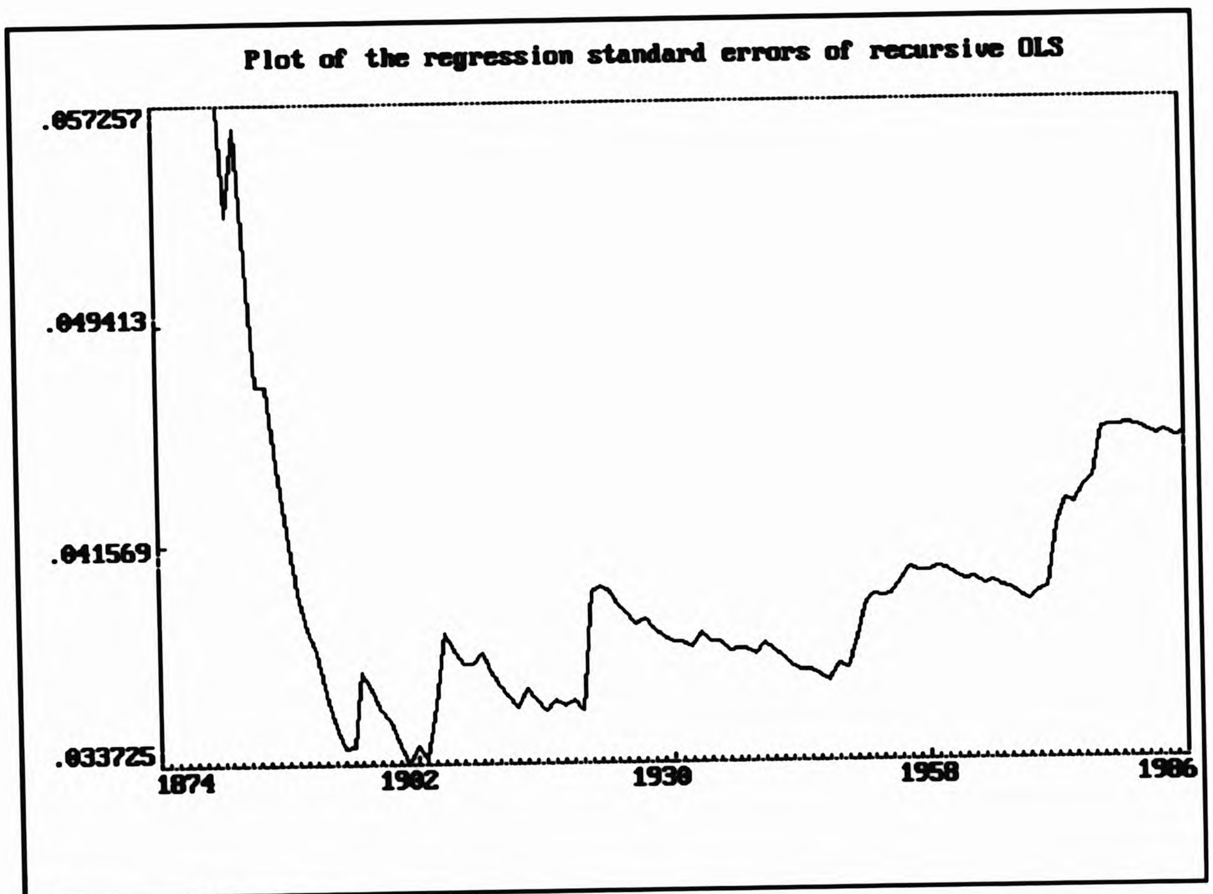

Figure 9.32

Attempts at finding an acceptable transactions velocity specification for the whole period revealed a number of problems, notably that concerning normality. It also disclosed that a different sub set of variables play a role when compared with the income velocity specification.

However, the results do not detract from our earlier tentative conclusion, that the relevant players in the short run velocity equation change over time, according to contemporaneous circumstances. In order to consider this point further, let us consider two sub samples, 1870-1946, a period of falling velocity, and 1950-1991 a time of rising velocity.

9.4 Sub Sample 1870-1946 - Falling Velocity

Let us commence with income velocity for the first sub sample. Once again the initial starting point was the general short run specification, which was simplified using the Hendry methodology.

Ordinary Least Squares

1873-1946

$$\Delta V1_t = \underset{(3.5906)}{-0.29282} + \underset{(5.4783)}{0.83870}\, \Delta (Y/PN)^P_t + \underset{(2.9998)}{0.30365}\, \Delta RL_{t-1}$$

$$- \underset{(3.3496)}{0.081923}\, RES_{t-1} \qquad (9.6)$$

$R^2 = 0.36857$ s.e. = 0.042268
$n = 74$
$k = 3$
D.W.= 2.1642 [$d_L = 1.395$ $d_U = 1.557$ $(4-d_U) = 2.443$]
t_{90} = [1.671]
t_{95} = [2.000]

$F_1(1,69) = 1.3951$ [3.98]
$F_2(1,69) = 3.0387$ [3.98]
$\chi^2(2) = 1.8545$ [5.991]
$F_3(1,72) = 19.1813$ [3.98]
$F_4(45,70) = 2.4634$ [1.55]
$F_5(4,111) = 2.4875$ [2.46]

Apart from the error correction term and the intercept, equation (9.6), has just two regressors, permanent income and the long term interest rate lagged one period. An R^2 of 0.36857 does not suggest a very good fit. However, all the basic statistical tests are passed, except F_3 the heteroscedasticity test, and the plot of cumulative sum of squares of recursive residuals. The lower critical boundary being crossed between 1908 and 1919, see figure 9.33. This is confirmed by the Chow test of stability of the regression coefficients, $F_5(4,111) = 2.4875$ [2.46].

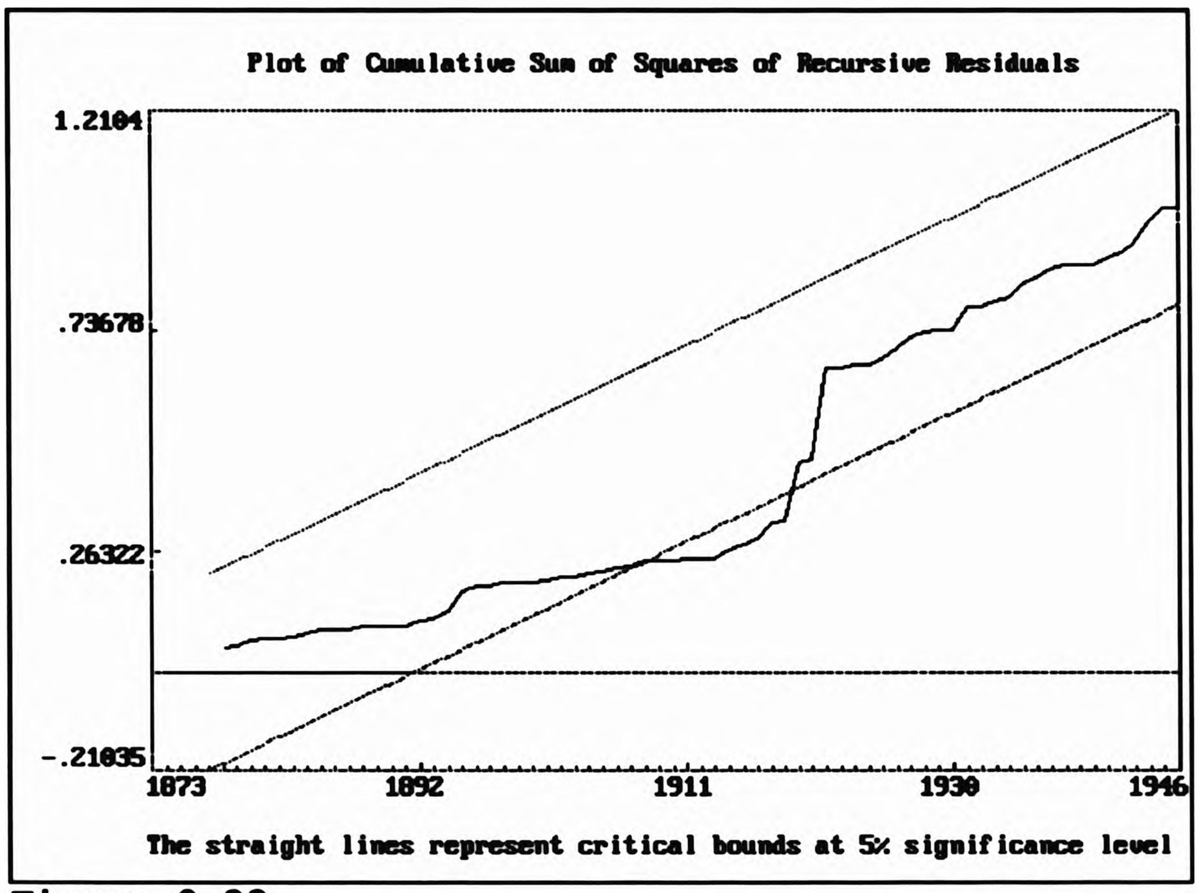

Figure 9.33

It is also interesting to note, that Chow's second test of adequacy of predictions also fails, $F_4(45,70) = 2.4634$ [1.55]. Confirming the argument that a specification for one sub period does not necessarily perform well in another period. This is also illustrated by a plot of actual and forecast values from 1947 onwards, figure 9.34

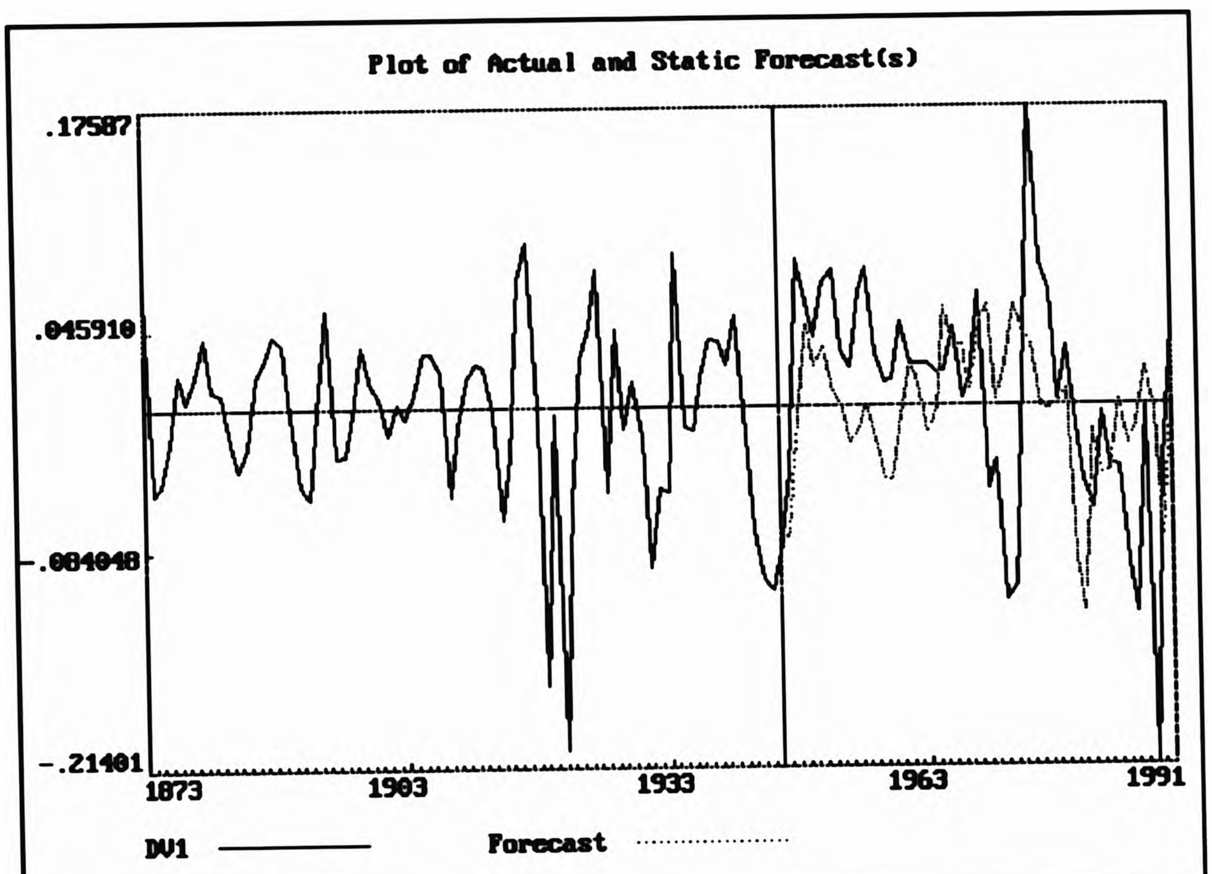

Figure 9.34

The problems outlined above, except the forecast errors, are resolved by the introduction of dummy variables for 1919 and 1921, as shown in equation (9.7).

Ordinary Least Squares

1873-1946

$$\Delta V1_t = \underset{(3.5906)}{-0.24270} + \underset{(5.4783)}{0.62399}\,\Delta(Y/PN)^P_t + \underset{(2.9998)}{0.32562}\,\Delta RI_{t-1}$$

$$- \underset{(3.2508)}{0.12354}\,D19 - \underset{(3.6752)}{0.15193}\,D21 - \underset{(3.1935)}{0.069076}\,RES_{t-1} \qquad (9.7)$$

R^2 = 0.51463 s.e. = 0.037058
n = 74
k = 5
D.W.= 1.6517 [d_L = 1.340 d_U = 1.617 (4-d_U) = 2.383]
t_{90} = [1.671]
t_{95} = [2.000]

$F_1(1,67)$ = 1.5055 [3.99]
$F_2(1,69)$ = 0.82563 [3.99]
$\chi^2(2)$ = 0.14759 [5.991]
$F_3(1,72)$ = 0.80883 [3.98]
$F_4(45,68)$ = 3.0246 [1.56]

Turning our attention to transactions velocity, the following results are derived:

Ordinary Least Squares

1873-1946

$$\Delta V2_t = \underset{(4.4995)}{0.19811} + \underset{(3.6829)}{0.52082}\ \Delta(Y/PN)^P_t + \underset{(2.1922)}{0.20259}\ \Delta RL_{t-1}$$

$$- \underset{(4.7919)}{0.29313}\ RES_{t-1} \qquad (9.8)$$

$R^2 = 0.2811$ s.e. = 0.038699
$n = 74$
$k = 3$
D.W.= 1.6968 [$d_L = 1.395$ $d_U = 1.557$ $(4-d_U) = 2.443$]
t_{90} = [1.671]
t_{95} = [2.000]

$F_1(1,69) = 2.3278$ [3.98]
$F_2(1,69) = 6.4120$ [3.98]
$\chi^2(2) = 0.013781$ [5.991]
$F_3(1,72) = 2.8703$ [3.98]
$F_4(45,70) = 4.2053$ [1.56]
$F_5(4,111) = 2.8306$ [2.46]

These are of equivalent specification, and equally as poor. The main statistical problem is functional form, as indicated by Ramsey's RESET test (F_2). Nevertheless, the CUSUM tests suggest that parameter stability is not a problem in this instance. However, this view is contradicted by the Chow test $F_5(4,111)$ = 2.8306 [2.46]. Once again Chow's second test of adequacy of predictions fails, $F_4(45,70) = 4.2053$ [1.56]. This is illustrated by a plot of actual and forecast values (figure 9.35).

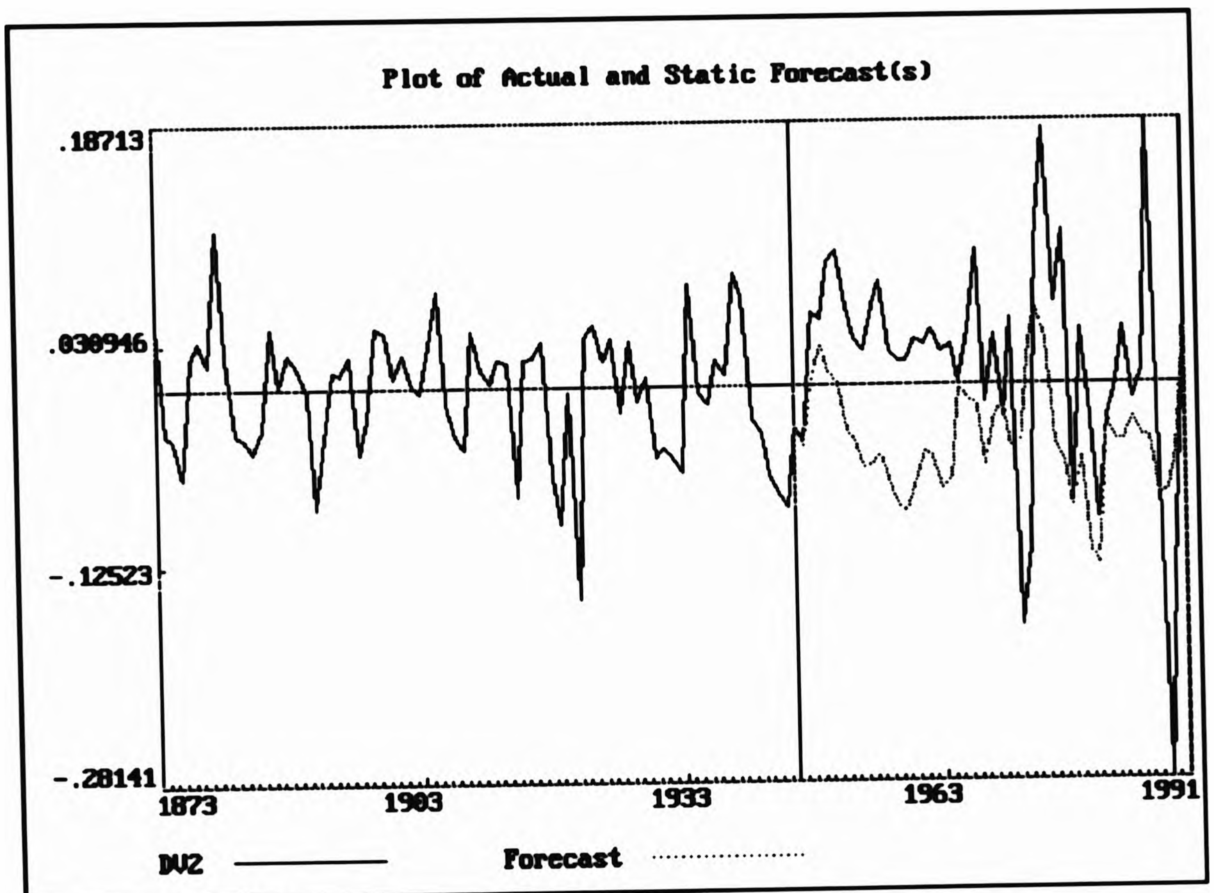

Figure 9.35

An attempt to correct the functional form problem using a dummy variable in 1921, the point of structural break, identified earlier, just resolves this problem, although introduced the additional problem of autocorrelation. This is reported in equation (9.9).

Ordinary Least Squares

1873-1946

$$\Delta V2_t = \underset{(4.7318)}{0.19596} + \underset{(2.7930)}{0.38903}\ \Delta(Y/PN)^P_t + \underset{(2.9328)}{0.26040}\ \Delta RL_{t-1}$$

$$- \underset{(3.1842)}{0.12835}\ D21 - \underset{(4.9430)}{0.28467}\ RES_{t-1} \qquad (9.9)$$

$R^2 = 0.36413$ s.e. $= 0.036396$
$n = 74$
$k = 4$
D.W.$= 1.4276$ [$d_L = 1.368$ $d_U = 1.587$]
t_{90} = [1.671]
t_{95} = [2.000]

$F_1(1,69) = 10.2037$ [3.98]
$F_2(1,69) = 3.9403$ [3.98]
$\chi^2(2) = 0.48718$ [5.991]
$F_3(1,72) = 0.15810$ [3.98]
$F_4(45,70) = 4.6891$ [1.56]

9.5 Sub Sample 1950-1991 - Rising Velocity

Let us turn to the second sub-period. Once again the general to specific methodology is used. The final specification is as follow:

Ordinary Least Squares

1950-1991

$$\Delta V1_t = - \underset{(1.5071)}{0.063045} + \underset{(3.3172)}{0.20269}\ \Delta RS_t - \underset{(3.3999)}{0.20911}\ \Delta ROWN_t$$

$$+ \underset{(2.7930)}{0.30992}\ \Delta TAXR_t + \underset{(9.7716)}{0.74867}\ \Delta(C/M)_t - \underset{(2.6913)}{0.068381}\ \Delta YSD_t$$

$$+ \underset{(2.7294)}{0.24250}\ \Delta PD_t - \underset{(1.9430)}{0.0087244}\ \Delta RFORG_{t-1} - \underset{(1.8614)}{0.024220}\ RES_{t-1} \qquad (9.10)$$

$R^2 = 0.85175$ s.e. $= 0.026250$
$n = 42$
$k = 8$
D.W.$= 2.0474$ [$d_L = 0.974$ $d_U = 1.768$ $(4-d_U) = 2.232$]
t_{90} = [1.684]
t_{95} = [2.021]

$F_1(1,32) = 0.15277$ [4.15]
$F_2(1,32) = 0.029262$ [4.15]
$\chi^2(2) = 1.6842$ [5.991]
$F_3(1,40) = 1.8884$ [4.08]

It consists of short term and "own rate" interest rates. The basic income tax rate. An economic stability term and price inflation. Together with a foreign portfolio term based on the German interest rate lagged one period. This is an excellent equation, all parameters, except the intercept, are of the correct sign, and significantly different from zero. Tests for serial correlation, functional form, normality and heteroscedasticity are all passed. The null hypothesis is accepted for both CUSUM tests. Thus it is possible to conclude that the regression model is correctly specified, and that there are no systematic changes in the regression coefficients (see figures 9.36 and 9.37.

