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Employment Growth, Inflation and Output Growth: Was Phillips Right? Evidence from a Dynamic Panel

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Employment Growth, Inflation and Output Growth: Was Phillips Right? Evidence from a Dynamic Panel

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Abstract

In this paper we analyse the short- and long-run relationship between employment growth, inflation and output growth in Phillips' tradition. For this purpose we apply FMOLS, DOLS, PMGE, MGE, DFE, and VECM methods to a nonstationary heterogeneous dynamic panel including annual data for 119 countries over the period 1970-2010, and also carry out multivariate Granger causality tests. The empirical results strongly support the existence of a single cointegrating relationship between employment growth, inflation and output growth with bidirectional causality between employment growth and inflation as well as output growth, giving support to Phillips' Golden Triangle theory.

Key words: Employment Growth, Inflation, Output Growth, Golden Triangle theory

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I. INTRODUCTION

In his famous contributions Phillips (1958, 1962) emphasised the importance of analysing the quantitative relationship between employment growth, inflation and output growth (the three nodes of the so-called Golden Triangle's internal equilibrium). In his model macroeconomic instability and failures with the associated problems (unemployment, inflation and stagnation) arise when economies move along a non-optimal (golden disequilibrium) path: unless the quantitative dynamic relationships between these variables are known exactly by policy makers, their actions are likely to result in an "overshooting" or "undershooting" of the targeted "equilibrium". Moreover, without this knowledge, it is not even possible to choose optimally the particular inflation rate, level of economic activity or "natural rate of unemployment" that should be targeted. Finally, a proper understanding of the employment/inflation/output relationship might also be instrumental to avoiding or at least alleviating cycles.

This paper is a comprehensive study of both the short- and long-run relationships between these three variables. It contributes to the literature on the Golden Triangle theory by analysing annual data for a panel of 119 countries over the period 1970-2010, and applying state-of-the art econometric methods for nonstationary heterogeneous panels. Specifically, the Nyblom-Harvey, Fisher-Johansen, Pedroni, Westerlund and Kao multivariate cointegration tests are carried out, and the cointegrating vectors are estimated using FMOLS, PMGE, MGE, DFE, VECM methods to deal with possible endogeneity and stationarity issues. Moreover, causality tests are conducted in the context of a panel VECM.

The layout of the paper is as follows. Section 2 briefly reviews the relevant literature. Section 3 describes the data and the econometric framework. Section 4 presents the empirical results. Section 5 offers some concluding remarks.

II. LITERATURE REVIEW

The two seminal studies by Phillips on the relationship between unemployment and the rate of change of nominal wages in the United Kingdom (1958) and that between employment growth, inflation, and output growth (1962) are amongst the most frequently cited articles in economics. Famously, Phillips (1962) argued:

"It is my belief that one of the main reasons for the difficulties that have been experienced in devising and implementing appropriate economic policies is lack of adequate quantitative knowledge and understanding on how the economic system works. (…) But in order to bring this knowledge to bear on the problem of formulating and attaining a consistent set of policy objectives we require also knowledge of the quantitative relations between economic variables. In particular it is necessary to know what quantitative relations hold between those economic variables which are either the objectives of policy or the instruments through which we attempt to attain the objectives."

Several studies have subsequently analysed the relationship between unemployment and gross domestic product, unemployment, and inflation. A few examples are Okun (1981) and Tobin (1982, 1987, 1996), who focused on the inflation-unemployment trade-off, whilst Kaldor (1992) examined the role of wages, and Phelps (1967, 1998) and Friedman (1968, 1971) highlighted the disagreement on the role of different policy instruments in achieving the goals of economic policy. Related papers are Gordon (1991, 1977), Phelps and Zoega (1998), Nickell (1998), Lorenzoni (2010), Acemoglu et al. (1994), Adams and Coe (1990), Aguiar and Martins (2005), Altig et al. (1997), Apergis and Rezitis (2003), Okun (1980), Samuelson (2008), and Thirlwall (1969). Among very recent empirical studies Hooker (2002) and Nakov and Pescatori (2010) both offer evidence of a backward-looking Phillips' curve for countries other than the US. Only few papers exist on the simultaneous relationship between all three variables (employment growth, inflation and output growth) – see Raurich and Sorolla, 2000, and Scott and McKean, 1964.

III. DATA AND ECONOMETRIC METHODS

A. Data

Our dataset is a balanced panel with annual data on employment, prices and output from