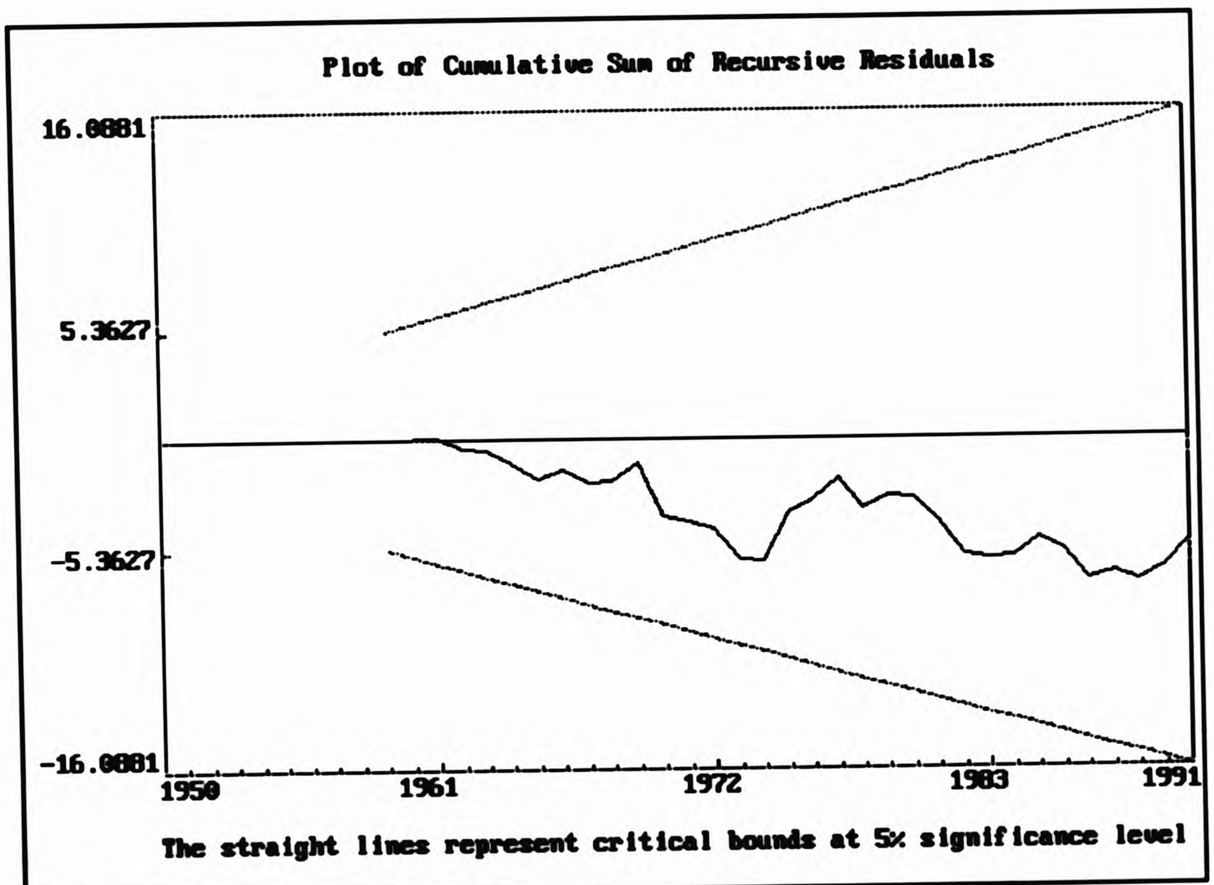

Figure 9.36

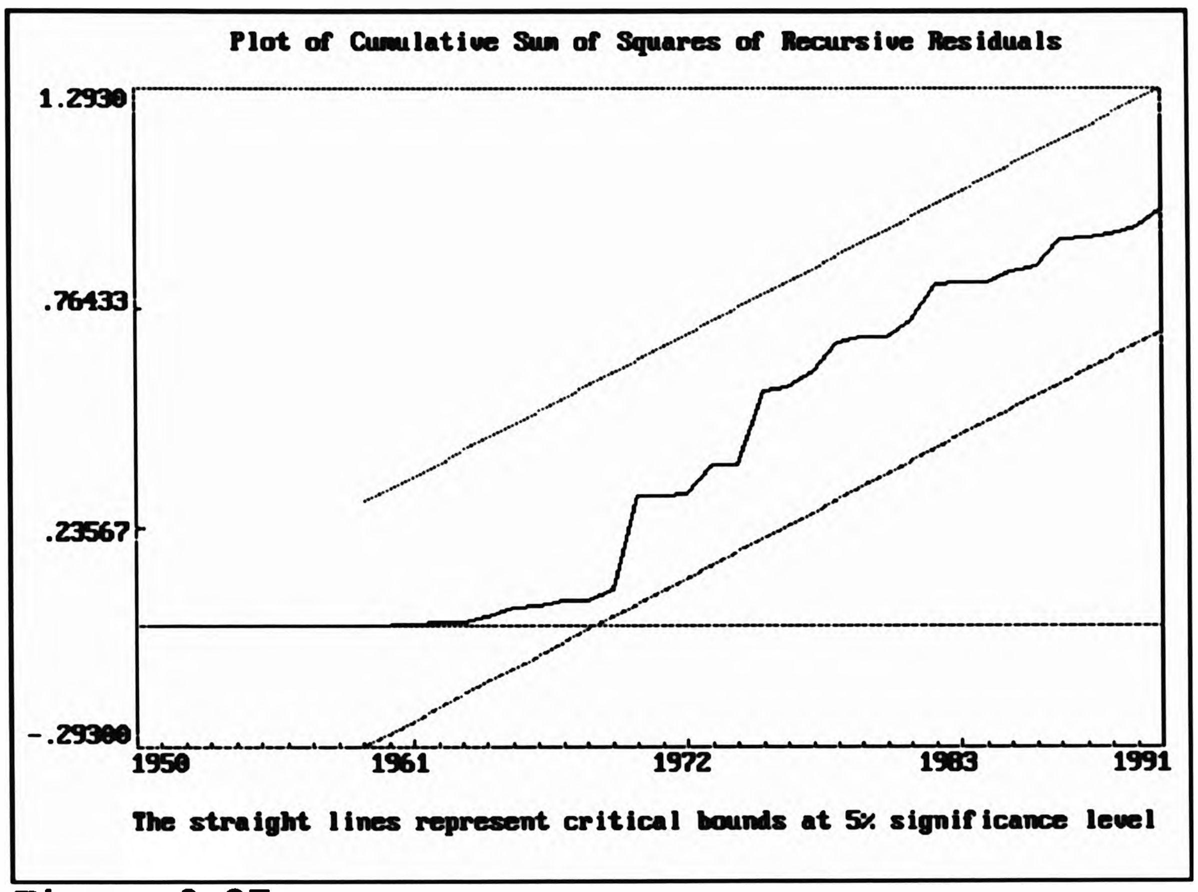

Figure 9.37

The equations exemplary performance is reinforced by a plot of actual and fitted values, figure 9.38, and residuals and standard error bands, figure 9.39. Indeed, over 85% of the variation in income velocity is explained by this specification.

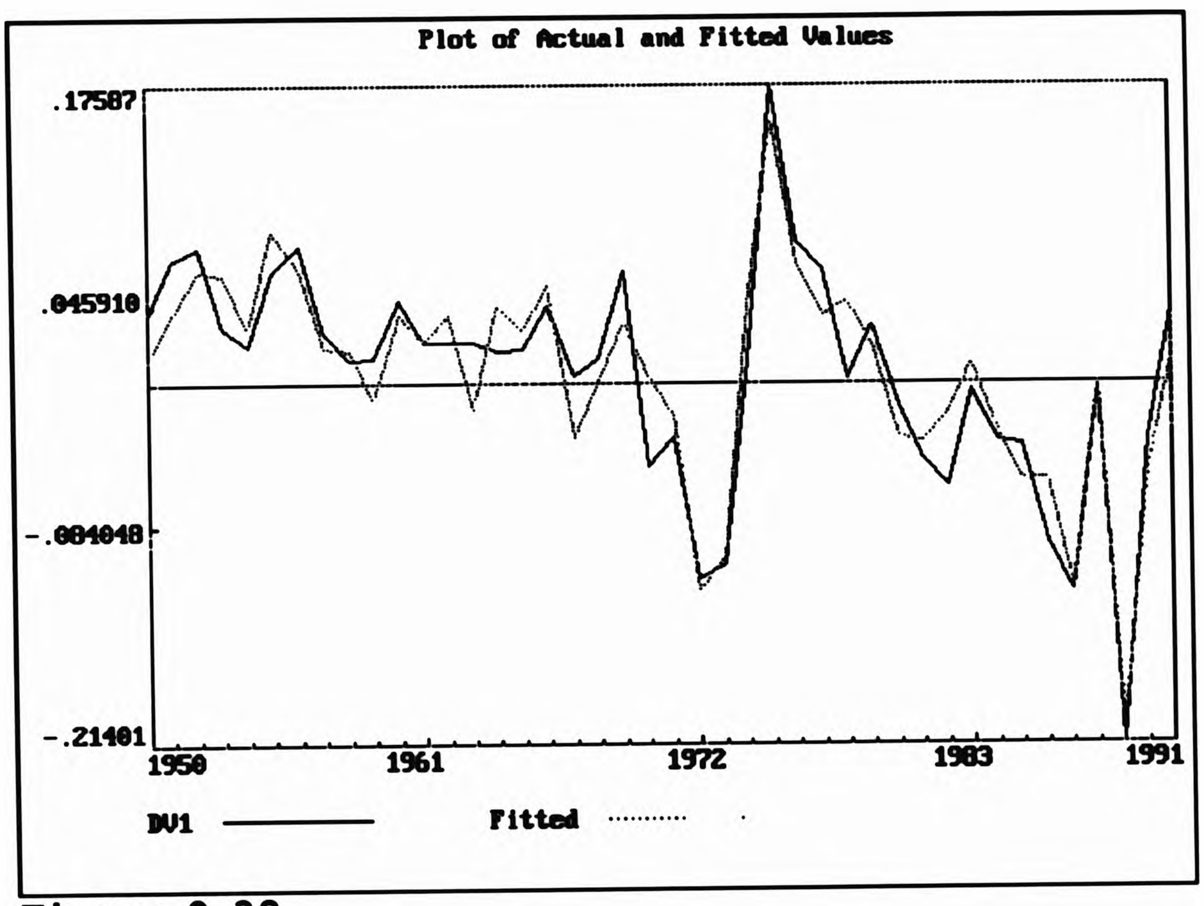

Figure 9.38

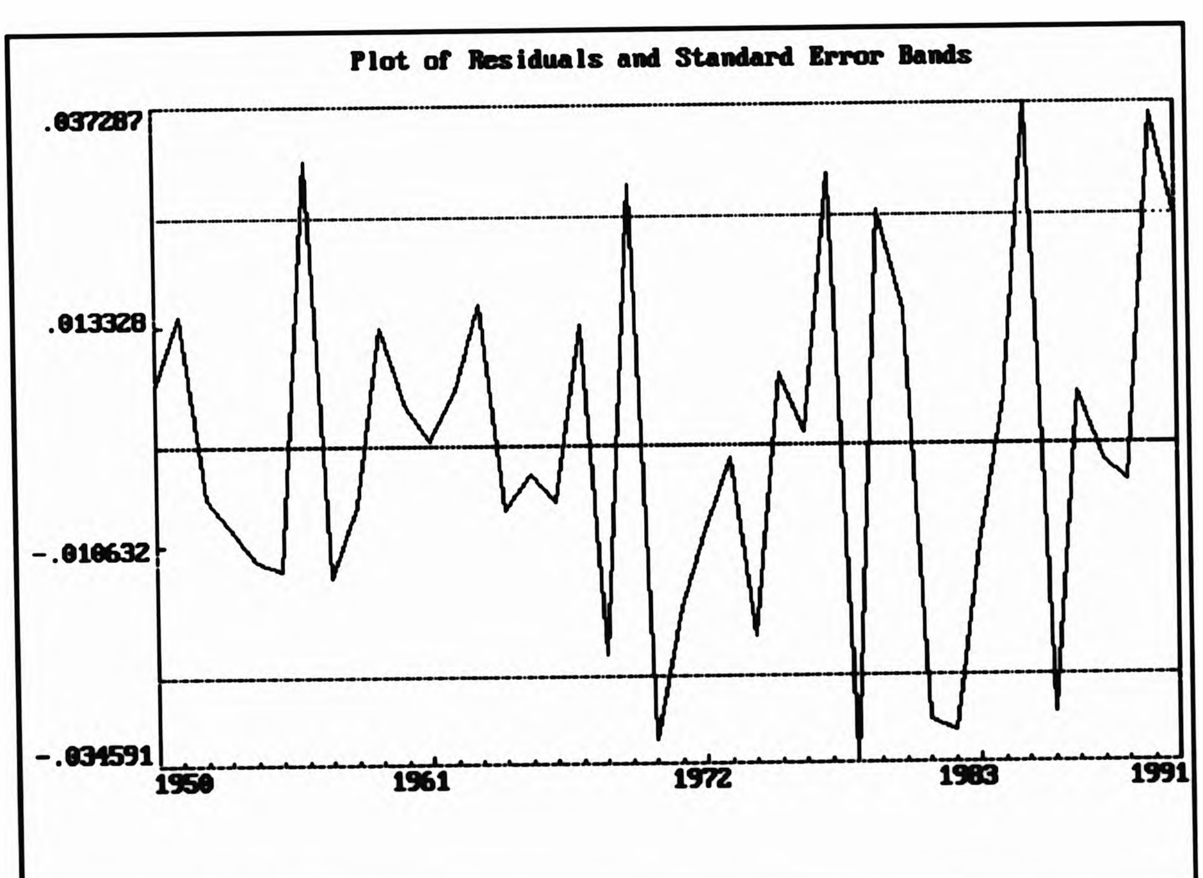

Figure 9.39

Further analysis of the sub period 1950-1991 continues with consideration of transactions velocity. Simplification of the general model using statistical tests, gives the following equation.

Ordinary Least Squares

1950-1991

$$\Delta V2_t = \underset{(2.4318)}{0.20535} + \underset{(2.4327)}{0.61350}\,\Delta TAXR_t + \underset{(3.0175)}{0.51743}\,\Delta (C/M)_t$$

$$- \underset{(1.5869)}{0.015951}\,\Delta RFORG_{t-1} - \underset{(1.9996)}{0.19161}\,RES_{t-1} \qquad (9.11)$$

$R^2 = 0.44914$ s.e $= 0.062641$
$n = 42$
$k = 4$
D.W.= 1.8693 [$d_L = 1.098$ $d_U = 1.518$ $(4-d_U) = 2.482$]
t_{90} = [1.684]
t_{95} = [2.021]

$F_1(1,36) = 0.17266$ [4.11]
$F_2(1,36) = 1.5537$ [4.11]
$\chi^2(2) = 54.6998$ [5.991]
$F_3(1,40) = 0.18302$ [4.08]

This is composed of the basic income tax rate, the currency money ratio, the foreign portfolio variable lagged once and the error correction term. Unfortunately, the normality problem invalidates the majority of diagnostic tests. As discussed earlier, this is caused by the outliers in 1987 and 1989, see figure 9.40, and is solved using dummies.

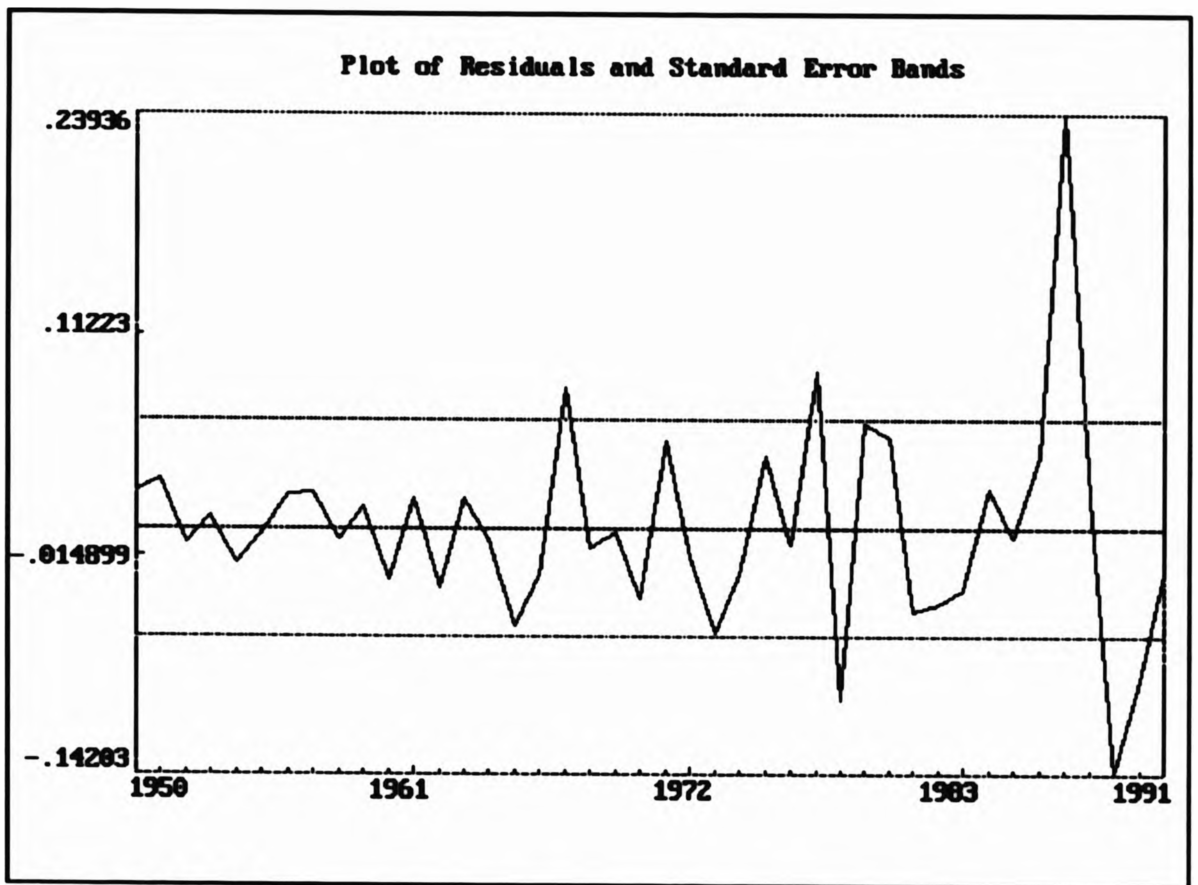

Figure 9.40

The revised results become:

Ordinary Least Squares

1950-1991

$$\Delta V2_t = \underset{(2.7210)}{0.16013} + \underset{(3.0593)}{0.53272}\, \Delta TAXR_t + \underset{(4.4599)}{0.58876}\, \Delta (C/M)_t$$

$$- \underset{(1.5022)}{0.010524}\, \Delta RFORG_{t-1} + \underset{(5.4117)}{0.25052}\, D87 - \underset{(2.8813)}{0.14132}\, D89$$

$$- \underset{(2.1193)}{0.14150}\, RES_{t-1} \quad (9.12)$$

$R^2 = 0.73869$ s.e. = 0.04314
n = 42
k = 6
D.W.= 2.4552 [d_L = 1.065 d_U = 1.643 (4-d_U) = 2.357]
t_{90} = [1.684]
t_{95} = [2.021]

$F_1(1,34)$ = 2.5321 [4.13]
$F_2(1,34)$ = 0.004308 [4.13]
$\chi^2(2)$ = 0.16849 [5.991]
$F_3(1,40)$ = 1.4571 [4.08]

All but one of the statistical tests are passed. The exception is the parameter on $\Delta RFORG_{t-1}$ which is just outside being significantly different from zero at the 90% confidence level. The entry of dummy variables late in the sample makes the computation of the CUSUM tests difficult. An alternative solution to the original normality problem is to curtail the sample period in 1986. This gives the following results;

<u>Ordinary Least Squares</u>

<u>1950-1986</u>

$$\Delta V2_t = \underset{(2.7243)}{0.16990} + \underset{(3.3535)}{0.58443}\ \Delta TAXR_t + \underset{(3.91494)}{0.53855}\ \Delta(C/M)_t$$

$$- \underset{(1.6220)}{0.011333}\ \Delta RFORG_{t-1} - \underset{(2.1427)}{0.15086}\ RES_{t-1} \quad (9.13)$$

R^2 = 0.57365   s.e. = 0.042569
n = 37
k = 4
D.W.= 2.5357 [d_L=1.058 d_U=1.514 $(4-d_U)$=2.486 $(4-d_L)$=2.942]
t_{90} = [1.684]
t_{95} = [2.021]

$F_1(1,31)$ = 3.4464 [4.16]
$F_2(1,31)$ = 0.036983 [4.16]
$\chi^2(2)$ = 0.047095 [5.991]
$F_3(1,35)$ = 0.77062 [4.12]
$F_4(5,32)$ = 9.6235 [2.51]

An R^2 of 0.57365 suggests a reasonable fit. The Durbin Watson statistic lies between $(4-d_U)$ and $(4-d_L)$, and therefore is inconclusive. However, the Lagrange Multiplier test suggests that autocorrelation is not a problem. With the exception of the marginal t statistic associated with $\Delta RFORG_{t-1}$ and the predictive failure test, which is not surprising given the outliers in 1987 and 1989, all other tests are passed. These include the CUSUM tests, illustrated in figures 9.41 and 9.42.

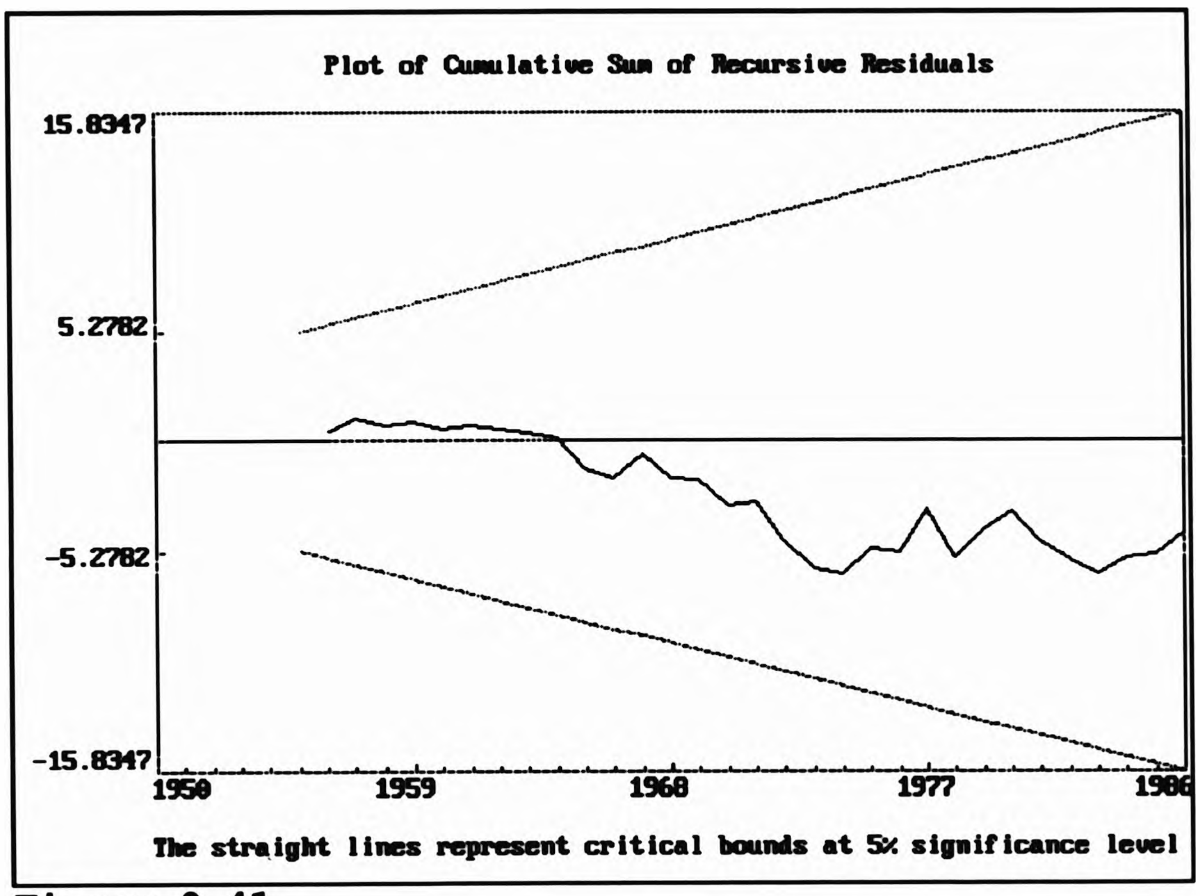

Figure 9.41

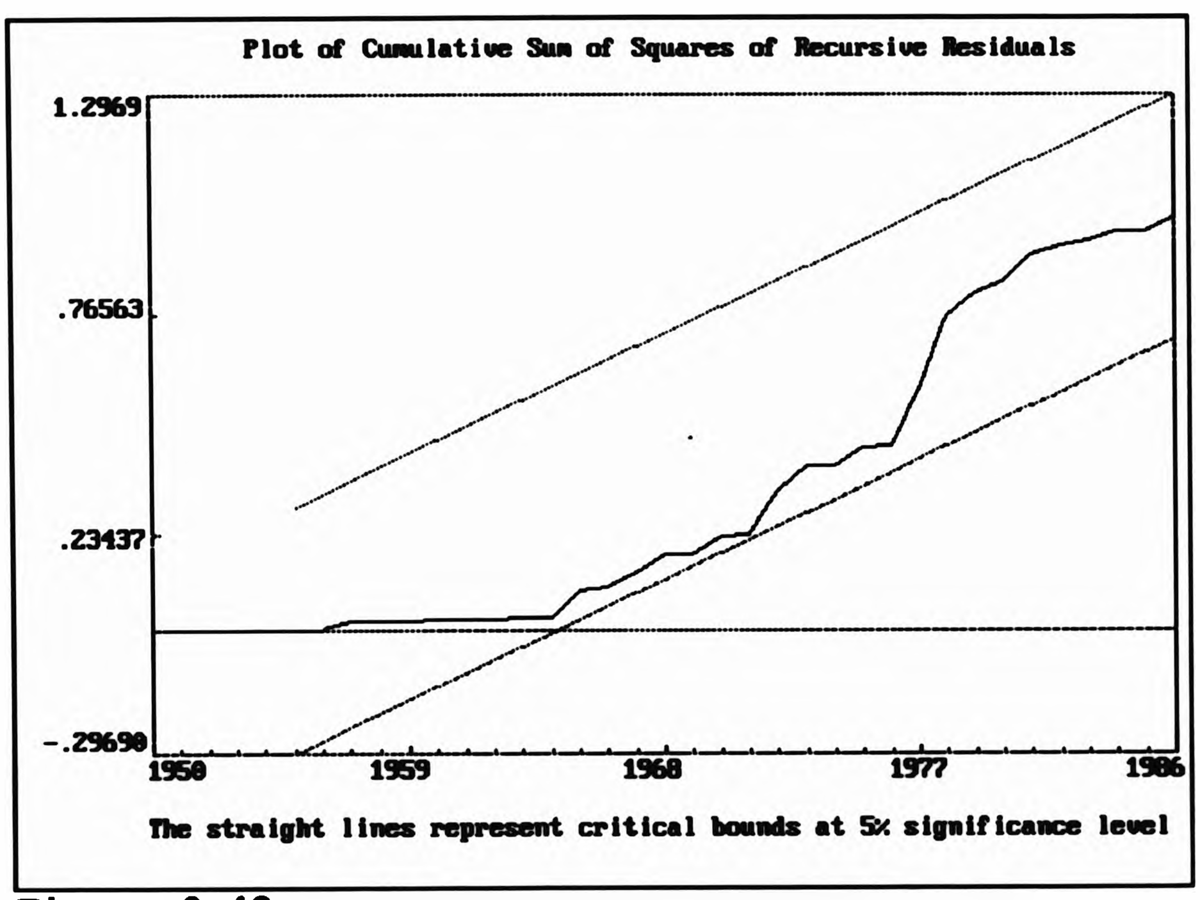

Figure 9.42

While a fairly good fit is indicated, there are still a number of outliers in 1967, 1976, and 1977, as illustrated in a plot of residuals and standard error bands, (figure 9.43).

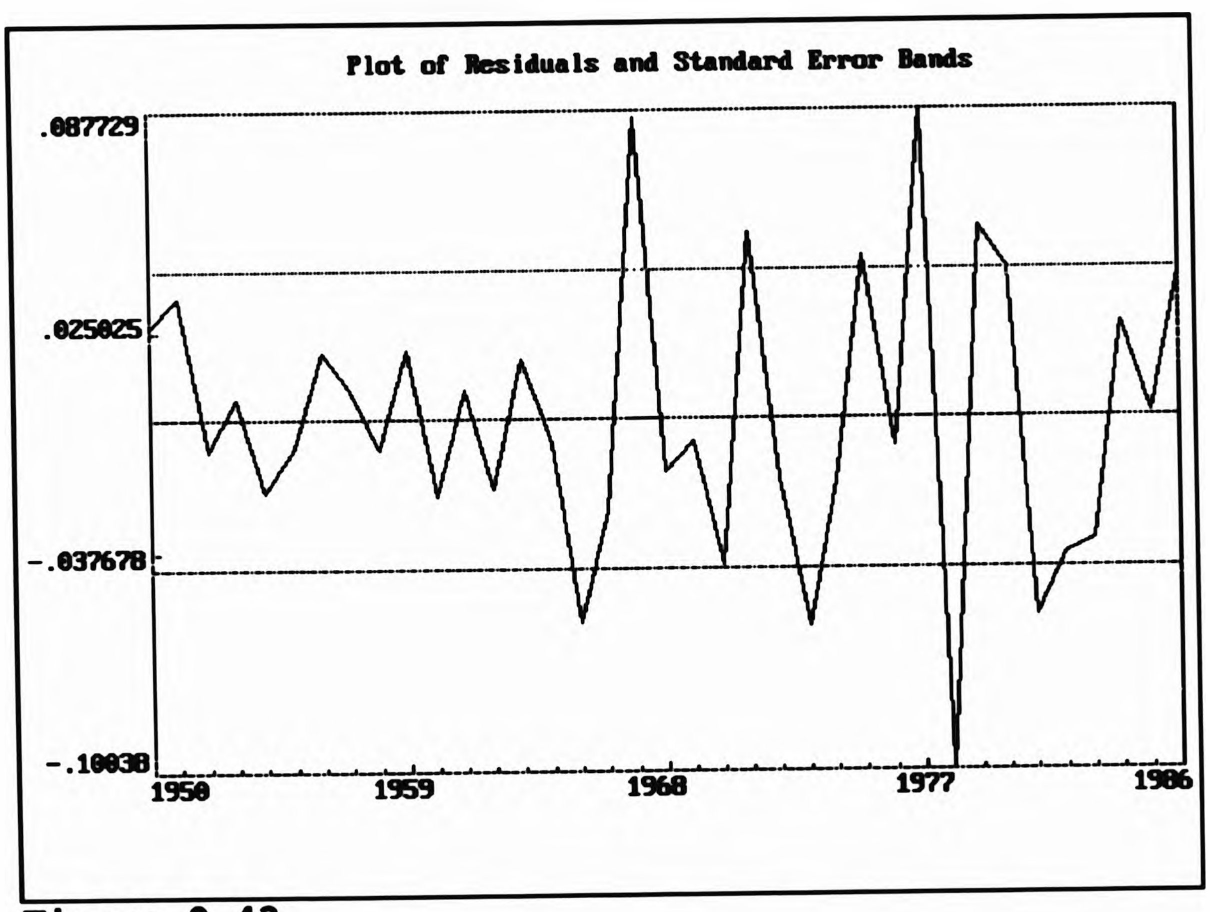

Figure 9.43

9.6 Review of Empirical Evidence

With the empirical work completed, it is possible to ascertain how well the theoretical model performs when confronted with the data. Just before we commence this task, it is useful to restate the two long run Johansen vectors, as these are the underlying foundation of the short term model.

For income velocity;

$$\ln V1_t = 0.44685 \ln(Y/PN)^P_t + 0.11847\ RL_t - 0.26820\ ROWN_t + 6.97990 \ln (TNBFA/TFA)_t$$

and transactions velocity;

$$\ln V2_t = 0.2520 \ln (Y/PN)^P{}_t + 0.030\ RL_t - 0.0455\ ROWN_t$$
$$+ 3.069 \ln(TNBFA/TFA)_t + 0.0465 \ln(C/M)_t$$
$$- 0.1041 \ln BANKS_t$$

The key short run equations are reported in Table 9.2. We will deal with each category of variable in turn, starting with interest rates.

The long term interest rate is one of the components of the Johansen vector, and thus has an intrinsic role in all the dynamic equations. It's lagged first difference also plays a part in the full sample, and falling velocity sub period. However, there is no direct function for long term interest rates in the post second world war dynamic relationships. If we recall, one of the main concerns of earlier empirical work, was the elasticity of velocity with respect to interest rates. The liquidity trap hypothesis being closely related to the proposition that the relationship between velocity and the rate of interest can be expected to be unstable over time. Nevertheless, there is no support for this from the empirical results. There is little variation in parameter sign. Indeed, the earlier plots of cumulative regression parameters, for all interest rates, proved to be the most stable of those investigated. The short term interest rate and the "own" rate of interest on money, appear only in the income velocity equations, for the full, and rising velocity sub period. It is interesting to note that the corresponding parameters on ΔRS and $\Delta ROWN$ are almost equal but opposite in sign. The foreign interest rate

Table 9.2 Key Short Run Dynamic Equations

Sample	1874-1991	1874-1991	1873-1946	1873-1946	1950-1991	1950-1991
Dependent	$\Delta V1$	$\Delta V2$	$\Delta V1$	$\Delta V2$	$\Delta V1$	$\Delta V2$
Intercept	-0.10309 (1.9793)	0.080297 (2.7983)	-0.29282 (3.5906)	0.19811 (4.4995)	-0.063045 (1.5071)	0.16013 (2.7210)
ΔRL_{t-1}	0.18459 (2.8397)	0.17362 (2.8178)	0.30365 (2.9998)	0.20259 (2.1922)		
ΔRS_t	0.20583 (2.0651)				0.20269 (3.172)	
$\Delta ROWN_t$	-0.20118 (2.0195)				-0.20911 (3.3999)	
$\Delta RFORG_{t-1}$					-0.0087244 (1.9430)	-0.010524 (1.5022)
$\Delta (Y/PN)^e_t$	0.51482 (3.4641)	0.34782 (2.2714)	0.83870 (5.4783)	0.52082 (3.6829)		
$\Delta YRGAP_t$						
$\Delta (TNBFA/TFA)_{t-3}$	1.0054 (1.9920)	2.1824 (4.2414)				
$\Delta POMPT_t$						
$\Delta (C/M)_t$	0.50772 (5.4968)	0.36111 (3.7802)			0.74867 (9.7716)	0.58876 (4.4599)
ΔYSD_t	-0.039508 (2.2249)				-0.068381 (2.6913)	
ΔTG_t	-0.045818 (2.7268)					
ΔSSG_t						
ΔMR_t						
$\Delta TAXR_t$					0.30992 (2.7930)	0.53272 (3.0593)
$\Delta MDEV_t$						
ΔPD_t	0.12796 (1.8420)				0.24250 (2.7294)	
$\Delta CCARD_t$						
$\Delta RSMAX_t$						
$\Delta RSMP_t$						
$\Delta FTBY_t$						
$\Delta TLSR_t$						
D87		0.23772 (5.0382)				0.25052 (5.4117)
D89		-0.19622 (4.0500)				-0.14132 (2.8813)
RES_{t-1}	-0.028459 (1.8183)	-0.10748 (2.8680)	-0.081923 (3.3496)	-0.29313 (4.7919)	-0.024220 (1.8614)	-0.14150 (2.1193)

Table 9.2 (continued)

Sample	1870-1991	1870-1991	1870-1946	1870-1946	1950-1991	1950-1991
R^2	0.44382	0.48564	0.36857	0.2811	0.85175	0.73869
n	118	118	74	74	42	42
k	10	7	3	3	8	6
D.W.	1.7132	1.7067	2.1642	1.6968	2.0474	2.4552
d_L	1.335	1.400	1.395	1.395	0.974	1.065
d_U	1.765	1.693	1.557	1.557	1.768	1.643
$(4-d_U)$	2.235	2.307	2.443	2.443	2.232	2.357
s.e.	0.044051	0.044887	0.042268	0.038699	0.026250	0.04314
t_{90}	1.658	1.658	1.671	1.671	1.684	1.684
t_{95}	1.980	1.980	2.000	2.000	2.021	2.021
F_1	(1,106) 3.0456 [3.94]	(1,109) 2.8362 [3.94]	(1,69) 1.3951 [3.98]	(1,69) 2.3278 [3.98]	(1,32) 0.15277 [4.15]	(1,34) 2.5321 [4.13]
F_2	(1,106) 7.2932 [3.94]	(1,109) 0.0059706 [3.94]	(1,69) 3.0387 [3.98]	(1,69) 6.4120 [3.98]	(1,32) 0.029262 [4.15]	(1,34) 0.004308 [4.13]
$\chi^2(2)$	4.0343 [5.991]	0.91808 [5.991]	1.8545 [5.991]	0.013781 [5.991]	1.6842 [5.991]	0.16849 [5.991]
F_3	(1,116) 3.5817 [3.92]	(1,116) 0.42609 [3.93]	(1,72) 19.1813 [3.98]	(1,72) 2.8703 [3.98]	(1,40) 1.8884 [4.08]	(1,40) 1.4571 [4.08]
F_4			(45.70) 2.4634 [1.55]	(45,70) 4.2053 [1.56]		
F_5			(4,111) 2.4875 [2.46]	(4,111) 2.8306 [2.46]		
CUSUM1	✓	✓	✓	✓	✓	✓
CUSUM2	x	x	x	✓	✓	✓
Equation	9.1	9.4	9.6	9.8	9.10	9.12

deviation term is the final variable in this group. This enters both income and transactions velocity equations for the post second world war sub period, although there is some doubt about its significance in the transactions velocity specification. Although the overall influence of this variable in velocity behaviour appears limited.

The second group of regressors are those associated with wealth. Permanent income plays a role in both long run vectors, and all but the post 1950 dynamic equations. In consequence the growth of expected income would appear to have no role in the post war period. The GDP gap, the difference between potential and actual real output, is not significant in any equation.

A proxy for financial sophistication, (TNBFA/TFA), a measure for financial development plays a significant role in both Johansen vectors. It is also interesting to note that the growth rate of this variable lagged three years is to be found in the full sample dynamic equations.

The first monetization variable, the currency money ratio is found in the transactions velocity vector, but not the income velocity one. It also appears in both sub samples. The alternative monetization variable, that is the urbanization of the population, is not significant in any equation.

The economic stability variable only appears in the income velocity equations, and even then is omitted from the 1870-1946 sub period. The alternative measure, TG, is only to be found in the full sample income velocity specification. However, with its negative sign, it is representing the stabilizing role played by governments as opposed to economic stability per se.

Apart from ΔTAXR which plays a role in the post war sub samples, none of the other GDP or monetary impactors are significant. Price expectations too is limited to the income velocity specifications, and then only for the 1870-1991 and 1950-1990 samples.

None of the financial innovation variables are significantly different from zero in any chosen sample period. This was perhaps not surprising, because by their very nature the number of observations was very small, in one case just twenty five data points. The statistical techniques used in this thesis are concerned with the long run. This led to the conclusion that it was not possible to test these relationships with velocity comprehensively here. An alternative would have been the use of quarterly data. This for some variables was not available, but interpolation techniques could have been employed.

An overall observation, was the fact that the final models of income and transactions velocity are different. Furthermore, the transactions velocity relationships performed less well than their income velocity counterparts. This may be due to unknown omitted variables. As past literature has concentrated on income velocity, and thus those factors which are concerned with value added. While transactions velocity includes intermediate transactions and second hand goods, will be affected by vertical integration of firms, and technological changes that lengthen or shorten the production process from raw material to final product.

The general statistical performance of the short run equations was good. Once the outliers in transactions velocity for 1987 and 1989 were corrected using dummies, the earlier normality problem was corrected. However, the results for the full sample period mark a major problem. The majority of parameters contained in these equations are extremely unstable, and recursive t statistics tests reveal that their significance is very much dependent on the sample period chosen.

As discussed earlier, one possible explanation for this fact, is that while there is a stable long term relationship, between velocity and a few variables, as described by the Johansen vector, the short run relationship is volatile, and depends on contemporaneous structural and institutional influences. Thus while it is possible to build short sub sample dynamic models, this is not possible for the whole sample period.

Nevertheless, the proposed short run model presented at the beginning of this chapter is not correct. With the hindsight of empirical work, income velocity can be rewritten as;

$$V1 = f(\underbrace{RL,\ RS,\ ROWN,\ RFORG,}_{\text{interest rates}}\ \underbrace{(Y/PN)^{P},}_{\text{wealth}}$$

$$\underbrace{(TNBFA/TFA),}_{\text{financial sophistication}}\ \underbrace{(C/M),}_{\text{monetization}}$$

$$\underbrace{YSD,\ TG,}_{\text{economic stability}}\ \underbrace{TAXR,}_{\text{G.D.P. shocks}}\ \underbrace{RPD}_{\text{inflation}}$$

and transactions velocity as;

$$V2 = f(\underbrace{RL,\ RFORG,}_{\text{interest rates}}\ \underbrace{(Y/PN)^{P},}_{\text{wealth}}$$

$$\underbrace{(TNBFA/TFA),}_{\text{financial sophistication}}\ \underbrace{(C/M),}_{\text{monetization}}$$

$$\underbrace{TAXR,}_{\text{G.D.P. shocks}}$$

Comparison with earlier literature is not straightforward, as much of this was carried out in levels rather than first differences. The most comprehensive work on the income velocity long run relationship is found in Siklos (1993) where similar results, using a less sophisticated model are to be found. In terms of the short run relationship, Bordo and Joung (1990) carried out some empirical work using first differences, and it is interesting to compare this with our own results. Table 9.3 shows this empirical work, together with their earlier work in levels.

Table 9.3 Institutional Variables in the long-run velocity function (Cochrane-Orcutt technique)

United Kingdom

Bordo and Jonung (1987)

Full Sample Period 1876-1974

#	Constant	ln(Y/PN)^p	RS	ln Cycle	ln(LNA/L)	ln(C/M)	ln(TNBFA/TFA)	lnYSD	R^2	SEE	DW	ρ
9.14	0.094 (0.095)	0.065 (3.352)	1.651 (3.352)	0.650 (3.287)					0.907	0.050	1.790	0.939
9.15	-0.395 (-0.344)	0.197 (1.240)	2.497 (5.014)	0.797 (4.588)	-6.271 (-2.313)	0.211 (2.167)	0.746 (3.107)	-0.034 (-2.059)	0.931	0.043	2.081	0.925
9.16	1.388 (4.324)			0.767 (3.957)	0.797 (0.264)	0.370 (3.547)	0.209 (0.846)	-0.026 (-1.377)	0.913	0.049	1.875	0.953
9.17	1.007 (3.835)		2.490 (4.989)	0.795 (4.565)	-4.183 (-1.867)	0.225 (2.315)	0.729 (3.024)	0.031 (-1.865)	0.931	0.043	2.110	0.929

Bordo and Jonung (1990)

Full Sample Period 1876-1986

Levels

#	Constant	ln(Y/PN)^p	RS	ln Cycle	ln(LNA/L)	ln(C/M)	ln(TNBFA/TFA)	lnYSD	R^2	SEE	DW	ρ
9.18	-0.953 (-0.875)	0.244 (1.41)	0.922 (2.16)	0.652 (3.468)					0.917	0.054	1.66	0.936
9.19	-1.497 (-0.814)	0.459 (1.75)	0.921 (2.406)	0.546 (3.034)	5.538 (1.7)	0.378 (4.256)	0.292 (1.83)	-0.962 (-0.586)	0.935	0.047	1.900	0.983

First Differences

Ordinary Least Squares

#	Constant	ln(Y/PN)^p	RS	ln Cycle	ln(LNA/L)	ln(C/M)	ln(TNBFA/TFA)	lnYSD	R^2	SEE	DW	ρ
9.20	-0.005 (-0.742)	0.542 (1.659)	0.859 (2.051)	0.599 (3.155)					0.16	0.054	1.73	
9.21	-0.009 (1.154)	0.53 (1.731)	0.918 (2.409)	0.542 (3.963)	5.104 (1.621)	0.379 (4.232)	0.264 (1.746)	-0.011 (-0.69)	0.352	0.048	1.89	
9.22	-0.004 (-0.07)	0.378 (1.274)	0.941 (2.433)	0.668 (3.963)		0.41 (4.621)*	0.262 (1.804)		0.342	0.048	1.72	

Equations 9.14 to 9.16 are in levels for the complete sample period. Note that full sample is slightly less than our own. All these equations perform well, although some parameters are not significantly different from zero. However, the general criticism of using the Cochrane-Orcutt technique to correct severe autocorrelation, discussed earlier, remains. A more direct comparison with our own work is found in equations 9.20 to 9.22. These equations perform less well than our own full sample income velocity specification. The best $R^2 = 0.352$ (9.21) compares with 0.44382 of equation 9.1. The parameters on $\Delta(Y/PN)^P$ are remarkably similar in size to the 0.51482 of our equation. However, much variation is found in the size of other parameters.

Table 9.4 reports Bordo and Jonung's (1987) results for both falling velocity (1876-1946) and rising velocity (1947-1974). All these results are in levels, making comparison difficult. Indeed, in terms of goodness of fit, all these equations perform better than our own, particularly for the 1870-1946 sub period. Nevertheless, the methodology problems outlined above still give concern.

Table 9.4 Institutional Variables in the long-run velocity function (Cochrane-Orcutt technique)

United Kingdom

Bordo and Jonung (1987)

#	Constant	ln(Y/PN)ᵖ	RS	ln Cycle	ln(LNA/L)	ln(C/M)	ln(TNBFA/TFA)	lnYSD	R^2	SEE	DW	ρ
Falling Velocity 1876-1946												
9.23	-3.479 (-1.73)	0.533 (1.84)	2.760 (4.54)	0.597 (3.03)					0.878	0.0452	2.214	0.989
9.24	0.50 (0.03)	0.075 (0.29)	2.810 (4.42)	0.887 (4.38)	-16.82 (-2.39)	0.106 (0.87)	1.812 (1.79)	-0.032 (-1.49)	0.891	0.0450	1.941	0.902
9.25	0.748 (1.58)			0.874 (3.98)	-16.95 (-2.14)	0.235 (1.83)	1.766 (1.56)	-0.038 (-1.61)	0.846	0.0508	1.784	0.915
9.26	0.565 (1.41)		2.817 (4.47)	0.902 (4.66)	-16.60 (-2.39)	0.117 (1.02)	1.848 (1.86)	-0.031 (-1.47)	0.881	0.0447	1.933	0.902
Rising Velocity 1947-1974												
9.27	3.217 (1.24)	-0.381 (-0.95)	0.090 (0.12)	-0.710 (-1.15)					0.951	0.0438	1.697	0.876
9.28	-0.573 (-0.34)	0.465 (1.90)	0.094 (0.15)	0.437 (1.41)	5.252 (1.30)	0.784 (6.22)	0.267 (1.35)	0.012 (0.98)	0.992	0.0182	2.496	0.305
9.29	2.703 (21.24)			0.444 (1.48)	12.892 (18.85)	0.778 (9.65)	0.206 (1.84)	0.010 0.84)	0.991	0.0188	2.784	0.236
9.30	2.571 (9.58)		0.367 (0.56)	0.424 (1.37)	11.717 (5.32)	0.720 (5.46)	0.307 (1.44)	0.007 (0.53)	0.991	0.0192	2.809	0.229

Overall, the empirical work reviewed in this thesis, has reached two main conclusions. A long term relationship between a few variables exists. However, the short run dynamic relationships are volatile, have unstable parameters, and give poor results for the complete sample period. The statistical work using the sub period when velocity was falling (1870-1946) are very weak. Fairly satisfactory results are found with the post second world war period, 1950-1991, a time of rising velocity.

Chapter 10

Summary and conclusions

One of the key assumptions that turns the equation of exchange into a theory of the determination of the price level, is that the velocity of circulation is a constant, or at least a stable function of a few economic variables. Even a cursory look at the velocity data denies the fact that it is a constant. Keynes sees no reason to suggest constancy. In fact he believes that in periods of underemployment equilibrium velocity may be quite volatile. It will be determined by economic structure, which may include the state of technology and institutional arrangements. Friedman, on the other hand, argues that velocity data is not constant because of deviations between actual and desired velocity, together with errors of measurement. It is the investigation of these two contradicting views, which has been at the centre of this thesis.

It is discernible from the literature on the definition of velocity, that there was an early divergence into two schools of thought. The "motion" theorists believed that the velocity of circulation is a property of money, the mechanical movement of coins being exchanged from hand to hand. The "cash balance" theorists argued that the proportion of income held as money is not dependent on the properties of coins, but on individuals' actions governed by economic motives.

It is of critical importance to realize that the two alternative views of velocity are not the same empirically. Income velocity measures transactions in terms of the value-added by each sector of the economy. Each firm's value added is the value of its output minus the cost of the inputs that it purchased elsewhere. On the other hand, transactions velocity includes in it's measure of transactions intermediate goods and the exchange of existing assets, in addition to payment for final goods and services. The transactions velocity will be affected by vertical integration of firms, which will reduce the number of transactions involved in a single income circuit. Furthermore, technological changes that lengthen or shorten the production process from raw materials to final product will also affect the number of transactions undertaken. This will not affect income velocity. The transactions version includes the purchase of existing assets, while the income version disregards these completely.

The measurement of velocity is not straightforward. It can be simply defined as the number of times a unit of money is transferred between economic agents in a given period of time, or the ratio of the value of goods and services to the stock of money. However, there are a number of different ways to measure both the numerator and denominator.

The problems associated with measuring transactions, the development of national income accounting and the development of the income version of the equation of exchange, are important milestones. Transactions velocity is put to one side, and income velocity forms the foundation for the major developments which later take place with Keynes's analysis. Therefore, it is usual in modern literature to only consider income velocity, while transactions velocity is dealt with in passing and then tends to be dismissed due to problems of measurement and lack of reliable statistical data. This thesis challenges this viewpoint, and constructs an original data series for a transactions measure for the period 1870-1991, which involves the use of over sixty variables and seven thousand observations. In consequence both income and transactions were available as the numerator in the velocity ratio.

There are at least four theoretical definitions of the money stock, and an even greater magnitude of official statistical measures. This leads to a lack of comprehensive data over long time periods. To overcome this problem, the updated data found in Capie and Webber (1985) were used. One major criticism of the official monetary definitions are the potential errors associated with the simple sum weighting scheme used to derive them. This gives the same weight to currency as money placed in a deposit account where interest is received. In terms of opportunity cost these have completely different characteristics. To surmount this problem, following Barnett (1983,1984), a number of divisia monetary aggregates were constructed.

Given recent advances in econometric methodology, it is possible to raise a number of objections to the manner in which earlier literature proceeded with their empirical work. The most comprehensive work on income velocity is conducted by Bordo and Jonung (1987), who correct severe positive autocorrelation using the Cochrane-Orcutt technique. Hendry and Mizon (1978) suggest that serial correlation in this context may be evidence of model mis-specification. Another problem is that it is now clear that many economic time series contain a unit root. It is argued that such series are best analyzed in first differences, rather than levels.

The concept of cointegration resolves many of these issues. Furthermore, it lends itself to testing the key economic arguments, as the model can be separated into long and short term elements. A review of earlier economic literature identified four types of velocity determinants in the long term: the traditional ones, wealth and interest rates; the institutional ones associated with monetization and financial development of the economic infrastructure. Empirical work found a long term relationship between income velocity and permanent income, a long-term interest rate, the own rate of interest on money, and a ratio of total non-bank financial assets to total financial assets, representing financial sophistication. A similar relationship was found between transactions velocity and these variables, together with the currency money ratio and the number of bank branches, which are both proxies for monetization. These results were in line with Friedman's view of a stable function of a few variables.

In addition to the four types already identified, an examination of the previous literature distinguished a greater number of determinants of velocity for the short run model. The additional variables were; economic stability, GDP and monetary shocks, value of time, inflation, and financial innovation variables. In estimating the short run dynamic equations, the econometric methodology suggested by Hendry's work, (see Hendry, Pagan, and Sargent, 1984) was adopted, that is from the general to the specific. In other words, a general model was adopted with a generous lag structure, which was simplified with the help of statistical tests, until an acceptable specific parsimonious model was derived. In this process many potential variables were dropped from the specification. The results for the full sample period mask a major problem. The majority of parameters contained in these equations are unstable, and recursive t-statistic tests revealed that their significance depended on the sample period chosen. To consider this problem still further, the sample period was divided into two sub samples, 1870-1946, and 1950-1991, corresponding to falling and rising velocity respectively. The early sample gave fairly poor results, but it was interesting to note that only two traditional velocity determinants, wealth and interest rates play a role. The post second world war sub period gave very good results, and parameter stability was not a major problem.

In consequence our statistical results would appear to support both the Friedman and Keynes hypotheses. On the one hand, a long term relationship between velocity and a few variables was identified. On the other, short run dynamic equations, over the full sample period were not stable, and the significance of individual variables unreliable. However, critiques of Hendry's "encompassing" methodology may argue that too much reliance was placed on econometric techniques, and that it was more appropriate to examine a wide variety of evidence, not all quantitative.

There also remains a number of unresolved issues which may be pointers towards further research. One direction may be to take a closer look at financial institutional innovation in the post second world war period by attempting to replicate the results of this study using quarterly data. Furthermore, results for the United Kingdom could be compared with empirical work for other countries.

Another area for development could be the extension of the divisia monetary aggregate time series using archive material, once again using quarterly data. This could be used to compare and contrast simple sum velocity with divisia velocity. Although this may prove difficult given the availability of long run reliable data given the number of redefinitions which have taken place.

Unfortunately, economic interpretation of the long run vectors derived from the Johansen estimation technique is not straightforward. Therefore developments in econometric methodology which resolve this problem could lead to a better understanding of the long run relationship.

Finally, the thesis has considered the study of the behaviour of velocity from an econometric modelling perspective. Equally, the problem could have been approached from a time series viewpoint, perhaps using state space models and the Kalman filter to understand the velocity time series. This approach being discussed only briefly.

APPENDIX

APPENDIX A VARIABLE DEFINITIONS & SOURCES

AGOP Agriculture Gross Total Output
£ million

1867 - 1914	Bellerby (1968) in Minchinton (1968) Table IV col.2 Page 276/7
1915 - 1944	Ojala (1952) Table XVI page 208 Table XVII page 209 Interpolations between groups of years
1945 - 1990	Annual Abstract of Statistics C.S.O. (Various)

1991 Ministry of Agriculture Fisheries and Food (1992)

BCLEAR Bank Clearings (Total)
£ million

1868 - 1938	Mitchell and Deane (1962)
1939 - 1965	Mitchell and Jones (1971)
1966 - 1991	Annual Abstract of Statistics

BLEND Bank Lending (Bank Advances)
£ million

1870 - 1966	Sheppard (1971) Table (A) 1.1 Col.16 pages 116-117
1967 -	Annual Abstract of Statistics

BONDSL British Government Securities
Security Yields
Long dated (20 years)

1945 - 1991 Annual Abstact of Statistics

BONDSS British Government Securities
Security Yields
Short dated (5 years)

BPFS Benefits Paid Friendly Societies
£ million
= Total Sickness Pay + Total Sums at Death
+ Total Other Benefits

1870 - 1934	Parliamentary Papers
1935 - 1991	Annual Abstract of Statistics

BR 1870 - 1982 Capie and Webber (1985)
Table III (10)
column I
pages 494 - 495

1983 - 1989 Economic Trends (June 1990)
Table 39 page 68

1990 - 1991 Financial Statistics

BRES Banks' Reserves (Till Money and Balances at the Bank of England
(£ thousand)

1871 - 1982 Capie and Webber (1985)
Col.IV
pages 153 - 154

1983 - 1991 Financial Statistics

BSAD Building Society Advances
£ million

1870 - 1879

1880 - 1966 Sheppard (1971)
Table (A) 2.4
pages 150 - 151

1967 - 1972 Annual Abstarct of Statistics (1973)
Table 378 page 363

1973 - 1980 Annual Abstract of Statistics (1982)
Table 17.22 page 434

1981 - 1990 Annual Abstract of Statistics (1992)
Table 17.13 page 294

BSDEP Building Society Deposits
£ million

1870 - 1879

1880 - 1966 Sheppard (1971)
Table (A) 2.4
pages 150 - 151

1967 - 1972 Annual Abstract of Statistics (1973)
Table 378 page 363

1973 - 1980 Annual Abstarct of Statistics (1982)
Table 17.22 page 434

1981 - 1990 Annual Abstract of Statistics (1992)
Table 17.13 page 294

BSHM3 Building societies holdings of M3
£ million

1963 - 1991 Financial Statistics

BSSH Building Society Shares
£ million

1870 - 1879
1880 - 1966 Sheppard (1971)
Table (A) 2.4
page 150

1967 - 1972 Annual Abstract of Statistics (1973)
Table 378 page 363

1973 - 1980 Annual Abstract of Statistics (1982)
Table 17.22 page 434

1981 - 1990 Annual Abstract of Statistics (1992)
Table 17.13 page 294

C Currency - Notes and coin in circulation outside
the Bank of England
£ million

1870 Capie & Webber (1985) Quarterly Data/4

1871 - 1982 Capie & Webber (1985) Table II(2) p.153 - 154

1982 - 1991 Bank of England Quarterly Bulletin

CHAPS Clearing House Automatic Payments System
£ billion

1984 - 1990 Annual Abstarct of Statistics

COPROF Company Profits, current prices
Gross trading profits of companies
£ million

1870 - 1965 Feinstein (1972)
pages T4 - T6
column 3

1966 - 1991 Economic Trends Annual Supplement

CWM1 Money Stock M1 - Capie & Webber (1985) Definition
£ million

1870 - 1982 Capie & Webber (1985)

1983 - 1991 Financial Statistics

CWM3 Money Stock M3 - Capie & Webber (1985) Definition
£ million

1870 - 1982 Capie & Webber (1985)

1983 - 1991 Financial Statistics

DD Demand Deposits Net of 60% of items, in transit
£ million

1870 - 1982 Capie & Webber (1985)

1983 - 1991 Financial Statistics

DIVCWM3 Divisia Money Stock M3
Based on Capie and Webber M3 data

DIVM3 Divisia Money Stock M3
Based on CSO data

DIVM4 Divisia Money Stock M4
Based on CSO data

DIVM5 Divisia Money Stock M5
Based on CSO data

ELECLEAR Electronic Bank Clearing
£ billion

1976 - 1977 British Bankers Association (BBA) Annual Abstract
of Banking Statistics Volume 2 Direct Debits + Standing Orders (Interbank) + Credits (Interbank)
Automated Items

1978 - 1990 Annual Abstract of Statistics

FTINDEX Financial Times Ordinary Share Index
1935 = 100

1870 - 1954 Mitchell (1988)
Financial Institutions Table 17
Share Price Indicies page 687

1955 - 1991 Economic Trends Annual Supplement 1991
Table 47

CWM3 Money Stock M3 - Capie & Webber (1985) Definition
£ million

1870 - 1982 Capie & Webber (1985)

1983 - 1991 Financial Statistics

DD Demand Deposits Net of 60% of items, in transit
£ million

1870 - 1982 Capie & Webber (1985)

1983 - 1991 Financial Statistics

DIVCWM3 Divisia Money Stock M3
Based on Capie and Webber M3 data

DIVM3 Divisia Money Stock M3
Based on CSO data

DIVM4 Divisia Money Stock M4
Based on CSO data

DIVM5 Divisia Money Stock M5
Based on CSO data

ELECLEAR Electronic Bank Clearing
£ billion

1976 - 1977 British Bankers Association (BBA) Annual Abstract
of Banking Statistics Volume 2 Direct Debits + Standing Orders (Interbank) + Credits (Interbank)
Automated Items

1978 - 1990 Annual Abstract of Statistics

FTINDEX Financial Times Ordinary Share Index
1935 = 100

1870 - 1954 Mitchell (1988)
Financial Institutions Table 17
Share Price Indicies page 687

1955 - 1991 Economic Trends Annual Supplement 1991
Table 47

G Government Expenditure on goods and services
£ million, current prices

1870 - 1965	Feinstein (1972) Table 2 page T8 column 2 Public authorities current expenditure on goods and services
1966 - 1991	Economic Trends Annual Supplement Table 3 page 14 column AAXI General government final consumption at market prices, current prices

GCF Government Capital Formation
Central Government, Local Authorities, & Public Corporations
£ million, current prices

1870 - 1949	Feinstein (1972) Table 39 Col.8 + Col.9 + Col.10 (1939 to 1947 includes all CF for W.W.2)
1950 - 1990	Economic Trends Annual Supplement 1991 Table 9 Col. AAYE + AAAK
1991	Monthly Digest of Statistics No.556 April 1992 Table 1.8 Col. AAYE + AAAK

GDPA Gross Domestic Product at factor cost
(average estimate)
£ million

1870 - 1965	Feinstein (1972)
1966 - 1990	Economic Trends Annual Supplement
1991	Economic Trends

GFC Public authorities (Central and Local Government)
current expenditure on goods and services
£ million

1870 - 1965	Feinstein (1972) Table 2 pages T8 - T9 Column 2
1966 - 1990	Economic Trends Annual Supplement 1991 Table 3 Column AAXI
1991	Monthly Digest of Statistics C.S.O. No.556 April 1992 Table 1.2 page 7 Column AAXI

GINVR Government Investment
£ million

1870 - 1965 Feinstein (1972) Table T85 - T86
Gross Domestic Fixed Capital Formation at current prices by sector col.8 Public Corporations + col.9 Central Government + col.10 Local authorities

1966 - 1987 Economic Trends Annual Supplement (1989) Table 9 page 60 col.2 & col.3

1988 - 1989 Economic Trends (June 1990)

1990 - 1991 Economic Trends

INEMP Income from Employment
£ million, current prices

1870 - 1965 Feinstein (1972)
Table 1 pages T4 - T7

1966 - 1990 Economic Trends Annual Supplement 1991
Table 4 DJAO

1991 Monthly Digest of Statistics
April 1992 No.556 C.S.O. Table 1.3 DJAO

INSEMP Income from Self Employment
£ million

1870 - 1888 not available

1889 - 1965 Feinstein (1972)
Table 1 pages T4 - T7

1966 - 1972 Annual Abstract of Statistics 1973
C.S.O. Table 306 Page 292

1973 - 1980 Annual Abstract of Statistics 1982
C.S.O. Table 14.3 page 347

1981 - 1990 Annual Abstract of Statistics 1992
C.S.O. Table 14.2 page 240

INVR Inventories - Value of physical increase in stocks and work in progress
£ million

1870 - 1965 Feinstein (1972) page T8 Table 2 col.4
Value of Physical Increase in stocks and work in progress.

1966 - 1989 Economic Trends Annual Supplement 1990
Table 3 page 14

1990 - 1991 Economic Trends

IPOL Insurance Premiums Other than Life
£ million

1870 - 1934 Sheppard (1971)

1935 - 1991 Annual Abstract of Statistics 1992

L Total Labour Force
(thousands)

1870 - 1951 Mitchell and Deane (1962) page 60
(linear interpolations)

1952 - 1991 Annual Abstract of Statistics 1992

LABOUT Life Assurance - Ordinary Business Total Outgoings)
£ million

1880 - 1934 Parliamentary Papers

1935 - 1945 Annual Abstract of Statistics (1947)
Table 292 page 244

1946 - 1991 Annual Abstract of Statistics

LABIN Life Assurance Ordinary Business - Total Income
£ million

1880 - 1934 Parliamentary Papers

1935 - 1945 Annual Abstract of Statistics (1947)
Table 292 page 244

1946 - 1991 Annual Abstract of Statistics

LNA Labour force non - aggricultural pursuits
(thousands)

1870 - 1951 Mitchell and Deane (1962) page 60
(linear interpolations)

1952 - 1991 Annual Abstract of Statistics 1992

LONCLEAR London Bank Clearing
£ billion

1870 - 1980 Mitchell (1988)
Financial Institutions 12
pages 676 - 677

1981 - 1990 Annual Abstract of Statistics

M Imports of goods and services
at market prices at factor cost
£ million

1870 - 1965 Feinstein (1972)

1966 - 1990 Economic Trends Annual Supplement

1991 Economic Trends

M1CSO Money Stock M1 - CSO Definition
£ million

1963 - 1991 Financial Statistics

M3CSO Money Stock M3 - CSO Definition
£ million

1963 - 1991 Financial Statistics

M4CSO Money Stock M4 - CSO Definition
£ million

1963 - 1991 Financial Statistics

M5CSO Money Stock M5 - CSO Definition
£ million

1963 - 1991 Financial Statistics

MB Monetary Base (High Powered Money)
£ thousands

1870 - 1982 Capie and Webber (1985)

1983 - 1991 Financial Statistics (various)

NCCWP Notes and coin in circulation with the public
£ million

1963 - 1991 Financial Statistics

NNP Net National Product in current market prices
£ million

1870 - 1965 Feinstein (1972) Table 1, column 13

1966 - 1988 Economic Trends Annual Supplement (1990) Gross National Product Table 2 page 10, column GIBF minus Gross Domestic fixed capital formation, Table 3, page 14 column DFDC

1989 - 1991 Economic Trends (defined as above)

NSDS National Savings deposits and securities
£ million

1963 - 1991	Financial Statistics

OD Other Deposits at the Bank of England
(Capie & Webber (1985) Definition

1870 - 1982	Capie and Webber (1985)
1982 - 1991	Bank of England Quarterly Bulletin

OMIXBS Other money market instruments - excluding holdings by banks and building societies
£ million

1963 - 1991	Financial Statistics

OP Industrial Output - Gross Total
£ million

1870 - 1906	Hoffman (1955) Total Industrial Production (including building) used as base from 1907 in real terms, worked backwards, and converted to current prices
1907	Census of Production (1907)
1908 - 1923	Lomax (1959) Total Industrial Production (including building)
1924	Census of Production (1924)
1925 - 1929	Lomax (1959)
1930	Census of Production (1930)
1931 - 1934	Lomax (1959)
1935	Census of Production (1935)
1936 - 1939	Lomax (1959)
1940 - 1949	Interpolation
1949 - 1984	Census of Production 1949, 1951, 1954, 1958, 1963, 1968, 1970, 1971, 1972 to 1984 Intervening years Interpolation C154 Business Monitor - Report on the Census of Production - Summary Tables Dept. of Industry - Business Statistics Office

	1985 - 1991	Monthly Digest of Statistics CSO
PC	Currency in hands of the public (Capie & Webber (1985) Definition	
	1870 - 1982	Capie and Webber (1985)
	1982 - 1991	Bank of England Quarterly Bulletin
PCF	Private Sector Capital Formation £ million	
	1870 - 1965	Feinstein (1972) Table 39 col.7 Pages T85 - T87
	1966 - 1990	Economic Trends Annual Supplement 1991 Table 9 col. DFDG
	1991	Monthly Digest of Statistics April No. 556 Table 1.8 column DFDG page 14
PCON	Expenditure on Private Consumption £ million, current prices	
	1870 - 1965	Feinstein (1972) Table 2 col. 1 page T8
	1966 - 1990	Economic Trends Annual Supplement 1991 Table 3 col. 1 AIIK
	1991	Economic Trends Table 3 col.1 CCBH in real terms rebased in current prices
PD	Implicit price deflator 1985 = 1	
	1870 - 1947	Table III (12) Column III Gross National Product Deflator
	1948 - 1991	Gross Domestic Product at market prices average estimate, current prices, divided by Gross Domestic Product at market prices average estimate, 1985 prices Economic Trends Annual Supplement Tables 2 and 3

PDY Personal Disposable Income from employment

1870 - 1919	Personal Disposable Income from employment Feinstein (1972) Table 1 pages T4 - T5 column 7 minus net receipts of Income Tax Mitchell and Deane (1962) page 428/9 col.11
1920 - 1965	Feinstein (1972) Table 10 pages T28 - 29
1966 - 1991	Economic Trends Annual Supplement

PN Population - United Kingdom - Persons
thousands

1870 - 1965	Feinstein (1972)
1966 - 1991	Annual Abstract of Statistics

PROFITCO Gross Trading Profits of Companies
£ million

1870 - 1965	Feinstein (1972) Table 1 page T4 - T7
1966 - 1990	Economic Trends Annual Supplement 1991 Table 4 Col.2 CIAC
1991	Monthly Digest of Statistics April 1992 No.556 CSO Table 1.3 col. CIAC
	NOTE: Includes Self-Employment for 1870 - 1888, and 1914 - 1919

PSSDBS Private sector shares and deposits with Building Societies
£ million

1963 - 1991 Financial Statistics

PSSTD U.K. private sector time deposits
£ million

1963 - 1991 Financial Statistics

RBDEP Rate of Interest paid on Bank Deposits

1870 - 1982	Capie and Webber (1985) Table III (10) column VII
1983 - 1990	Economic Trends Annual Supplement 1991
1991	Bank of England Quarterly Bulletin

RBSDEP Rate of Interest on Building Society Deposit Accounts

1935 - 1990 Annual Abstract of Statistics

1991 Financial Statistics

RBSSH Rate of Interest on Building Society Share Accounts

1935 - 1990 Annual Abstract of Statistics

1991 Financial Statistics

RENT Rents
£ million

1870 - 1965 Feinstein (1972)
Table 1 pages T4 - T7

1966 - 1972 Annual Abstract of Statistics (1973)
CSO Table 305 page 291

1973 - 1980 Annual Abstract of Statistics (1982)
CSO Table 14.2 page 346

1981 - 1990 Annual Abstract of Statistics (1992)
CSO Table 14.1 page 239

RGER German Short - term interest rate

1870 - 1875

1876 - 1922 Deutsche Bundesbank (1976) F Table 2.01
pages 278 - 279 Geldmarktzinsen -
Privatdiskontsatz (Private Short Term
Interest Rate)

1923 - 1924 Interpolation

1925 - 1944 Deutsche Bundesbank (1976) F Table 2.01
pages 278 - 279 Geldmarktzinsen -
Privatdiskontsatz (Private Short Term
Interest Rate)

1945 - 1979 Sommariva and Tullio (1986)
pages 237 - 239
Private short term interest rate

1980 - 1991 International Financial Statistics
- Germany Money Market Rate line 60b

RINTB London Interbank - 3 month 7 day deposit rate (average) Percentage Rate

1963 - 1990	Economic Trends Annual Supplement Table 47 column 3
1991	Financial Statistics August 1992 Table 13.8 page 143

RL Long term rate of Interest
Rate of interest on consols (2.5%)

1870 - 1966	Sheppard (1971) Table A.3.7 pages 190 - 191 Column II
1967 - 1991	Financial Statistics

RLA Interest rates for Deposits with local authorities
3 months Percentage rate per anum

1956 - 1989	Economic Trends Annual Supplement Table 47 Column 2 page 224
1990 - 1991	Financial Statistics August 1992 Table 13.14 column AJOI

RNS Rate of Interest National Savings Investment Account
Percentage rate per anum

1968 - 1991	Financial Statistics July 1991 Table 13.9

RPQD Rate of growth of Import Prices

1870 - 1965	Feinstein (1972) Table 61 page T133 column 6 Price Indicies - Imports of goods and services
1966 - 1991	Imports current prices divided by Imports 1985 prices (constant prices) Economic Trends Annual Supplement 1991

RS Short term Interest Rate
Prime Bank Bill Rate

1870 - 1982	Capie and Webber (1985) Table III (10) % p.a. Column V page 494 - 495
1983 - 1991	Financial Statistics

RUS United States Interest Rates

1870 - 1889	Unadjusted index of yields on American railroad bonds. United States Department of Commerce (1976) Series 476 page 1003
1890 - 1970	Prime commercial paper 4 to 6 months U.S. Department of Commerce (1976) Series 445 page 1001
1971 - 1991	Federal Funds Rate International Financial Statistics United States line 60b

SDIB U.K. private sector sterling sight deposits with monetary sector. (Interest Bearing)

1963 - 1991	Financial Statistics

SDNI U.K. private sector sterling sight deposits with monetary sector. (Non Interest Bearing) (adjusted for transit items)

1963 - 1991	Financial Statistics

SPRIM Life and Other Types of Insurance Premiums Paid Yearly to U.K. based companies £ million

1870 - 1879	
1880 - 1886	Life and Annuity Assurance Premiums - Total Premiums Sheppard (1971) Table (A) 2.7 pages 160 - 161 column IB
1887 - 1912	Life, Annuity, Industrial Assurance Premiums Sheppard (1971) Table (A) 2.7 pages 160 - 161 column A
1913 - 1965	As above, plus Company Accident Premiums, Company Capital and Redemption and Sinking Fund, Company Fire Insurance, Marine Insurance, Transport Employers Liability
1966 - 1974	Annual Abstract of Statistics
1974 - 1991	Association of British Insurers

STRIKES Number of working days lost through Disputes (thousands)

1891 - 1938	Mitchell and Deane (1962) page 72
1939 - 1976	Clifton et al (1978)
1977 - 1988	Annual Abstract of Statistics
1989 - 1991	Employment Gazette

SURPCO Gross trading surplus of public corporations £ million

1870 - 1965	Feinstein (1972) Table 1 pages T4 - T7
1966 - 1990	Economic Trends Annual Supplement 1991 Table 4 Col.3 ADRD
1991	Monthly Digest of Statistics April 1992 No,556 CSO Table 1.3 col. ADRD

NOTE: For years 1939 to 1945 see SURPENT

SURPENT Gross trading surplus of other public enterprises £ million

1870 - 1965	Feinstein (1972) Table 1 pages T4 - T7
1966 - 1990	Economic Trends Annual Supplement 1991 Table 4 Col.4 DJAQ
1991	Monthly Digest of Statistics April 1992 No,556 CSO Table 1.3 col. DJAQ

NOTE: For years 1939 to 1945 includes SURPCO

TAXCON Taxes on Expenditure £ million

1870 - 1965	Feinstein (1972) Table 2 pages T8 and T9 col. 7
1966 - 1991	Economic Trends Annual Supplement

TAXI Taxes and National Insurance and Health Contributions on Personal Income
£ million, current prices

1870 - 1899	Mitchell and Deane (1962) Table: Public Finance 3 pages 393 - 394
1900 - 1965	Feinstein (1972) Table 14 pages T35 - T36 Column 1 and Column 3
1966 - 1988	Economic Trends Annual Supplement (1990) Table 5 page 35 Total Personal Income before Tax (AIIA) minus Total Personal Disposable Income (AIIJ)
1989 - 1991	Monthly Digest of Statistics June 1992 Table 1.5 page 11 AIIA - AIIJ

TAXR Basic rate of income tax

1870 - 1938	Mitchell and Deane (1962) pages 428 - 429
1939 - 1950	Mitchell and Jones (1971) page 172

TBCLEAR Total Bank Clearing (excluding electronic clearing)
£ billion

1870 - 1980	Mitchell (1988) Financial Institutions 12 pages 676 - 677
1981 - 1990	Annual Abstract of Statistics

TD Time Deposits, Net of Interbank Deposits
£ million

1870 - 1982	Capie and Webber (1985)
1983 - 1991	Bank of England Quarterly Bulletin

TFA Total Assets of Financial Institutions in Great Britain

1870 - 1963	Linear interpolations between Goldsmith's (1969) benchmarks Appendix Table D-10
1964 - 1991	Updates using Goldsmiths sources see table in main text in chapter 4

TFCLG Transfers Central to Local Government
£ million

1869	Mitchell and Deane (1962) Public Finance 9 Receipts of Local Authorities pages 414 - 415 column Government Grants etc
1870 - 1879	Interpolation
1880 - 1898	As 1969
1900 - 1965	Feinstein (1972) Table 13 page T33 column (4) Current grants from Central Government
1966 - 1970	National Income and Expenditure (1971) VIII LOCAL AUTHORITIES Table 42 Current Account Total Grants from Central Government
1971 - 1976	National Income and Expenditure (1977) Table 8.1
1977 - 1985	National Income and Expenditure (1986) Table 8.1
1986 - 1990	National Income and Expenditure (1991) Table 8.1 column CUKZ

TFGR Transfers - Government Receipts
£ million

1870 - 1899	Mitchell and Deane (1962) pages 386 - 400
1900 - 1965	Feinstein (1972) Table 14 column 7 pages T35 - T36
1966 - 1988	Economic Trends Annual Supplement 1990 Table 35 page 168 col ABKA + ABKB
1989 - 1991	Financial Statistics No. 360 April 1992 Table 2.1 page 19 column AAXA

TFGEXP Transfers - Government Expenditure
£ million

1870 - 1899	Mitchell and Deane (1962) pages 386 - 400
1900 - 1965	Feinstein (1972) Table 14 column 11 - 8 pages T35 - T36
1966 - 1988	Economic Trends Annual Supplement 1990 Table 35 page 168 col ABAB - AAXI - ABKC
1989 - 1991	Financial Statistics No. 360 April 1992 Table 2.1 page 19 column AAXH - AAXI - AAYE (Table 2.2)

TG Total Government Expenditure minus interest payments on the national debt divided by net national income

1870 - 1938	Mitchell and Deane (1962)
1939 - 1950	Mitchell and Jones (1971)
1951 - 1991	Economic Trends Annual Supplement

TGDEF Total Government Expenditure minus interest payments on the national debt and defence expenditure divided by net national income

1870 - 1938	Mitchell and Deane (1962)
1939 - 1950	Mitchell and Jones (1971)
1951 - 1991	Economic Trends Annual Supplement

TNBFA Total non - bank Assets of Financial Institutions in Great Britain

1870 - 1963 Linear interpolations between Goldsmith's (1969) benchmarks Appendix Table D-10 excluding lines
1. Bank of England
5. P.O. Savings Bank
7. Birmingham Municipal Bank
21. Superannuation funds
23. National Insurance funds

1964 - 1987	Updates using Goldsmiths sources see table in main text of chapter 4

TOCS Turnover Collecting Societies (Income Total)
£ million

1951 - 1960	Annual Abstract of Statistics (1963) C.S.O. Table 348 page 293
1961 - 1971	Annual Abstract of Statistics (1973) C.S.O. Table 385 page 368
1972 - 1980	Annual Abstract of Statistics (1982) C.S.O. Table 17.3 page 440
1981 - 1991	Annual Abstract of Statistics (1992) C.S.O. Table 17.21 page 300

TOFS Turnover Friendly Societies
£ million

1951 - 1991	Annual Abstract of Statistics

TOSECRGILT Turnover Securities (Government Gilts)
£ million

1870 - 1929	Parliamentary Papers
1930 - 1964	Interpolation
1965 - 1990	Quality of Markets Quarterly Review Autumn 1990 The International Stock Exchange London
1991	Stock Exchange Quarterly London Stock Exchange Spring Edition January - March 1992

TOSECRORD Turnover Securities (Ordinary Shares)
£ million

1870 - 1929	Parliamentary Papers
1930 - 1964	Interpolation
1965 - 1990	Quality of Markets Quarterly Review Autumn 1990 The International Stock Exchange London

	1991	Stock Exchange Quarterly London Stock Exchange Spring Edition January - March 1992

TOWNCL Town Bank Clearing
£ million

1870 - 1901	Interpolation
1941 - 1990	Annual Abstract of Statistics

U Percentage Unemployed

1870 - 1965	Feinstein (1972) Table 57 page T125 column 6
1966 - 1991	Economic Trends Annual Supplement

UTDEP Unit Trust Sales

1960 - 1979	Financial Statistics
1980 - 1991	Financial Times Unit Trust Year Book 1992 Financial Times Business Information

UTWITH Unit Trust Repayments

1960 - 1979	Financial Statistics
1980 - 1991	Financial Times Unit Trust Year Book 1992 Financial Times Business Information

W Average weekly wage rates

1870 - 1965	Feinstein (1972) Table 65 pages T140 - 141 column (1)
1966 - 1991	Economic Trends Annual Supplement

Appendix B:

Critical Values for Cointegration Analysis

Empirical Distribution of Φ_1 for $(\alpha, \rho) = (0, 1)$

Probability of a smaller value

Sample Size	0.01	0.025	0.05	0.10	0.90	0.95	0.975	0.99
25	0.29	0.38	0.49	0.65	4.12	5.18	6.30	7.88
50	0.29	0.39	0.50	0.66	3.94	4.86	5.80	7.06
100	0.29	0.39	0.50	0.67	3.86	4.71	5.57	6.70
250	0.30	0.39	0.51	0.67	3.81	4.63	5.45	6.52
500	0.30	0.39	0.51	0.67	3.79	4.61	5.41	6.47
∞	0.30	0.40	0.51	0.67	3.78	4.59	5.38	6.43
s.e.	0.002	0.002	0.002	0.002	0.01	0.02	0.03	0.05

Empirical Distribution of Φ_2 for $(\alpha, \beta, \rho) = (0, 0, 1)$

Probability of a smaller value

Sample Size	0.01	0.025	0.05	0.10	0.90	0.95	0.975	0.99
25	0.61	0.75	0.89	1.10	4.67	5.68	6.75	8.21
50	0.62	0.77	0.91	1.12	4.31	5.13	5.94	7.02
100	0.63	0.77	0.92	1.12	4.16	4.88	5.59	6.50
250	0.63	0.77	0.92	1.13	4.07	4.75	5.40	6.22
500	0.63	0.77	0.92	1.13	4.05	4.71	5.35	6.15
∞	0.63	0.77	0.92	1.13	4.03	4.68	5.31	6.09
s.e.	0.003	0.003	0.003	0.003	0.01	0.02	0.03	0.05

Empirical Distribution of Φ_3 for $(\alpha, \beta, \rho) = (\alpha, 0, 1)$

Probability of a smaller value

Sample Size	0.01	0.025	0.05	0.10	0.90	0.95	0.975	0.99
25	0.74	0.90	1.08	1.33	5.91	7.24	8.65	10.61
50	0.76	0.93	1.11	1.37	5.61	6.73	7.81	9.31
100	0.76	0.94	1.12	1.38	5.47	6.49	7.44	8.73
250	0.76	0.94	1.13	1.39	5.36	6.30	7.20	8.34
500	0.76	0.94	1.13	1.39	5.36	6.30	7.20	8.34
∞	0.77	0.94	1.13	1.39	5.34	6.25	7.16	8.27
s.e.	0.004	0.004	0.003	0.004	0.015	0.020	0.032	0.058

Source: Dickey and Fuller (1981, p.1063)

Appendix B (continued)

Critical Values for Co-Integration Statistics

Number of variables	Sample size	Engle and Yoo (1987)						McKinnon (1990)		
		Dickey-Fuller Test			Augmented Dickey-Fuller Test					
		1%	5%	10%	1%	5%	10%	1%	5%	10%
1	50	-3.58	-2.93	-2.60	nq	nq	nq	-3.55	-2.92	-1.62
	100	-3.51	-2.89	-2.58	nq	nq	nq	-3.49	-2.89	-1.62
	200*	-3.46	-2.88	-2.57	nq	nq	nq	-3.46	-2.88	-1.62
2	50	-4.32	-3.67	-3.28	-4.12	-3.29	-2.90	-4.12	-3.46	-3.13
	100	-4.07	-3.37	-3.03	-3.73	-3.17	-2.91	-4.00	-3.40	-3.09
	200	-4.00	-3.37	-3.02	-3.78	-3.25	-2.98	-3.95	-3.37	-3.07
3	50	-4.84	-4.11	-3.73	-4.45	-3.75	-3.36	-4.59	-3.92	-3.58
	100	-4.45	-3.78	-3.47	-4.34	-3.78	-3.51	-4.37	-3.78	-3.48
	200	-4.35	-3.78	-3.47	-4.34	-3.78	-3.51	-4.37	-3.78	-3.48
4	50	-4.94	-4.35	-4.02	-4.61	-3.98	-3.67	-5.02	-4.32	-3.98
	100	-4.75	-4.22	-3.89	-4.61	-4.02	-3.71	-4.83	-4.21	-3.89
	200	-4.70	-4.18	-3.89	-4.72	-4.13	-3.83	-4.74	-4.15	-3.85
5	50	-5.41	-4.76	-4.42	-4.80	-4.15	-3.85	-5.42	-4.70	-4.35
	100	-5.18	-4.58	-4.26	-4.98	-4.36	-4.06	-5.18	-4.56	-4.24
	200	-5.02	-4.48	-4.18	-4.97	-4.43	-4.14	-5.07	-4.49	-4.19

Notes:
1. * this figure in Engle and Yoo is 250 not 200
2. McKinnon statistics are for "no trend" case but values "with trend" are available in his paper.
3. nq relevant statistics not quoted

Source: Holden and Thompson (1992), Engle and Yoo (1987), and McKinnon (1990)

Appendix C:

Construction of Transactions Velocity

All variables are in £ million unless otherwise stated.

Current Transactions
CT = OP + AGOP + PCON + IN + PAPG
where OP = industrial output - gross total, AGOP = agriculture output - gross total, PCON = personal final consumption (expenditure on consumption of the personal sector), IN = Incomes (from employment, self employment, profit, rent), PAPG = public sector payments for goods and services.

Incomes
IN = INEMP + INSEMP - TAXI + PROFITCO + SURPCO + SURPENT + RENT
where INEMP = income from employment, INSEMP = income from self employment, TAXI = taxes on personal income, PROFITCO = gross trading profits of companies, SURPCO = gross trading surplus of public corporations, SURPENT = gross trading surplus of other public enterprises, RENT = rent.

Public Sector Payments for Goods and Services
PAPG = GFC + GCF
where GFC = government final consumption, GCF = government capital formation.

Transfers
TF = TFPS + TFGS + TFCLG
where TFPS = transfers of the private sector, TFGS = transfers of the government sector (including inter-governmental transfers), TFCLG = transfers - central to local government.

Transfers Private Sector
TFPS = LABIN + LABOUT + LAINDIN + LAINDOUT + IPOL + TOCS + OGCS + TOFS + BPFS
where LABIN = life assurance business (ordinary business) - Income, LABOUT = life assurance business (ordinary business) - outgoings, LAINDIN = life assurance business (industrial business) - income, IPOL = insurance premiums - other than life, TOCS = turnover collecting societies, OGCS = outgoings collecting societies, TOFS = turnover friendly societies, BPFS = benefits paid friendly societies.

Transfers of the Government Sector
TFGS = TFGEXP + TFGR
where TFGEXP = transfers - Government expenditure, TFGR = transfers - Government receipts.

Asset and Portfolio Adjustment
APA = PCF + PORTA
where PCF = private sector capital formation, PORTA = private sector portfolio adjustment.

Private Sector Portfolio Adjustment

PORTA = BSDEP + BSWITH + BSDEPREC + BSDEPWITH + NSDEP + NSWITH + UTDEP + UTWITH + BSAD + MORTR + MORTI + TOSECRORD + TOSECRGIL

where BSDEP = Building Society shares subscribed (deposits), BSWITH = Building Society shares withdrawn (including interest), BSDEPREC = Building Society deposits received, BSDEPWITH = Building Society deposits withdrawn (including interest), NSDEP = National Savings Deposits, NSWITH = National Savings withdrawals, UTDEP = Unit Trust deposits, UTWITH = Unit Trust withdrawals, BSAD = mortgage Advances (Building Societies), MORTR = Mortgage repayments of principal, MORTI = mortgage interest, TOSECRORD = turnover securities (ordinary shares), TOSECRGIL = turnover securities (government gilts).

Transactions in the U.K. Economy 1870 - 1991

Year	Variable	1870	1871	1872	1873	1874	1875	1876
Current Transactions								
Industrial Production Output	OP	1047	1112	1215	1280	1275	1250	1249
Agriculture Gross Output	AGOP	209	216.7	221.4	233.1	227.6	230.4	230.3
Personal Consumption	PCON	954	1004	1065	1123	1123	1118	1126
OP+AGOP+PCON		2210	2332.7	2501.4	2636.1	2625.6	2598.4	2605.3
Income								
Income from Employment	INEMP	431	457	512	559	547	544	542
Income from Self Employment	INSEMP							
Taxes on Personal Income	TAXI	10	6.4	9.1	7.5	5.7	4.3	4.1
Gross Trading Profit of Companies	PROFITCO	360	402	409	429	407	391	372
Gross Trading Surplus of Public Corporations	SURPCO							
Gross Trading Surplus of Other Public Corp	SURPENT							
Rent	RENT	127	130	133	137	140	143	149
Total Income	IN	908	982.6	1044.9	1117.5	1088.3	1073.7	1058.9
Payment for Public Goods								
Government Final Consumption	GFC	55	56	57	55	58	60	61
Government Capital Formation	GCF	6.5	6.5	7.5	9.5	12.5	11.5	13.5
Total Payment for Public Goods	PAPG	61.5	62.5	64.5	64.5	70.5	71.5	74.5
TOTAL CURRENT TRANSACTIONS		3179.5	3377.8	3610.8	3818.1	3784.4	3743.6	3738.7
Year	Variable	1870	1871	1872	1873	1874	1875	1876
TRANSFERS								
Private Sector								
Life Assurance Business - All business								
Income - Ordinary Business	LABIN							
Outgoings - Ordinary Business	LABOUT							
Income - Industrial Business	LAINDIN							
Outgoings - Industrial Business	LAINDOUT							
LIFE ASSURANCE TOTAL TRANSACTIONS		0	0	0	0	0	0	0
Insurance Business Other than Life								
Accident Insurance Business - Income	INACCIN							
Accident Insurance Business - Outgoings	INACCOUT							
Capital Redemption, Sinking Fund - Income	INCAPIN							
Capital Redemption, Sinking Fund - Outgoings	INCAPOUT							
Employers Liability - Income	INEMPIN							
Employers Liability - Outgoings	INEMPOUT							
Fire Insurance - Income	INFIREIN							
Fire Insurance - Outgoings	INFIREOUT							
Marine Insurance - Income	INMARIN							
Marine Insurance - Outgoings	INMAROUT							
Motor Vehicle Insurance - Income	INCARSIN							
Motor Vehicle Insurance - Outgoings	INCAROUT							
Miscellaneous Insurance - Income	INMISCIN							
Miscellaneous Insurance - Outgoings	INMISCOUT							

Variable	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887
OP	1242	1234	1202	1265	1253	1302	1303	1272	1259	1242	1277
AGOP	214.8	210.6	180.3	191.6	192.7	194.8	194.8	184.6	178.8	171.2	166.7
PCON	1133	1120	1057	1146	1125	1157	1190	1162	1138	1126	1162
	2589.8	2564.6	2439.3	2602.6	2570.7	2653.8	2687.8	2618.6	2575.8	2539.2	2605.7
INEMP	545	526	518	529	547	580	587	568	555	551	579
INSEMP											
TAXI	5.3	5.8	8.7	9.2	10.7	9.9	11.9	10.7	12	15.2	15.9
PROFITCO	359	342	325	357	375	377	355	339	330	351	363
SURPCO											
SURPENT											
RENT	152	155	156	157	159	161	161	162	165	166	166
IN	1050.7	1017.2	990.3	1033.8	1070.3	1108.1	1091.1	1058.3	1038	1052.8	1092.1
GFC	62	64	69	70	71	74	76	76	83	80	78
GCF	16.5	17.5	15.5	15.5	13.5	11.5	11.5	13.5	12.5	11.5	12.5
PAFG	78.5	81.5	84.5	85.5	84.5	85.5	87.5	89.5	95.5	91.5	90.5
	3719	3663.3	3514.1	3721.9	3725.5	3847.4	3866.4	3766.4	3709.3	3683.5	3788.3
Variable	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887
LABIN				17.802	18.179	18.697	18.839	19.289	19.635	19.828	20.734
LABOUT				14.262	14.137	14.227	15.163	15.397	16.358	16.486	16.816
LAINDIN				1.988	2.307	2.677	3.152	3.409	3.69	3.916	4.206
LAINDOUT				1.638	1.868	2.286	2.477	2.661	2.884	3.043	3.656
	0	0	0	35.69	36.491	37.887	39.631	40.756	42.567	43.273	45.412
INACCIN											
INACCOUT											
INCAPIN											
INCAPOUT											
INEMPIN											
INEMPOUT											
INFIREIN											
INFIREOUT											
INMARIN											
INMAROUT											
INCARSIN											
INCAROUT											
INMISCIN											
INMISCOUT											

Variable	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
OP	1301	1341	1381	1390	1418	1449	1464	1482	1499	1552	1608
AGOP	165.9	172.3	178.8	185.4	173.2	164.1	158.2	156.6	161.1	165.8	169.2
PCON	1186	1227	1253	1315	1314	1310	1336	1355	1406	1435	1500
	2652.9	2740.3	2812.8	2890.4	2905.2	2923.1	2958.2	2993.6	3066.1	3152.8	3277.2
INEMP	614	674	704	705	701	704	722	737	766	785	824
INSEMP		296	294	281	250	241	278	281	279	291	303
TAXI	14.4	12.7	12.8	13.3	13.8	13.5	15.2	15.6	16.1	16.7	17.3
PROFITCO	398	126	124	116	108	115	143	152	158	175	201
SURPCO											
SURPENT		4	5	5	5	6	6	6	6	6	7
RENT	168	170	172	172	174	177	184	189	192	196	200
IN	1165.6	1257.3	1286.2	1265.7	1224.2	1229.5	1317.8	1349.4	1384.9	1436.3	1517.7
GFC	78	80	85	87	87	89	91	97	102	106	112
GCF	9.5	9.5	10	14	14	18	17	17	18.5	21	26
PAPG	87.5	89.5	95	101	101	107	108	114	120.5	127	138
	3906	4087.1	4194	4257.1	4230.4	4259.6	4384	4457	4571.5	4716.1	4932.9
Variable	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
LABIN	21.566	22.241	22.874	22.421	25.236	25.724	26.85	28.794	30.062	30.588	31.702
LABOUT	16.483	15.98	17.138	17.775	19.498	19.026	19.23	20.166	20.166	19.978	22.657
LAINDIN	4.58	5.11	5.308	5.788	6.116	6.332	6.823	7.098	7.68	8.144	8.725
LAINDOUT	3.612	4.139	4.474	5.085	5.508	5.374	5.523	6.055	6.329	6.616	7.246
	46.241	47.47	49.794	51.069	56.358	56.456	58.426	62.113	64.237	65.326	70.33
INACCIN											
INACCOUT											
INCAPIN											
INCAPOUT											
INEMPIN											
INEMPOUT											
INFIREIN											
INFIREOUT											
INMARIN											
INMAROUT											
INCARSIN											
INCAROUT											
INMISCIN											
INMISCOUT											

Variable	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
OP	1659	1811	1642	1629	1649	1666	1699	1715	1765	1667.7	1706.6
AGOP	178.6	179.9	179.7	187.6	178.8	177.6	185.6	194.1	201.4	198.7	196.9
PCON	1561	1637	1677	1686	1699	1719	1736	1766	1811	1813	1831
	3398.6	3627.9	3498.7	3502.6	3526.8	3562.6	3620.6	3675.1	3777.4	3679.4	3734.5
INEMP	857	909	908	899	908	893	913	952	1008	975	987
INSEMP	331	323	304	314	287	285	310	332	348	310	314
TAXI	18	20	30	36	37	29	31	31	32	33	33
PROFITCO	227	230	216	223	208	204	228	258	271	242	245
SURPCO											
SURPENT	7	8	8	10	11	14	13	14	15	15	17
RENT	204	209	213	217	221	225	227	230	233	235	237
IN	1608	1659	1619	1627	1598	1592	1660	1755	1843	1744	1767
GFC	136	182	202	190	169	163	163	163	163	167	173
GCF	30	34.5	41	43	38	38	33	29	26.5	24.5	24
PAPG	166	216.5	243	233	207	201	196	192	189.5	191.5	197
	5172.6	5503.4	5360.7	5362.6	5331.8	5355.6	5476.6	5622.1	5809.9	5614.9	5698.5
Variable	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
LABIN	32.396	32.492	33.601	34.504	35.829	36.854	38.417	39.457	40.745	42.423	44.653
LABOUT	23.084	24.409	24.489	24.416	25.805	26.435	26.913	28.095	29.473	33.568	33.479
LAINDIN	9.104	10.043	10.476	11.118	11.695	12.116	12.743	13.658	14.409	14.744	15.654
LAINDOUT	7.531	8.347	8.511	8.946	9.305	9.745	10.149	10.892	11.636	11.927	12.929
	72.115	75.291	77.077	78.984	82.634	85.15	88.222	92.102	96.263	102.662	106.715
INACCIN											
INACCOUT											
INCAPIN											
INCAPOUT											
INEMPIN											
INEMPOUT											
INFIREIN											
INFIREOUT											
INMARIN											
INMAROUT											
INCARSIN											
INCAROUT											
INMISCIN											
INMISCOUT											

Variable	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
OP	1743.4	1840.9	1906.186	2181.62	2013.04	2241.09	2451.68	2878.03	3280.71	4240.12	5752.44
AGOP	198	212.7	218.9	210	237.7	273.7	309.8	345.8	381.8	417.89	453.93
PCON	1877	1936	2006	2070	2074	2384	2581	2979	3600	4535	5020
	3818.4	3989.6	4131.086	4461.62	4324.74	4898.79	5342.48	6202.83	7262.51	9193.01	11226.37
INEMP	1027	1065	1114	1160	1260	1556	1858	2340	2881	3076	3449
INSEMP	329	353	366	367							752
TAXI	40	42	54	64	69	103	256	452	553	651	651
PROFITCO	261	272	308	326	674	870	1165	1339	1462	1631	621
SURPCO											
SURPENT	17	18	21	20	21	26	31	49	71	36	20
RENT	239	243	246	249	252	259	272	278	281	284	224
IN	1833	1909	2001	2058	2138	2608	3070	3554	4142	4376	4415
GFC	182	188	196	203	324	1045	1332	1685	1842	935	488
GCF	24	23	24.5	30	30	17	9	6	8	33	103
PAFG	206	211	220.5	233	354	1062	1341	1691	1850	968	591
	5857.4	6109.6	6352.586	6752.62	6816.74	8568.79	9753.48	11447.83	13254.51	14537.01	16232.37
Variable	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
LABIN	44.502	45.856	47.284	48.972	49.897	49.266	49.026	49.839	55.809	61.203	66.042
LABOUT	32.555	34.29	36.305	37.667	40.689	48.543	44.301	45.27	44.178	46.447	54.271
LAINDIN	17.309	17.997	18.686	19.617	20.461	21.081	22.23	23.984	26.236	29.08	33.789
LAINDOUT	14.16	15.041	15.772	16.889	17.581	18.428	18.62	19.731	21.643	22.484	24.675
	108.526	113.184	118.047	123.145	128.628	137.318	134.177	138.824	147.866	159.214	178.777
INACCIN							1.986	2.175	2.247	2.582	2.729
INACCOUT							0.903	0.921	0.944	1.13	1.184
INCAPIN											
INCAPOUT											
INEMPIN							3.902	4.309	5.162	6.337	8.851
INEMPOUT							1.714	1.773	1.973	2.391	2.98
INFIREIN							31.895	36.018	41.72	49.526	58.507
INFIREOUT							15.83	18.597	18.809	21.58	27.891
INMARIN											
INMAROUT											
INCARSIN											
INCAROUT											
INMISCIN											
INMISCOUT											

Variable	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
OP	4129.58	4035.72	3910.31	3747	3918	3647	4104	3910	4104	3371	3062
AGOP	489.97	454.92	419.87	384.82	349.77	314.72	279.67	271.02	262.38	253.74	245.1
PCON	4315	3842	3717	3777	3878	3833	3887	3939	3983	3932	3805
	8934.55	8332.64	8047.18	7908.82	8145.77	7794.72	8270.67	8120.02	8349.38	7556.74	7112.1
INEMP	2835	2411	2318	2376	2419	2336	2505	2497	2545	2485	2382
INSEMP	618	626	614	633	652	642	653	670	668	616	552
TAXI	550	490	439	415	409	383	376	368	377	384	410
PROFITCO	343	437	456	477	468	420	478	474	485	411	360
SURPCO											
SURPENT	25	44	44	40	42	40	48	51	52	54	55
RENT	252	270	267	278	290	299	311	330	347	362	373
IN	3523	3298	3260	3389	3462	3354	3619	3654	3720	3544	3312
GFC	489	435	395	398	412	420	423	425	435	443	443
GCF	159	120	88	97	122	137	143	125	123	132	142
PAPG	648	555	483	495	534	557	566	550	558	575	585
	13105.55	12185.64	11790.18	11792.82	12141.77	11705.72	12455.67	12324.02	12627.38	11675.74	11009.1
Variable	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
LABIN	69.098	74.486	79.364	83.151	92.417	93.097	100.673	107.471	111.727	110.652	109.742
LABOUT	47.564	51.171	53.708	55.583	55.775	57.026	65.881	71.487	76.001	85.872	92.451
LAINDIN	36.028	37.127	39.423	41.446	44.956	45.554	48.252	51.013	52.973	55.735	57.662
LAINDOUT	25.571	25.666	26.725	27.996	29.591	31.49	34.958	38.127	41.889	41.523	48.728
	178.261	188.45	199.22	208.176	222.739	227.167	249.764	268.098	282.59	293.782	308.583
INACCIN	2.91	3.149	3.024	3.27	3.284	3.348	3.412	3.4765	3.5407	3.6048	3.669
INACCOUT	1.381	1.708	1.636	1.62	1.597	1.639	1.6811	1.723	1.7655	1.8077	1.8499
INCAPIN											
INCAPOUT											
INEMPIN	7.519	5.688	5.181	5.532	5.708	5.722	5.73778	5.75266	5.76	5.78	5.79
INEMPOUT	2.903	2.873	2.872	2.903	2.949						
INFIREIN	54.215	55.002	57.694	58.321	60.582	59.27	57.95	56.64	53.33	54.02	52.71
INFIREOUT	30.747	29.407	28.928	29.373	30.039	28.86	27.69	26.51	25.34	24.16	22.995
INMARIN											
INMAROUT											
INCARSIN											
INCAROUT											
INMISCIN											
INMISCOUT											

Variable	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
OP	2926	3083	3366	3543	3889	4283	4274	5093	5912	6731	7549
AGOP	236.46	238.07	239.68	241.3	242.91	244.53	259.95	275.38	290.8	306.23	403.82
PCON	3683	3696	3802	3935	4080	4289	4392	4539	4799	5104	5410
	6845.46	7017.07	7407.68	7719.3	8211.91	8816.53	8925.95	9907.38	11001.8	12141.23	13362.82
INEMP	2357	2402	2507	2597	2744	2908	2989	3215	3843	4535	5042
INSEMP	548	590	596	629	663	631	615	696	791	892	949
TAXI	441	400	385	382	392	433	492	548	747	1180	1475
PROFITCO	321	380	464	514	627	717	687	865	1109	1238	1377
SURPCO	1	3	7	8	9	9	10				
SURPENT	58	59	60	60	60	62	62	76	77	90	136
RENT	387	390	396	413	425	448	460	480	485	475	475
IN	3231	3424	3645	3839	4136	4342	4331	4784	5558	6050	6504
GFC	431	430	446	483	536	617	749	1179	2952	4097	4581
GCF	119	94	97	115	140	174	198	540	520	480	450
PAPG	550	524	543	598	676	791	947	1719	3472	4577	5031
	10626.46	10965.07	11595.68	12156.3	13023.91	13949.53	14203.95	16410.38	20031.8	22768.23	24897.82
Variable	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
LABIN	125.353	126.686	131.12	135.457	136.765	139.346	141.719	137.513	133.052	131.89	137.016
LABOUT	87.274	86.745	95.804	99.303	93.984	97.668	102.298	118.384	120.691	104.581	102.981
LAINDIN	60.176	62.099	64.253	65.562	68.827	71.455	74.302	76.328	79.2	81.026	86.062
LAINDOUT	43.265	45.868	45.996	46.368	48.468	51.29	52.335	61.179	65.002	62.614	62.685
	316.068	321.398	337.173	346.69	348.044	359.759	370.654	393.404	397.945	380.111	388.744
INACCIN	3.733	3.7974	3.8616	3.99	4.167	4.512	4.615	4.548	4.018	3.944	4.067
INACCOUT	1.892	1.9334	1.976	2.061	2.082	2.161	2.295	2.104	1.818	1.657	1.617
INCAPIN				5.139	3.243	2.809	3.391	2.439	2.016	1.69	1.66
INCAPOUT				1.898	1.613	2.071	2.443	1.986	2.064	6.019	2.185
INEMPIN	5.81	5.82	5.83	5.842	6.101	6.711	7.068	6.896	7.371	9.6	9.367
INEMPOUT											
INFIREIN	51.4	50.089	49	48.778	48.946	49.831	49.52	49.609	51.027	54.455	56.305
INFIREOUT	21.8	20.6	20.1	19.473	20.331	19.744	20.585	20.91	23.814	23.43	23.891
INMARIN				10.067	10.458	12.584	12.848	14.797	22.558	24.787	39.173
INMAROUT				7.662	7.637	9.91	10.796	10.152	13.441	13.718	30.011
INCARSIN				33.337	35.304	37.374	37.897	36.58	31.913	34.011	28.382
INCAROUT				19.122	19.628	21.389	21.607	21.44	18.02	18.009	13.9
INMISCIN											
INMISCOUT											

Variable	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
OP	8368	9187	10006	10825	11643	12462	13281	16007	18733	19787	20842
AGOP	501.41	599	582	624	616	718	834	906	935	1089	1156
PCON	5525	5846	6391	7273	8028	8609	8969	9461	10215	10766	11475
	14394.41	15632	16979	18722	20287	21789	23084	26374	29883	31642	33473
INEMP	5472	5751	5889	5758	6227	6785	7246	7627	8501	9107	9634
INSEMP	977	991	1074	1126	1210	1305	1375	1389	1437	1490	1539
TAXI	1866	2057	2072	1898	1740	1945	2231	2251	2378	2649	2641
PROFTTCO	1405	1388	1350	1476	1694	1793	1843	2126	2483	2180	2313
SURPCO				20	36	117	155	196	260	277	321
SURPENT	149	134	119	66	99	107	108	143	182	46	69
RENT	495	470	405	429	472	456	463	539	552	598	671
IN	6632	6677	6765	6977	7998	8618	8959	9769	11037	11049	11906
GFC	4983	5056	4190	2282	1735	1756	1975	2062	2423	2883	3025
GCF	360	300	350	925	1199	665	761	820	988	1168	1313
PAPG	5343	5356	4540	3207	2934	2421	2736	2882	3411	4051	4338
	26369.41	27665	28284	28906	31219	32828	34779	39025	44331	46742	49717
Variable	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
LABIN	144.766	151.273	164.888	192.929	206.622	225.232	239.203	260.787	297.93	324.204	353.29
LABOUT	106.867	111.419	114.455	123.11	129.263	137.617	149.584	158.948	186.434	196.854	188.859
LAINDIN	90.94	94.79	111.626	113.759	114.456	121.773	126.766	131.072	138.224	144.37	152.705
LAINDOUT	65.323	65.828	69.711	71.965	78.971	85.874	95.681	99.186	116.856	122.684	112.757
	407.896	423.31	460.68	501.763	529.312	570.496	611.234	649.993	739.444	788.112	807.611
INACCIN	4.338	4.704	5.106	6.205	7.735	8.563	9.602	10.466	12.965	14.516	16.646
INACCOUT	1.655	1.779	1.973	2.198	2.836	3.561	3.858	4.642	5.413	6.358	7.551
INCAPIN	1.704	1.772	2.273	3.2	3.355	3.245	2.071	2.145	2.038	1.799	1.83
INCAPOUT	2.483	3.003	4.397	2.443	2.967	2.839	2.737	2.218	2.492	2.596	2.912
INEMPIN	13.229	13.903	13.444								
INEMPOUT											
INFIREIN	59.929	65.054	71.777	88.285	108.626	127.606	146.18	168.477	190.52	202.66	205.5
INFIREOUT	24.786	29.5	32.745	38.368	53.454	57.501	61.917	72.292	79.394	87.264	93.382
INMARIN	30.044	26.346	22.618	27.145	40.87	50.526	55.618	58.367	67.991	73.049	66.496
INMAROUT	19.075	16.358	15.376	15.904	25.1	31.152	36.099	40.074	47.317	54.982	54.973
INCARSIN	24.636	26.405	33.828	46.901	61.474	70.734	84.69	102.708	119.42	142.156	155.279
INCAROUT	11.371	12.538	17.202	27.063	36.808	41.244	47.323	61.406	76.319	86.355	91.672
INMISCIN				57.992	73.15	73.898	75.578	85.782	97.064	111.569	122.494
INMISCOUT				30.862	37.477	40.856	39.749	44.993	52.149	59.166	66.031

Variable	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
OP	21897	22796	23696	24596	25496	26810	28124	29438	30752	32066	34109
AGOP	1262	1294	1356	1388	1468	1469	1496	1507	1612	1639	1660
PCON	12163	13110	13821	14582	15362	16175	16990	17903	18991	20195	21577
	35322	37200	38873	40566	42326	44454	46610	48848	51355	53900	57346
INEMP	10284	11244	12262	12958	13465	14102	15164	16397	17289	18160	19662
INSEMP	1578	1661	1713	1772	1780	1883	2004	2104	2142	2202	2326
TAXI	2679	2913	3006	3249	3584	3655	3638	4150	4652	4688	4973
PROFITCO	2576	2886	2928	3075	2983	3317	3739	3646	3599	4113	4616
SURPCO	354	315	345	323	340	391	539	645	751	846	931
SURPENT	115	120	130	138	165	185	201	121	98	108	119
RENT	737	791	853	913	1061	1153	1244	1340	1446	1553	1676
IN	12965	14104	15225	15930	16210	17376	19253	20103	20673	22294	24357
GFC	3108	3170	3427	3584	3672	3919	4163	4497	4822	5080	5395
GCF	1297	1326	1377	1474	1483	1592	1648	1826	1963	2142	2590
PAPG	4405	4496	4804	5058	5155	5511	5811	6323	6785	7222	7985
	52692	55800	58902	61554	63691	67341	71674	75274	78813	83416	89688

Variable	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
LABIN	393.796	436.676	469.943	523.248	582.155	654.284	730.17	820.69	898.675	1046.981	1176.084
LABOUT	199.054	225.738	274.173	283.8	292.57	309.138	335.692	386.613	444.342	478.482	541.591
LAINDIN	169.009	172.334	183.171	194.116	207.981	219.051	232.558	252.94	264.262	278.196	300.007
LAINDOUT	115.402	122.555	136.525	158.51	153.21	155.359	160.62	187.989	202.215	206.143	210.221
	877.261	957.303	1063.812	1159.674	1235.916	1337.832	1459.04	1648.232	1809.494	2009.802	2227.903
INACCIN	17.642	19.043	21.599	23.542	25.956	28.606	31.598	35.777	38.622	42.15	46.3
INACCOUT	8.363	9.027	10.362	11.518	13.262	14.385	15.768	18.617	20.462	22.31	24.514
INCAPIN	2.026	2.059	2.009	2.149	2.072	2.131	2.219	2.565	2.857	2.24	2.283
INCAPOUT	2.952	2.751	3.598	3.331	3.065	4.921	4.506	3.229	3.23	2.867	2.545
INEMPIN											
INEMPOUT											
INFIREIN	209.863	218.914	249.759	260.532	266.375	277.876	286.724	302.86	314.783	317.175	338.944
INFIREOUT	100.615	102.021	123.12	133.574	132.21	139.242	148.37	158.447	177.747	201.349	186.763
INMARIN	63.126	65.448	69.478	77.617	78.098	80.44	84.545	91.2	91.887	95.487	100.166
INMAROUT	49.24	49.251	54.602	60.124	64.549	63.892	61.28	70.087	72.07	75.2	80.602
INCARSIN	165.126	180.505	210.138	240.132	266.698	283.823	307.538	333.804	354.79	390.712	440.732
INCAROUT	99.87	113.751	141.266	156.244	175.314	182.973	199.97	219.908	233.158	265.532	296.342
INMISCIN	131.345	139.801	162.296	177.682	184.025	194.897	208.684	218.426	230.826	247.996	266.501
INMISCOUT	70.271	74.247	88.733	99.095	106.847	112.866	121.133	130.593	135.56	151.044	158.846

Variable	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
OP	36152	38195	40238	42281	46842	51404	54744	58770	68355	102994	116993
AGOP	1825	1886	1923	2014	2056	2357	2521	2792	3608	4129	4985
PCON	22956	24505	25761	27751	29466	32114	36010	40750	46589	53691	66125
	60933	64586	67922	72046	78364	85875	93275	102312	118552	160814	188103
INEMP	21218	22842	23799	25455	27227	30553	33489	37870	43877	52379	68494
INSEMP	2518	2679	2843	3090	3298	3662	4167	4764	7188	7736	8507
TAXI	5708	5670	6204	7032	7733	8718	9629	10328	12137	15952	22494
PROFITCO	4820	4483	4526	5126	5614	5981	7016	7988	10106	11210	11684
SURPCO	995	1042	1132	1363	1451	1447	1523	1683	2065	2531	3094
SURPENT	129	124	127	151	175	179	201	163	151	133	127
RENT	1831	2143	2363	2616	2936	3315	3667	4182	4178	5299	6315
IN	25803	27643	28586	30769	32968	36419	40434	46322	55428	63336	75727
GFC	5919	6539	7230	7681	8018	9038	10305	11751	13398	16716	23117
GCF	2786	3146	3640	3794	3737	4119	4436	4516	5742	7243	8915
PAPG	8705	9685	10870	11475	11755	13157	14741	16267	19140	23959	32032
	95441	101914	107378	114290	123087	135451	148450	164901	193120	248109	295862
Variable	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
LABIN	1239.566	1339.228	1640.155	1959.028	1979.853	2201.867	2776.205	3709	3933	4054	5637
LABOUT	611.555	706.229	797.358	928.46	1196.821	1269.803	1487.214	1710	2251	4921	2694
LAINDIN	328.736	333.325	351.479	384.958	395.06	413.149	454.279	472.815	506.978	535.952	700.58
LAINDOUT	226.078	255.228	271.779	291.8	310.981	334.575	347.188	376.3	386.188	648.089	456.969
	2405.935	2634.01	3060.771	3564.246	3882.715	4219.394	5064.886	6268.115	7077.166	10159.04	9488.549
INACCIN	48.551	50.632	53.474	61.31							
INACCOUT	25.78	26.928	27.141	30.654							
INCAPIN	2.29	2.13	2.015	1.997							
INCAPOUT	3.168	3.931	3.417	2.679							
INEMPIN											
INEMPOUT											
INFIREIN	368.161	395.286	421.006	498.085	533.668	569.251	604.834	640.417	676	789	970
INFIREOUT	207.92	212.84	234.577	285.4							
INMARIN	104.439	114.062	130.784	163.862	180	217	242	262	276	337	408
INMAROUT	94.996	107.526	112.568	132.443							
INCARSIN	478.166	501.192	540.381	597.112	569.8896	542.667	515.444	488.224	461	507	623
INCAROUT	320.706	340.059	360.953	409.895							
INMISCIN	287.592	314.289	345.258	399.724							
INMISCOUT	173.352	193.877	220.01	254.282							

Variable	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
OP	139300	160872	176385	203999	222200	225385	241903	259915	284380	307987	311772	345811
AGOP	6026	6589	7158	8079	8686	9879	11103	11482	12492	12174	12270	12562
PCON	76881	87875	101244	119989	139604	155412	170650	187028	199425	217618	241275	264880
	222207	255336	284787	332067	370490	390676	423656	458425	496297	537779	565317	623253
INEMP	78005	86572	98843	115866	137783	149737	158838	169847	180883	195708	211729	229532
INSEMP	10077	11248	13654	16502	18394	19980	22140	24750	27804	30116	34769	39383
TAXI	26510	28447	30613	34290	40930	46119	50878	55399	58354	63488	68802	73916
PROFITCO	14620	19951	22366	29145	27861	27341	31176	39528	44656	51767	47049	59315
SURPCO	4505	5095	5466	5710	6309	7974	9502	10004	8381	7120	8056	6802
SURPENT	152	183	216	180	180	236	216	50	-117	265	155	-75
RENT	7388	8443	9578	11286	13231	16366	17700	18857	19804	21792	23826	25772
IN	88237	103045	119510	144399	162828	175515	188694	207637	223057	243280	256782	286813
GFC	27042	29469	33407	38830	48940	55374	60363	65787	69760	73805	79381	85349
GCF	10115	9596	9767	11058	12480	11596	11751	13934	14160	12803	13057	12186
PAPG	37157	39065	43174	49888	61420	66970	72114	79721	83920	86608	92438	97535
	347601	397446	447471	526354	594738	633161	684464	745783	803274	867667	914537	1007601
Variable	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
LABIN	5482	7591	8635	9680	10725	11769	12814	13859	14903	15948	16993	20172
LABOUT	3180	3447	4309	5172	6035	6898	7761	8624	9487	10350	11213	13377
LAINDIN	656.959	790.715	854.562	1080.735	1296.551	1430.365	1685.658	1812.348	2138.229	2199.242	2314.009	2490.07
LAINDOUT	510.239	557.806	608.959	699.425	829.058	961.773	1119.894	1228.631	1403.906	1562.315	1711.128	1826.814
	9829.198	12386.52	14407.52	16632.16	18885.61	21059.14	23380.55	25523.98	27932.14	30059.56	32231.14	37865.88
INACCIN												
INACCOUT												
INCAPIN												
INCAPOUT												
INEMPIN												
INEMPOUT												
INFIREIN	1206	1419	1666	1913	2316	2577	2771	3078	3486	4298	5328	6118
INFIREOUT												
INMARIN	517	567	515	532	670	808	946	1084	1222	1360	1498	1364
INMAROUT												
INCARSIN	744	877	1066	1296	1561	1694	1729	1790	1938	2179	2666	3411
INCAROUT												
INMISCIN												
INMISCOUT												

Variable	1988	1989	1990	1991
OP	386111	421674	450278	463439
AGOP	12492	13480	13801	13243
PCON	298796	326489	349421	378164
	697399	761643	813500	854846
INEMP	255357	283585	316408	330865
INSEMP	44835	51605	57661	53529
TAXI	82657	89632	107664	111286
PROFITCO	63950	66203	62916	60744
SURPCO	7354	6418	4265	3061
SURPENT	-32	199	17	117
RENT	29292	32091	38433	44092
IN	318099	350469	372036	381122
GFC	91729	99029	109651	121488
GCF	11125	15072	17396	15779
PAFG	102854	114101	127047	137267
	1118352	1226213	1312583	1373235
Variable	1988	1989	1990	1991
LABIN	20856	28579	32196	38147
LABOUT	13997	16067	19142	21576
LAINDIN	2571.831	3324.42	3255	3495
LAINDOUT	2004.055	2367.226	2786	2992
	39428.89	50337.65	57379	66210
INACCIN				
INACCOUT				
INCAPIN				
INCAPOUT				
INEMPIN				
INEMPOUT				
INFIREIN	7057	8094	8835	9709
INFIREOUT				
INMARIN	1532	1643	1564	1835
INMAROUT				
INCARSIN	4016	4545	4843	5195
INCAROUT				
INMISCIN				
INMISCOUT				

Year	Variable	1870	1871	1872	1873	1874	1875	1876
INSURANCES (OTHER THAN LIFE)								
Insurance Premiums (other than life)		0	0	0	0	0	0	0
Insurance Company Outgoings		0	0	0	0	0	0	0
Turnover Collecting Societies	TOCS							
Outgoings Collecting Societies (Claims)	OGCS							
Turnover Friendly Societies	TOFS							
Benefits Paid Friendly Societies	BPFS							
FRIENDLY & COLLECTING SOCIETIES								
Total Income Coll & Friendly		0	0	0	0	0	0	0
Total Benefit Coll & Friendly		0	0	0	0	0	0	0
PRIVATE SECTOR TRANSFERS **	TFPS	0	0	0	0	0	0	0
Public Sector								
Government Transfers - Expenditure	TFGEXP	20.07864	20.2881	20.91649	20.58733	22.32289	21.84412	22.35282
Government Transfers - Receipts	TFGR	96.45112	89.25327	95.6659	97.75982	98.80677	96.32025	98.80677
TRANSFERS PUBLIC SECTOR **	TFGS	116.5298	109.5414	116.5824	118.3471	121.1297	118.1644	121.1596
TRANSFERS CENTRAL TO LOCAL GOVERNMENT **	TFCLG	1	1.18	1.37	1.56	1.75	1.94	2.13
Asset Transactions								
PRIVATE SECTOR ASSET TRANSACTIONS								
Private Sector Capital Formation **	PCF	58	74	83	85	96	104	110
Year	Variable	1870	1871	1872	1873	1874	1875	1876
PORTFOLIO ADJUSTMENT								
Building Society Shares Deposits Subscribed	BSDEP							
Building Society Shares Withdrawn (incl int)	BSWITH							
Building Society Deposits Received	BSDEPREC							
Building Society Deposits Withdrawn	BSDEPWITH							
National Savings Deposits	NSDEP	13.904	15.079	16.691	17.221	17.931	18.65	18.894
National Savings Withdrawals	NSWITH	12.925	13.265	14.222	15.655	16.092	16.834	17.329
Unit Trusts Deposits	UTDEP							
Unit Trust Withdrawals	UTWITH							
Mortgage Advances	BSAD							
Mortgage Repayments of Principal	MORTR							
Mortgage Interest	MORTI							
TOTAL DEPOSITS		13.904	15.079	16.691	17.221	17.931	18.65	18.894
TOTAL WITHDRAWALS		12.925	13.265	14.222	15.655	16.092	16.834	17.329
STOCK EXCHANGE								
Turnover Securities (Ordinary Shares)	TOSECRORD	635	806	1016	1038	1010	1043	761
Turnover Securities (Government Gilts)	TOSECRGILT	163	211	247	250	260	252	226
Townclearing	TOWNCL							
TOTAL PORTFOLIO ADJUSTMENT **	PORTA	824.829	1045.344	1293.913	1320.876	1304.023	1330.484	1023.223
Banks - Clearings	BCLEAR	3914	4826	5916	6071	5937	5686	4962

Variable	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
TOCS											
OGCS											
TOFS											
BPFS											
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
TFPS	0	0	0	35.69	36.491	37.887	39.631	40.756	42.567	43.273	45.412
TFGEXP	22.65205	23.81907	24.77662	24.38761	24.1183	24.92624	26.06333	25.55463	26.48225	27.58942	26.93111
TFGR	100.5081	101.6859	106.2664	95.92764	107.1824	109.9307	114.3803	112.8099	115.1655	117.2594	118.8299
TFGS	123.1601	125.505	131.043	120.3152	131.3008	134.857	140.4436	138.3645	141.6478	144.8489	145.761
TFCLG	2.32	2.51	2.6	2.7	2.7	2.9	3.3	3.5	3.6	3.8	4
PCF	103	92	74	82	81	85	90	80	67	58	56
Variable	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887
BSDEP											
BSWITH											
BSDEPREC											
BSDEPWITH											
NSDEP	19.191	19.343	19.547	20.087	21.921	23.352	24.123	25.538	25.931	26.894	27.656
NSWITH	17.738	18.879	19.689	19.422	20.454	21.196	22.188	22.873	23.709	24.461	25.388
UTDEP											
UTWITH											
BSAD											
MORTR											
MORTI											
	19.191	19.343	19.547	20.087	21.921	23.352	24.123	25.538	25.931	26.894	27.656
	17.738	18.879	19.689	19.422	20.454	21.196	22.188	22.873	23.709	24.461	25.388
TOSBCRORD	744	795	843	1152	1383	1229	1059	961	935	1199	1146
TOSBCRGILT	228	227	225	255	279	278	255	268	249	263	297
TOWNCL											
FORTA	1008.929	1060.222	1107.236	1446.509	1704.375	1551.548	1360.311	1277.411	1233.64	1513.355	1496.044
BCLEAR	5042	4992	4886	5794	6357	6221	5929	5799	5511	5902	6077

Variable	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
TOCS											
OGCS											
TOFS											
BPFS											
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
TFPS	46.241	47.47	49.794	51.069	56.358	56.456	58.426	62.113	64.237	65.326	70.33
TFGEXP	25.94363	25.88379	27.11065	27.9485	28.72651	28.66667	29.4746	30.19276	31.44955	32.82603	33.60404
TFGR	117.5212	117.652	123.8029	126.2895	129.0377	127.8599	128.776	133.2256	143.1717	146.9669	151.94
TFGS	143.4648	143.5358	150.9136	154.238	157.7642	156.5266	158.2506	163.4183	174.6212	179.7929	185.544
TFCLG	4.3	4.8	6.5	7.1	8	8.9	8.8	9	9.2	9.6	11
PCF	64	74	79	80	83	75	82	82	94	111	132
Variable	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
BSDEP						19.16	21.01	22.86	24.71	26.56	28.41
BSWITH											
BSDEPREC											
BSDEPWITH											
NSDEP	30.181	30.814	32.108	32.246	33.732	35.607	42.809	45.383	50.742	50.438	52.444
NSWITH	27.712	28.763	30.034	30.108	31.024	32.048	33.963	36.037	40.253	42.039	44.869
UTDEP											
UTWITH											
BSAD						4.8137	5.2854	5.7571	6.2288	6.7005	7.1722
MORTR											
MORTI											
	30.181	30.814	32.108	32.246	33.732	54.767	63.819	68.243	75.452	76.998	80.854
	27.712	28.763	30.034	30.108	31.024	36.8617	39.2484	41.7941	46.4818	48.7395	52.0412
TOSBCRORD	1252	1339	1417	1067	1023	1003	964	1305	1163	1114	1232
TOSBCRGILT	332	352	359	315	299	300	301	345	380	363	403
TOWNCL											
PORTA	1641.893	1750.577	1838.142	1444.354	1386.756	1394.629	1368.067	1760.037	1664.934	1602.738	1767.895
BCLEAR	6942	7619	7801	6848	6482	6478	6337	7979	8039	7974	8605

Variable	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
TOCS											
OGCS											
TOFS										2.87	3.42
BPFS										1.915	2.27
	0	0	0	0	0	0	0	0	0	2.87	3.42
	0	0	0	0	0	0	0	0	0	1.915	2.27
TFPS	72.115	75.291	77.077	78.984	82.634	85.15	88.222	92.102	96.263	107.447	112.405
TFGEXP	35.2199	43	60	53	50	46	47	47	46	46	55
TFGR	154.2956	170	189	208	211	212	216	218	223	220	223
TFGS	189.5155	213	249	261	261	258	263	265	269	266	278
TFCLG	11.8	16	16	16	18	22	23	25	25	25	24
PCF	153	164	156	154	160	149	144	146	124	103	108
Variable	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
BSDEP	30.26	32.11	33.96	35.81	36.37	36.94	37.5	38.06	38.63	39.19	39.75
BSWITH											
BSDEPREC											
BSDEPWITH											
NSDEP	54.882	53.699	53.941	55.022	53.569	53.172	55.518	57.388	57.333	58.064	59.049
NSWITH	47.74	51.679	53.141	54.954	56.767	56.024	56.179	58.205	61.713	60.418	59.803
UTDEP											
UTWITH											
BSAD	7.6439	8.1156	8.9	8.9	9.7	9.4	9	9.2	9.6	8.9	9
MORTR											
MORTI											
	85.142	85.809	87.901	90.832	89.939	90.112	93.018	95.448	95.963	97.254	98.799
	55.3839	59.7946	62.041	63.854	66.467	65.424	65.179	67.405	71.313	69.318	68.803
TOSECRORD	1544	1340	1583	1567	1457	1537	2071	2032	1822	1672	2129
TOSECRGILT	403	438	484	570	594	597	629	645	632	645	678
TOWNCL				9158	9235	9678	11355	11719	11657	10408	11744
PORTA	2087.526	1923.604	2216.942	2291.686	2207.406	2289.536	2858.197	2839.853	2621.276	2483.572	2974.602
BCLEAR	9721	9593	10167	10644	10745	11219	12953	13390	13453	12772	15402

Variable	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
	0	0	0	0	0	0	37.783	42.502	49.129	58.445	70.087
	0	0	0	0	0	0	18.447	21.291	21.726	25.101	32.055
TOCS											
OGCS											
TOFS	3.977	4.52	5.08	5.63	6.18	6.73	7.28	7.84	8.39	8.94	9.49
BPFS	2.63	2.99	3.35	3.71	4.07	4.43	4.79	5.16	5.52	5.88	6.24
	3.977	4.52	5.08	5.63	6.18	6.73	7.28	7.84	8.39	8.94	9.49
	2.63	2.99	3.35	3.71	4.07	4.43	4.79	5.16	5.52	5.88	6.24
TFPS	115.133	120.694	126.477	132.485	138.878	148.478	184.03	194.326	210.905	232.479	264.594
TFGEXP	56	58	62	67	80	111	174	271	437	623	659
TFGR	244	251	272	284	291	371	555	787	968	1142	1242
TFGS	300	309	334	351	371	482	729	1058	1405	1765	1901
TFCLG	24	25	25	25	26	26	26	29	32	50	67
PCF	112	109	111	130	130	113	106	142	153	193	379
Variable	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
BSDEP	40.32	40.88	41.44	42.01	42.57	43.13	43.7	44.26	44.82	45.38	45.95
BSWITH											
BSDEPREC											
BSDEPWITH											
NSDEP	59.927	64.426	65.46	66.456	62.664	72.107	75.676	161.48	175.087	304.857	213.801
NSWITH	60.801	61.442	64.691	66.594	65.544	84.643	68.994	88.126	79.306	181.81	132.374
UTDEP											
UTWITH											
BSAD	9.3	8.9	8.3	9.1	8.8	6.5	4.9	4.5	7	15.8	25.1
MORTR											
MORTI											
	100.247	105.306	106.9	108.466	105.234	115.237	119.376	205.74	219.907	350.237	259.751
	70.101	70.342	72.991	75.694	74.344	91.143	73.894	92.626	86.306	197.61	157.474
TOSECRORD	2261	2219	2362	2383	2404	2425	2446	2467	2488	2509	2530
TOSECRGILT	733	679	725	821.4177	719.7172	776.0953	884.1628	1106.781	1227.004	1343.696	1901.63
TOWNCL	12697	12596	13814	14191	12434	13408	15275	19121	21198	23214	32853
PORTA	3164.348	3073.648	3266.891	3388.578	3303.295	3407.475	3523.433	3872.147	4021.217	4400.543	4848.855
BCLEAR	15402	15388	16814	17336	15496	14398	16487	20559	22975	30699	42153

Variable	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
	64.644	63.839	65.899	67.123	69.574	68.34	67.09978	65.86916	62.6307	63.4048	62.169
	35.031	33.988	33.436	33.896	34.585	30.499	29.3711	28.233	27.1055	25.9677	24.8449
TOCS											
OGCS											
TOFS	10.04	10.6	11.15	11.7	12.25	12.8	13.36	13.91	14.46	15.01	15.56
BPFS	6.6	6.96	7.32	7.68	8.04	8.4	8.76	9.12	9.48	9.84	10.2
	10.04	10.6	11.15	11.7	12.25	12.8	13.36	13.91	14.46	15.01	15.56
	6.6	6.96	7.32	7.68	8.04	8.4	8.76	9.12	9.48	9.84	10.2
TFPS	259.545	269.849	283.589	294.679	312.603	316.707	338.9838	356.9972	369.1607	382.0368	396.512
TFGEXP	676	617	565	546	562	598	566	584	601	622	643
TFGR	1205	1115	1036	966	990	992	1029	1045	1048	1050	1058
TFGS	1881	1732	1601	1512	1552	1590	1595	1629	1649	1672	1701
TFCLG	77	77	77	79	82	84	87	88	104	128	132
PCF	299	261	246	277	298	264	283	295	319	303	266
Variable	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
BSDEP	46.51	47.07	47.64	48.2	48.76	49.33	49.89	50.45	51.02	51.58	52.14
BSWITH											
BSDEPREC											
BSDEPWITH											
NSDEP	157.49	216.75	159.038	158.955	153.874	142.749	144.139	152.45	157.365	156.597	160.364
NSWITH	158.419	161.105	146.764	148.16	153.689	147.961	155.933	160.552	172.367	163.547	158
UTDEP											
UTWITH											
BSAD	19.7	22.7	32	40.6	49.8	52.2	55.9	58.7	74.7	88.8	90.3
MORTR											
MORTI											
	204	263.82	206.678	207.155	202.634	192.079	194.029	202.9	208.385	208.177	212.504
	178.119	183.805	178.764	188.76	203.489	200.161	211.833	219.252	247.067	252.347	248.3
TOSBCRORD	2551	2572	2593	2614	2635	2656	2677	2698	2719	2741	2762
TOSBCRGILT	1752.003	1897.405	1867.884	2028.162	2072.269	2045.933	2131.252	2275.439	2311.615	2244.819	1841.606
TOWNCL	30268	32780	32270	35039	35801	35346	36820	39311	39936	38782	31816
PORTA	4685.122	4917.03	4846.326	5038.077	5113.392	5094.173	5214.114	5395.591	5486.067	5446.343	5064.41
BCLEAR	36716	38958	38429	41414	42303	41453	43261	45877	46496	44906	37436

Variable	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
	60.943	59.7064	58.6916	107.153	108.219	113.821	115.339	114.869	118.903	128.487	138.954
	23.692	22.5334	22.076	50.216	51.291	55.275	57.726	56.592	59.157	62.833	71.604
TOCS				16.41	17.2	18.32	19	19.64	20.04	20.61	22
OGCS				5.93	5.98	6.25	6.18	6.95	7.98	7.77	7.33
TOFS	16.12	16.67	17.22	17.77	18.33	17.71	17.71	16.66	16.6	20	18.63
BPFS	10.56	10.92	11.28	11.65	12.47	12.74	12.23	12.68	13.01	11.98	11.77
	16.12	16.67	17.22	34.18	35.53	36.03	36.71	36.3	36.64	40.61	40.63
	10.56	10.92	11.28	17.58	18.45	18.99	18.41	19.63	20.99	19.75	19.1
TFPS	403.691	408.6944	424.3646	505.603	510.243	528.6	541.113	564.203	574.478	568.958	587.428
TFGEXP	644	602	584	592	577	579	612	617	680	788	894
TFGR	1098	1057	1070	1086	1129	1196	1274	1396	1812	2578	3056
TFGS	1742	1659	1654	1678	1706	1775	1886	2013	2492	3366	3950
TFCLG	125	124	126	134	139	139	142	178	225	278	269
PCF	228	263	330	341	377	400	394				

Variable	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
BSDEP	52.71	53.27	53.83	54.4	69.3	75.8	77.6	67.3	40.4	28.7	26.7
BSWITH				47.3	51.8	55.9	64.8	75	65.8	47.8	38.1
BSDEPREC					0	42.2	46.2	35.7	21.7	16.5	17.5
BSDEPWITH					0	31.1	37.9	43.6	35.5	23.4	19.4
NSDEP	180.051	185.696	190.687	202.6	218.1	230.7	238.8	358.6	712.8	834.3	807
NSWITH	170.473	163.423	161.309	164.1	179.5	200.3	208.9	219.4	198.3	224.1	262.5
UTDEP											
UTWITH											
BSAD	82.1	103.2	124.6	130.9	140.3	136.9	137	94.3	21.2	10	16.3
MORTR				77.2	82.9	87.2	86.6	75	49.5	43.8	51.8
MORTI				26.2	27.8	29.8	31.9	33.4	32.9	31.4	29.8
	232.761	238.966	244.517	360.4	398.1	465.7	481.1	570	857.3	954.7	932.8
	252.573	266.623	285.909	342.3	371.6	424.2	448.6	432.3	320.8	305.3	336.3
TOSBCRORD	2783	2804	2825	2846	2867	2888	2909	2930	2951	2972	2993
TOSBCRGILT	1611.115	1604.227	1779.323	1877.956	2028.162	2125.406	1960.034	1593.866	1458.709	1323.611	1493.787
TOWNCL	27834	27715	30740	32444	35039	36719	33862	27536	25201	22867	25807
PORTA	4879.449	4913.816	5134.749	5426.656	5664.862	5903.306	5798.734	5526.166	5587.809	5555.611	5755.887
BCLEAR	33350	33381	36779	38843	42011	44158	40869	37911	41427	44482	50137

Variable	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
	133.88	138.184	149.046	229.728	295.21	334.572	373.739	427.945	489.998	545.749	568.245
	59.37	63.178	71.693	116.838	158.642	177.153	191.683	225.625	263.084	296.721	316.521
TOCS	23.68	24.82	25.96	27.76	30.55	32.14	34.09	35	36.36	38.01	39.62
CGCS	7.89	8.64	8.93	9.17	9.78	10.12	11.26	11.78	13.29	13.23	13.89
TOFS	19.29	19.58	19.732	19.8	20.6	18.27	17.08	17.13	17.68	18.82	19.64
BPFS	12.33	12.96	13.64	14.65	14.85	15.76	15.63	15.05	15.21	14.54	15.28
	42.97	44.4	45.692	47.56	51.15	50.41	51.17	52.13	54.04	56.83	59.26
	20.22	21.6	22.57	23.82	24.63	25.88	26.89	26.83	28.5	27.77	29.17
TFPS	604.966	627.494	677.988	802.871	900.302	981.358	1063.033	1156.898	1311.982	1418.461	1464.286
TFGEXP	997	1082	1273	1692	1771	1870	1858	1832	1910	2052	2119
TFGR	3559	3743	3692	3611	3725	4211	4504	4636	4992	5359	5460
TFGS	4556	4825	4965	5303	5496	6081	6362	6468	6902	7411	7579
TFCLG	245	240	247	255	275	294	302	313	352	389	416
PCF						757	816	880	901	938	1046
Variable	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
BSDEP	35.4	40.5	46.1	80.4	101.7	117.2	148.2	184.3	192.1	239.3	269.4
BSWITH	34.8	33.7	40.1	53.2	59.9	67.5	79	98.1	119.8	136.6	148.4
BSDEPREC	19.7	22.1	25.3	35.4	44.9	45	46.7	47.2	49.2	44.6	50.3
BSDEPWITH	19.5	19.3	21.8	29.7	31.6	35.9	40.7	47	50	58.9	48.7
NSDEP	954.6	1025.6	1101.2	1123.5	997.8	815.8	775	820.8	931.2	980.5	1031.8
NSWITH	315.3	399.7	627.9	797.7	808.9	789	846.7	911.7	1016.4	1102.6	1170.7
UTDEP											
UTWITH											
BSAD	28.1	52.9	97.6	188.2	242.5	264	276	269.7	367.6	266.1	299.5
MORTR	60.3	67.3	86.1	120.9	149.5	160.7	160.7	163.8	169.1	160.2	166.6
MORTI	28.4	26.8	26.6	26.4	29.4	33.3	37.6	42	46.5	52.3	60.5
	1098.4	1182.3	1285.3	1386.6	1323.3	1172	1168.2	1258.1	1388.1	1476.9	1578.6
	397.7	505.6	787.4	1068.8	1142.9	1156.4	1242.4	1326.5	1553.8	1564.2	1667.3
TOSBCRORD	3014	3035	3056	3077	3098	3120	3141	3162	3183	3204	3225
TOSBCRGILT	1781.176	1988.455	2240.651	2897.623	3048.813	3323.873	3623.707	4025.647	4670.406	4771.759	5445.054
TOWNCL	30772	34353	38710	50060	52672	57424	62604	69548	80687	82438	94070
PORTA	6291.276	6711.355	7369.351	8430.023	8613.013	8772.273	9175.307	9772.247	10795.31	11016.86	11915.95
BCLEAR	58275	63588	67974	70270	74743	81947	87946	96317	111057	112637	125513

Variable	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
	589.128	625.77	715.279	781.654	823.224	867.773	921.308	984.632	1033.765	1095.76	1194.926
	331.311	351.048	421.681	463.886	495.247	518.279	551.027	600.881	642.227	718.302	749.612
TOCS	41.67	43.69	45.23	47.52	50.55	52.44	55.82	57.87	59.24	61.73	64.48
OGCS	14.38	15.13	16.55	21.97	24.72	23.47	25.03	29.48	29.83	28.86	29.8
TOFS	18.84	17.03	21.94	18.54	21.33	23.3	24.95	26.48	27.83	28.95	30.29
BPFS	15.27	15.53	16.12	16.62	16.99	17.63	17.64	19.59	20.43	21.28	22.16
	60.51	60.72	67.17	66.06	71.88	75.74	80.77	84.35	87.07	90.68	94.77
	29.65	30.66	32.67	38.59	41.71	41.1	42.67	49.07	50.26	50.14	51.96
TFPS	1556.549	1674.453	1878.931	2045.978	2172.73	2322.445	2503.788	2766.284	2980.589	3246.382	3569.559
TFGEXP	2203	2203	2427	2541	2844	3001	3260	3616	3822	4129	4307
TFGR	5661	6088	6397	6817	7308	7619	7870	8666	9531	9718	10528
TFGS	7864	8291	8824	9358	10152	10620	11130	12282	13353	13847	14835
TFCLG	441	490	544	621	660	711	780	828	926	1031	1159
PCF	1255	1503	1726	1907	2009	2144	2472	2795	2769	2774	3280
Variable	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
BSDEP	333	377.3	378.2	393.1	435.5	535.7	519	555.1	702.6	885.4	1019.9
BSWITH	171.6	223.2	256.7	286.5	327.6	363.8	409.6	454.6	473	542.4	672.2
BSDEPREC	63.8	53.3	41.3	42	53.9	65	65.1	64.7	73.1	90.9	93.9
BSDEPWITH	48.4	63.1	69.3	51.8	50	55.7	63.2	68.2	63.9	69.8	79.9
NSDEP	1166.7	1239.6	1673.8	1485.4	1868.3	1832.3	1882.4	1859.1	1996.2	2079.1	2324.9
NSWITH	1175.9	1381.3	1680.1	1598.9	1688.5	1594.6	1702.8	1847.8	1877.7	1976.5	2215.4
UTDEP							26.88	21.567	45.01	77.46	99.64
UTWITH							13.368	14.21	11.07	17.78	22.6
BSAD	373.2	394.4	334.9	374.1	374.7	517.3	559.8	545.8	613	849.4	1042.5
MORTR	195.5	216.2	207.8	220.3	228.4	288.6	318.7	322.6	344.6	431.6	505.4
MORTI	68	77.5	96.5	116.9	129.1	137.1	149	173.2	198.6	210.1	235.6
	1827	1963.9	2397.6	2257.7	2715.2	2858.7	2961.08	2996.267	3360.11	3774.56	4279.34
	1769.1	2062	2341	2311.3	2440.8	2531.4	2748.768	2930.61	3038.67	3455.88	4032.6
TOSBCRORD	3246	3267	3288	3309	3330	3351	3372	3393	3414	3435	3456
TOSBCRGILT	6536.322	6864.75	7282.723	7838.979	8237.851	9073.16	10379.12	11326.89	12980.03	14482.1	17205.03
TOWNCL	112923	118597	125818	135428	142319	156750	179312	195686	224246	250196	297238
PORTA	13378.42	14157.65	15309.32	15716.98	16723.85	17814.26	19460.96	20646.77	22792.81	25147.54	28972.97
BCLEAR	146634	155083	163286	175173	183362	201804	228175	245183	275617	305155	358669

Variable	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	1289.199	1377.591	1492.918	1722.09	1283.558	1328.918	1362.278	1390.641	1413	1633	2001
	825.922	885.161	958.666	1115.353	0	0	0	0	0	0	0
TOCS	67.66	70.79	76.23	76.5	79.87	84.13	88.81	93.6	100.47	107.74	119.45
OGCS	32.3	36.48	39.56	42	41.07	43.75	45.35	49.17	49.76	55.27	62.67
TOFS	30.23	40.58	36.38	40.75	34.46	19.73	49.66	51.78	53.48	49.98	52.93
BPFS	23.024	24.46	25.62	26.6	28.4	26.83	28.08	29.25	30.95	35.32	38.27
	97.89	111.37	112.61	117.25	114.33	103.86	138.47	145.38	153.95	157.72	172.38
	55.324	60.94	65.18	68.6	69.47	70.58	73.43	78.42	80.71	90.59	100.94
TFPS	3848.348	4183.911	4731.479	5472.186	5350.073	5722.752	6639.064	7882.556	8724.826	12040.35	11762.87
TFGEXP	4822	6244	7482	8444	8751	9433	10639	11940	13447	18148	23457
TFGR	11924	13454	14973	16907	19013	21218	22583	23996	27024	33797	43041
TFGS	16746	19698	22455	25351	27764	30651	33222	35936	40471	51945	66498
TFCLG	1249	1481	1706	1898	2099	2450	2858	3233	3965	4726	7709
PCF	3533	3917	4068	4712	5095	5617	6458	7424	8984	10254	12120
Variable	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
BSDEP	1258.7	1495.5	1891.9	1960.2	2282.4	2890.2	3821.2	4965.8	5804.1	6126.7	8784.6
BSWITH	800.3	955.8	1087.7	1476.6	1744.1	1928.5	2444	3467.4	4574.2	5375.8	6119
BSDEPREC	86.9	87.3	105.6	108.4	115.2	136.7	235.1	335.6	255.8	254.1	369.8
BSDEPWITH	95.3	93.6	94.4	108.4	117.8	119.8	145.6	258.9	287.8	259.6	287.7
NSDEP	2335	2863.3	2769.6	2786.8	2907.9	3165.3	4254.8	4064.7	4233.1	4687.1	5799.4
NSWITH	2570.1	3090.9	2834.5	2956	3295.5	3210.8	3843	3793.5	4484	4815.1	5570.9
UTDEP	80.8	129.69	126.56	328.93	262.7	171.1	203.9	436.8	357.4	194.3	320.9
UTWITH	21.78	24.26	42.65	70.45	76.5	73.4	127.3	195.5	171.4	109.8	130.8
BSAD	955.4	1244.7	1462.7	1589.9	1588.7	1953.7	2705.3	3630.4	3512.7	2945.1	4908
MORTR	503.3	568.1	651.8	723.9	757.5	908.5	1124.5	1417.4	1526	1447.3	2134.2
MORTI	286.3	339.3	405.3	482.9	589.7	706.3	819.3	945.2	1282.9	1688.5	1929.3
	4551	5483.19	5950.76	6391.13	6915.4	7978.1	10458.8	12165.5	13459.3	14398	19338.2
	4442.88	5409.26	5521.95	6201.35	6822.6	7286.2	9265.2	11345.7	13030.1	13505.4	17016.4
TOSECRORD	3478.6	3566	5804	9118.3	8712.8	8812.6	13376.8	20065.7	17079.1	12616	17546.5
TOSECRGILT	15995.6	16606.9	27972	21034.6	19459.8	27349.8	47397.2	32743.4	35410.9	38262.4	67244.1
TOWNCL	346505	384473	485954	515727	606603	678581	738094	947372	1310885	1479238	1605547
PORTA	28468.08	31065.35	45248.71	42745.38	41910.6	51426.7	80498	76320.3	78979.4	78781.8	121145.2
BCLEAR	411576	455468	561858	599546	699192	773087	844350	1071833	1457238	1641088	1795833

Variable	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	2467	2863	3247	3741	4547	5079	5446	5952	6646	7837	9492	10893
	0	0	0	0	0	0	0	0	0	0	0	0
TOCS	129.09	143.22	159.39	189.66	218.63	251.2	266.77	293.09	355.64	341.83	379.67	410.92
OGCS	60.74	60.38	63.07	67.29	77.27	82.75	100.23	116.2	118.73	129.32	149.43	177.17
TOFS	15.22	52.78	75.13	86.77	104.98	127.7	166.55	200.21	248.79	296.22	125.12	545.385
BPFS	50.42	37.64	38.14	42.42	48	59.79	61.33	67.46	76.59	93.02	118.51	121.92
	144.31	196	234.52	276.43	323.61	378.9	433.32	493.3	604.43	638.05	504.79	956.305
	111.16	98.02	101.21	109.71	125.27	142.54	161.56	183.66	195.32	222.34	267.94	299.09
TFPS	12551.67	15543.54	17990.25	20759.3	23881.49	26659.58	29421.43	32152.94	35377.89	38756.95	42495.87	50014.28
TFGEXP	26185	27691	34291	41699	49640	57132	63823	66599	70544	76367	75485	76486
TFGR	50117	56958	63230	75688	92886	107604	119039	127590	136173	149416	156797	168785
TFGS	76302	84649	97521	117387	142526	164736	182862	194189	206717	225783	232282	245271
TFCLG	9367	9202	9976	11267	13240	15209	16213	18707	20251	20689	21813	23277
PCF	14389	17440	21293	25867	29081	29708	33073	34681	40807	47550	51457	61891
Variable	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BSDEP	10146.2	13549.3	15684.6	18849.4	21916.5	26126.9	32434.8	40204.5	54251.7	76151.5	83866.9	97503.5
BSWITH	8200.8	10183.9	12769.4	16313.6	19726.1	24373	28218	34813.3	47759	70444.9	79262.9	92024.6
BSDEPREC	407.8	783.4	670.1	678.4	1091.2	1571.5	2029.3	4801.4	11244.2	17924.9	28100.8	38325.7
BSDEPWITH	375.3	470.3	710.1	749	780.9	964.1	1389.2	3001.2	8996.1	16244.5	23329.2	35957.5
NSDEP	6434.4	5453.4	5731.8	2800.5	3913.1	5898.4	5211.8	5302.5	5701.2	4517.3	6521.8	6069.7
NSWITH	5786.1	4008.1	4982.5	2262.4	2520.7	3012.1	3698.2	3777.5	4649.3	4718.2	5341.2	6044.9
UTDEP	333.3	371.7	529.3	412	532	955	1157.51	2459.75	2918.2	4486.7	8716.7	14545.1
UTWITH	165.7	257.6	293.8	354	424	428.04	567.23	960.18	1476.7	1949.1	3482.1	8214.3
BSAD	6183.3	6741.1	8807.8	9002.8	9503.4	12005.3	15036.4	19346.5	23770.9	26530.8	35913.2	36034
MORTR	2422.9	2882.2	3614.8	3805.4	3867.9	5566.9	7214	8316.8	9345.2	11650.8	16976.3	19864.6
MORTI	2287.7	2706.1	2770.1	4082.5	5912.9	6398.1	7030.7	6845.9	8843.5	12027.6	12820	14306.7
	22032.3	25746.1	29000.7	30628.2	37233.6	46516.8	55078.11	67930.85	92304	126758.8	157002.5	190615.3
	20711.2	21661	27563.6	28681.8	32955.1	40782.54	48909.03	61898.68	86652	119887.5	147328.6	178275.3
TOSBCRORD	14162.9	20167.9	19214.6	24105.9	30801.4	32386.7	37414	56131	73119.1	105554.3	181211.4	283073.3
TOSBCRGILT	81924	135759.1	103678.8	128948.7	151698.2	146055.6	203389	210755.5	268679.2	261529	424414.8	1175851
TOWNCL	1980730	2336486	2544254	3258830	4051000	4404000	5292000	6258000	6922000	7464000	8173000	8325000
PORTA	138830.4	203334.1	179457.7	212364.6	252688.3	265741.6	344790.1	396716	520754.3	613729.6	909957.3	1827815
BCLEAR	2205286	2599495	2847030	3616555	4458326	4835414	5771350	6800818	7544555	8143884	8939234	9184717

Variable	1988	1989	1990	1991
	12605	14282	15242	16739
	0	0	0	0
TOCS	406.88	579.13	603.413	554.6
OGCS	192.28	207.12	372.211	381.124
TOFS	509.26	378.98	338.947	398.193
BPFS	149.544	178.62	194.189	261.425
	916.14	958.11	942.36	952.793
	341.824	385.74	566.4	642.549
TFPS	53291.85	65963.5	74129.76	84544.34
TFGEXP	75479	75887	78732	83566
TFGR	186200	199897	214222	220432
TFGS	261679	275784	292954	303998
TFCLG	23452	24043	27678	33720
PCF	77833	86770	87779	79084
Variable	1988	1989	1990	1991
BSDEP	111716.9	97386.2	98292.67	110232.8
BSWITH	100991.8	87744.1	89808	101864
BSDEPREC	58637.2	62271.1	62850.7	70485.48
BSDEPWITH	54924.7	54149.8	55422	62862
NSDEP	6995	5559.7	6406.5	4662.91
NSWITH	8488	9432	7339.8	6947.99
UTDEP	7675.7	10609	8610.6	10482.5
UTWITH	5880.4	6742.9	8219	7713.5
BSAD	47374.9	42032.2	43081	42948
MORTR	25002.8	37862.3	45098	47110
MORTI	15965.1	18395.5	24862	24168
	225992.7	232083.8	246120.5	267141.7
	217659.8	200101	203869.8	222335.5
TOSECRORD	191720.7	264228.2	205223.1	234116.5
TOSECRGILT	1129111	987640	973184.4	1112714
TOWNCL	7693000	6754000	4776000	
PORTA	1764484	1684053	1628398	1836307
BCLEAR	8646156	7784138	5865000	

Appendix D : Assets of Financial Institutions in Great Britain

	1964	1965	1966	1967	1968	1969	1970
Bank of England	2961	3187	3480	3633	3841	3945	3989
Deposit Banks	29524	31037	32825	34267	36774	38145	35531
P.O. savings banks	1823	1837	1840	1730	1664	1598	1497
Trustee Savings Banks	900	1011	1126	1237	1366	1401	1503
Discount Houses	1283	1455	1565	1747	1663	1817	2352
Building Societies	4862	5531	6305	7445	8298	9289	10818
Hire Purchase Companies	1280	1386	1313	1273	1319	1299	1383
Investment and Trust Co.	3293	3619	3586	4800	6932	6246	5785
Life insurance companies	1458	1561	1639	1719	1812	1896	1975
Collecting societies	378	399	416	435	451	469	489
Industrial and Provident Soc.	1246	1330	1384	1457	1485	1564	1679
Friendly Societies	281	288	304	315	329	335	328
Private Superannuation funds	2985	3293	3365	3879	4648	4468	4673
Superannuation funds, local authorities	791	814	838	907	1086	1220	1246
Other public superannuation funds	1071	1145	1182	1434	1746	1699	1846
National Insurance funds	200	225	212	121	246	160	217
Total	54336	58118	61380	66399	73660	75551	75311
Total non-bank assets (TNBFA)	48561	52055	55010	60008	66823	68628	68362
Ratio	0.893717	0.895678	0.89622	0.903749	0.907182	0.908367	0.907729
17th May 1992							

Appendix D Continued

	1971	1972	1973	1974	1975	1976	1977	1978
Bank of England	4153	3995	6009	7120	7916	9522	10262	11401
Deposit Banks	39623	53234	74693	88153	107682	136274	144850	167408
P.O. savings banks	1474.7	1475	1517	1534	1539	1551	1549	1722
Trustee Savings Banks	1670	1917	2069	2094	2269	2555		
Discount Houses	3066	2618	2517	2821	2814	2869	3934	4308
Building Societies	12919	15246	17545	20093	24203	28202	34288	39538
Hire Purchase Companies	1623	2047	2550	2986	3423	3860	4750	6234
Investment and Trust Co.	7563	9826	7102	4142	7680	8016	9450	9934
Life insurance companies	2082	2179	2299	2187	2430	2581	2814	3081
Collecting societies	511	532	558	582	604	628	671	721
Industrial and Provident Soc.	1744	2007	2144	2337	2856	3579	4439	5342
Friendly Societies	349	372	385	400	427	392	407	444
Private Superannuation funds	6175	7109	7489	6307	9642	11847	16983	20253
Superannuation funds, local authorities	1317	1845	1587	1630	2330	3072	3867	5135
Other public superannuation funds	2523	3060	2813	2521	4333	5795	8301	10586
National Insurance funds	206	341	586	1212	2278	3237	3927	4197
Special Finance corporations								
Total	86998.7	107803	131863	146119	182426	223980	250492	290304
Total non-bank assets (TNBFA)	79848	100147	122164	134623	168363	206598	230887	267849
Ratio	0.917807	0.928982	0.926446	0.921324	0.922911	0.922395	0.921734	0.92265

Appendix D (continued)

	1979	1980	1981	1982	1983	1984	1985
Bank of England	12100	11787	13064	14029	14516	15215	14948
Deposit Banks	199591	233403	332039	411602	480369	604477	589880
P.O. savings banks	1848	1821	1740	1702	1734	1757	1734
Discount Houses	4909	5305	5084	5459	6953	8096	8713
Building Societies	45789	53792	61814	73032	85868	102688	120763
Hire Purchase Companies	7989	9126	9769	9657	11851	13984	17416
Investment and Trust Co.	10596	12981	14273	17360	24214	29248	36518
Life insurance companies	3463	3930	4400	4969	5552	6287	6924
Collecting societies	793	877	980	1075	1177	1336	1470
Industrial and Provident Soc.	6311	7456	8820	10400	11761	13330	14937
Friendly Societies	488	545	613	719	851	1023	1227
Private Superannuation funds	24948	33102	38831	51310	66591	84924	111740
Superannuation funds, local authorities	5373	7518	8635	11268	14316	17982	20765
Other public superannuation funds	12050	15653	18684	24329	30468	36384	35554
National Insurance funds	4752	5277	4194	4164	4742	5165	5379
Total	341000	402573	522940	641075	760963	941896	987968
Total non-bank assets (TNBFA)	316927	376170	495307	609912	725655	901777	945142
Ratio	0.929405	0.934414	0.947158	0.951389	0.953601	0.957406	0.956652

Appendix D (continued)

	1986	1987	1988	1989
Bank of England	15888	16963	18815	21940
Deposit Banks	704158	728649	816592	1014290
P.O. savings banks	1686	1668	1658	1633
Discount Houses	9539	11566	12015	15276
Building Societies	140602	160096	188844	187012
Hire Purchase Companies	19910	36412	42086	46255
Investment and Trust Co.	51000	53037	59147	79616
Life insurance companies	7527	8190	8832	9786
Collecting societies	1613	1754	1877	2449
Industrial and Provident Soc.	15645	18660	19811	22677
Friendly Societies	1233	1657	2016	2217
Private Superannuation funds	141844	161319	198994	265028
Superannuation funds, local authorities	25401	26470	29289	37669
Other public superannuation funds	43975	39612	43973	48414
National Insurance funds	5879	7481	10635	10580
Total	1185900	1273534	1454584	1764842
Total non-bank assets (TNBFA)	1137046	1220952	1394187	1693020
Ratio	0.958804	0.958712	0.958478	0.959304
17th May 1992				

Appendix E:
Provisional Johansen Vectors for Income Velocity

120 observations from 1872-1991 Maximum Lag in VAR = 2 List of variables included in cointegrating vector: ln V1, ln(Y/PN)^P, RL, ROWN, ln(TNBFA/TFA), ln(C/M), ln BANKS				
List of eigenvalues in descending order: 0.33767 0.29132 0.22378 0.15327 0.084214 0.058970 0.002694				
LR Test Based on Maximal Eigenvalue of the Stochastic Matrix (with trend in DGP)				
Null	Alternative	Statistic	95% critical value	90% critical value
r=0	r>=1	49.4388	45.2770	42.3170
r<=1	r>=2	41.3216	39.3720	36.7620
r<=2	r>=3	30.3989	33.4610	30.9000
r<=3	r>=4	19.9647	27.0670	24.7340
r<=4	r>=5	10.5567	20.9670	18.5980
r<=5	r>=6	7.2936	14.0690	12.0710
r<=6	r>=7	0.0323	3.7620	2.6870
LR Test Based on Trace of Stochastic Matrix				
r=0	r>=1	159.0066	124.2430	118.500
r<=1	r>=2	109.5678	94.1550	89.483
r<=2	r>=3	68.2462	68.5240	64.843
r<=3	r>=4	37.8474	47.2100	43.949
r<=4	r>=5	17.8827	29.6800	26.785
r<=5	r>=6	7.3260	15.4100	13.325
r<=6	r>=7	0.0323	3.7620	2.687

Sample 1872-1991 Maximum lag in VAR = 2				
Variable	Vector 1	Vector 2		$\chi^2(2)$
ln V1	-1.00000	-1.000000		
$\ln(Y/PN)^P$	0.78104	0.829100		10.8834
RL	0.22635	-0.064927		9.4725
ROWN	-0.45409	0.028552		18.2855
ln(TNBFA/ TFA)	7.93210	3.738400		11.0375
ln(C/M)	-0.57085	0.837210		8.2612
ln BANKS	-0.34075	-0.255580		8.4603
				critical value $\chi^2(2)$ = 5.991

120 observations from 1872-1991 Maximum Lag in VAR = 2 List of variables included in cointegrating vector: ln V1, ln(Y/PN)^P, RL, ROWN, ln(TNBFA/TFA), ln(C/M)				
List of eigenvalues in descending order: 0.32996 0.22364 0.17485 0.10015 0.065913 0.0024831				
LR Test Based on Maximal Eigenvalue of the Stochastic Matrix (with trend in DGP)				
Null	Alternative	Statistic	95% critical value	90% critical value
r=0	r>=1	48.0502	39.3720	36.7620
r<=1	r>=2	30.3760	33.4610	30.9000
r<=2	r>=3	23.0621	27.0670	24.7340
r<=3	r>=4	12.6626	20.9670	18.5980
r<=4	r>=5	8.1822	14.0690	12.0710
r<=5	r>=6	0.2983	3.7620	2.6870
LR Test Based on Trace of Stochastic Matrix				
r=0	r>=1	122.6315	94.1550	89.4830
r<=1	r>=2	74.5813	68.5240	64.8430
r<=2	r>=3	44.2053	47.2100	43.9490
r<=3	r>=4	21.1432	29.6800	26.7850
r<=4	r>=5	8.4806	15.4100	13.3250
r<=5	r>=6	0.2983	3.7620	2.6870

Sample 1872-1991 Maximum lag in VAR = 2				
Variable	Vector 1	Vector 2		$\chi^2(2)$
ln V1	-1.00000	-1.00000		
$\ln(Y/PN)^P$	0.40231	-2.92400		3.3399
RL	0.41806	0.47320		10.0013
ROWN	-0.74121	0.10252		20.7612
ln(TNBFA/ TFA)	11.04440	-14.41700		3.5100
ln(C/M)	-1.58620	-3.6346		3.1154
				critical value $\chi^2(2) = 5.991$

APPENDIX F

Time Series Properties of Proposed Short Run Relationship Variables
(Wealth, Interest Rates, and Prices)

Variable	Φ_1	Φ_2	Φ_3	t_{α} (constant)	t_{time}	type	I(0)	I(1)	I(2)	I(3)	k
ln(Y/PN)'	2.7756 (4.71)	7.9401 (4.88)	1.4266 (6.49)	1.6416 (1.96)	1.6660 (1.96)	non trended	0.27642 (-2.8855)	-6.3422 (-2.8857)			2
ln PCONR	1.5487 (4.71)	9.5261 (4.88)	0.81336 (6.49)	1.2191 (1.96)	1.2445 (1.96)	non trended	0.27869 (-2.8857)	-5.9122 (-2.8859)			2
ln CYCLE	0.58174 (4.71)	18.2004 (4.88)	27.2608 (6.49)	-4.7210 (1.96)	0.76272 (1.96)	non trended	-7.3575 (-2.8855)				1
RS	3.9449 (4.71)	1.6834 (4.88)	2.4410 (6.49)	-0.48254 (1.96)	1.9862 (1.96)	non trended	-0.62195 (-2.8857)	-6.4275 (-2.8859)			2
RL	5.0288 (4.71)	2.3541 (4.88)	2.7716 (6.49)	0.18393 (1.96)	2.2425 (1.96)	non trended	-0.72186 (-2.8857)	-6.0796 (-2.8859)			2
ROWN	3.7851 (4.71)	1.5008 (4.88)	2.1153 (6.49)	-0.73975 (1.96)	1.9455 (1.96)	non trended	-0.072813 (-2.8857)	-6.4912 (-2.8859)			2
RFORG	0.59541 (4.71)	0.76487 (4.88)	0.30405 (6.49)	-1.2321 (1.96)	0.77163 (1.96)	non trended	-2.6187 (-2.8868)	-7.2588 (-2.8870)			1
ln PD	3.7858 (4.71)	4.0931 (4.88)	3.4389 (6.49)	-1.0067 (1.96)	1.9457 (1.96)	non trended	1.7690 (-2.8857)	-3.6997 (-2.8857)			1
ln PQD	3.9989 (4.71)	13.6095 (4.88)	20.4123 (6.49)	6.38917 (1.96)	1.9997 (1.96)	trended	-6.3836 (-3.4475)				1
ln (W/P)	8.9403 (4.71)	7.3555 (4.88)	10.8587 (6.49)	-3.3955 (1.96)	2.9900 (1.96)	trended	-4.5909 (-3.4475)				1

Time Series Properties of Proposed Short Run Relationship Variables
(G.D.P. and Monetary Shocks)

Variable	Φ_1	Φ_2	Φ_3	t_a (constant)	t_{time}	type	I(0)	I(1)	I(2)	I(3)	k
ln STL	1.3622 (4.71)	5.1642 (4.88)	7.6161 (6.49)	-1.3544 (1.96)	-1.1671 (1.96)	non trended	-3.7172 (-2.8906)				1
INVR	0.048926 (4.71)	0.019925 (4.88)	7.12703 (6.49)	-0.16822 (1.96)	0.22119 (1.96)	non trended	-7.6557 (-2.8855)				1
ln MR	2.6532 (4.71)	3.15071 (4.88)	1.3284 (6.49)	1.5644 (1.96)	1.62891 (1.96)	non trended	-0.060332 (-2.8857)	-6.7269 (-2.8859)			1
ln TAXR	0.022431 (4.71)	1.8319 (4.88)	1.5916 (6.49)	-0.32480 (1.96)	0.14977 (1.96)	non trended	-1.7856 (-2.8859)	-5.9201 (-2.8861)			3
YRGAP	0.010446 (4.71)	0.22580 (4.88)	0.0059079 (6.49)	-0.30197 (1.96)	-0.10221 (1.96)	non trended	-2.1112 (-2.8857)	-6.8909 (-2.8859)			2
MDEV	0.082553 (4.71)	0.22829 (4.88)	0.052457 (6.49)	0.12180 (1.96)	0.28732 (1.96)	non trended	-1.0446 (-2.8855)	-7.8682 (-2.8857)			1

Time Series Properties of Proposed Short Run Relationship Variables
(Institutional Factors)

Variable	Φ_1	Φ_2	Φ_3	t_a (constant)	t_{time}	type	I(0)	I(1)	I(2)	I(3)	k
Monetization											
ln (C/M)	2.0980 (4.71)	1.4159 (4.88)	1.2055 (6.49)	0.11300 (1.96)	-1.4485) (1.96)	non trended	0.55680 (-2.8855)	-5.1400 (-2.8857)			1
ln (C/D)	0.96251 (4.71)	0.85044 (4.88)	0.69462 (6.49)	-0.28272 (1.96)	-0.98108 (1.96)	non trended	-0.65336 (-2.8857)	-4.7443 (-2.8859)			2
ln BANKS	6.7143 (4.71)	8.0461 (4.88)	9.2407 (6.49)	0.14116 (1.96)	-2.5912 (1.96)	trended	0.28968 (-3.4475)	-6.4618 (-3.4478)			1
ln(LNA/L)	6.1457 (4.71)	9.6947 (4.88)	7.5561 (6.49)	-2.3315 (1.96)	2.4791 (1.96)	trended	-3.0522 (-3.4478)	-3.1865 (-3.4478)	-10.7449 (-3.4481)		1
ln POMPT	0.11919 (4.71)	2.4862 (4.88)	3.3097 (6.49)	2.0618 (1.96)	-0.34524 (1.96)	non trended	-2.5592 (-2.8855)	-3.3761 (-2.8857)			1
Financial Sophistication											
ln (TNBFA/ TFA)	2.1917 (4.71)	1.0489 (4.88)	1.5035 (6.49)	-1.3970 (1.96)	1.4804 (1.96)	non trended	-0.89857 (-2.8857)	-3.8539 (-2.8859)			2
Economic Stability											
ln YSD	0.80166 (4.71)	3.1317 (4.88)	4.6641 (6.49)	2.5814 (1.96)	-0.89536 (1.96)	non trended	-2.9225 (-2.8855)	-8.4707 (-2.8857)			1
ln SSG	4.9280 (4.71)	10.4401 (4.88)	8.9379 (6.49)	1.4629 (1.96)	2.2199 (1.96)	non trended	-3.5394 (-2.8855)	-8.0043 (-2.8857)			
ln TG	2.9675 (4.71)	2.8527 (4.88)	3.4762 (6.49)	-2.1169 (1.96)	1.7227 (1.96)	non trended	-2.6218 (-2.8855)	-6.7937 (-2.8857)			1
ln TGDEF	10.7650 (4.71)	8.5958 (4.88)	12.7328 (6.49)	4.3590 (1.96)	3.2810 (1.96)	non trended	-3.6835 (-2.8855)				1

Time Series Properties of Proposed Short Run Relationship Variables (Financial Innovation)

Variable	Φ_1	Φ_2	Φ_3	t_α (constant)	t_{time}	type	I(0)	I(1)	I(2)	I(3)	k
ln ATM (1970-1991)	0.09491 (4.86)	3.0607 (5.13)	3.1260 (6.73)	0.34681 (1.96)	0.30812 (1.96)	non trended	-0.20378 (-2.9202)	-2.8800 (-2.9202)	-5.8738 (-2.9215)		1
ln CCARD (1966-1991)	1.0555 (4.86)	4.2978 (5.13)	3.9309 (6.73)	1.0705 (1.96)	1.0274 (1.96)	non trended	-0.47056 (-2.91967)	-3.3818 (-2.9167)			1
ln BSSARN (1945-1991)	1.2317 (4.86)	4.0243 (5.13)	5.9616 (6.73)	-1.2880 (1.96)	1.1098 (1.96)	trended	-1.7947 (-2.92256)	0.99433 (-3.5088)	-3.4615 (-2.9271)		3
ln RSMAX (1870-1991)	2.6521 (4.71)	3.0172 (4.88)	1.6753 (6.49)	0.95837 (1.96)	1.6285 (1.96)	non trended	0.82978 (-2.8857)	-6.6823 (-2.8859)			2
ln RSMP (1935-1991)	0.070803 (4.86)	0.053635 (5.13)	0.073140 (6.73)	-0.083498 (1.96)	0.25691 (1.96)	non trended	-0.36293 (-2.9190)	-6.4915 (-2.967)			2
ln FTEY (1940-1991)	0.075544 (4.86)	0.56818 (5.13)	0.81426 (6.73)	0.36004 (1.96)	0.15184 (1.96)	non trended	-1.2681 (-2.9179)	-9.3021 (-2.967)			1
ln TLSR (1945-1991)	2.2248 (4.86)	1.1392 (5.13)	1.6172 (6.73)	1.5373 (1.96)	-1.4916 (1.96)	non trended	-1.7639 (-2.9190)	-5.5279 (-2.967)			2

Footnotes

Chapter 3

1. It is interesting to note the parameter instability between equation 3.8 (sample 1909-1958) and equation 3.15 (sample 1880-1970).

Chapter 4

1. For a full definition and derivation of the following terms, the reader should refer to Pesaran and Pesaran (1991), Appendix B.19.1 Estimation and hypothesis testing in cointegrated systems by the Johansen method - ML estimation and cointegration tests, pages 222-223.

2. Microfit 3.0 does not allow for full implementation of the Johansen literature. Therefore the long-run model and short-run model cannot be solved simultaneously. This could have been achieved using the RATS software, but this was unavailable. Here, the Johansen vectors residuals were saved, and then entered as a lagged variable using OLS for the short-run dynamic equations.

Chapter 5

This was a document published by the Bank of England in May 1971. It had three aims, i) to increase competition in the Banking Sector, ii) to improve the bank regulatory system to help demand management policy, iii) measures to help the monetary authorities control the money supply. For a full discussion and the implications of CCC see Gowland (1984) and Hall (1983).

Chapter 7

1. The absence of inflation in the long run equation stems from its origins. It is derived from a permanent income long-run demand for money function, (see Bordo and Jonung 1981, 1987, 1990), defined in real terms as:

$$\log(M/PN) = A_o + A_1 \log(Y/PN)^P + A_2 i + e \qquad \text{(A1)}$$

where (M/PN) = real money balances per capita, $(Y/PN)^P$ = permanent income per capita, and i is an interest rate.

It follows from this analysis that the demand for money is a demand for real balances. That is the demand for nominal money is proportional to the general price level.

Let us now define the velocity of circulation in similar terms.

$$\log V = \log(Y/PN) - \log(M/PN) \qquad \text{(A2)}$$

So velocity equals real income per capita divided by real money balances per capita.

Substituting (A1) into (A2) gives

$$\log V = \log(Y/PN) - A_0 - A_1\log(Y/PN)^P - A_2 i + e \qquad (A3)$$

this can also be written as:

$$\log V = -A_0 + (1+A_1)\log(Y/PN)^P - A_2 i + \log(Y/Y^P) + e \qquad (A4)$$

The term (Y/Y^P) is the ratio of measured to permanent real per capita income, (defined as cycle elsewhere in the thesis). Bordo and Jonung (1987) use this proxy to avoid the problem of calculating permanent prices independently from permanent income. This is useful when price expectations vary greatly over a sample. (see Klein, 1977).

However, in the long run;

$$Y = Y^P \qquad (A5)$$

so that

$$(Y/Y^P) = 1 \qquad (A6)$$

As the logarithm of one is zero, equation (A4) becomes;

$$\log V = - A_0 + (1-A_1)\log(Y/PN)^P - A_2 i + e \qquad (A7)$$

With the addition of the institutional terms, this equation becomes the initial starting point of analysis of the long run relationship, and explains why P does not enter explicitly.

2. Full definition and sources of all variables can be found in appendix A.

3. The actual statistical results can be found in appendix E.

<u>Chapter 8</u>

1. The foreign portfolio term for the United States was also considered but was not pursued as it did not improve the empirical results.

<u>Chapter 9</u>

1. If one accepts that TG is moving counter cyclically to velocity, representing the stabilization role of central government.

2. Estimation of the specification omitting ΔTG and ΔPD resolve the misspecification problem but create additional statistical problems.

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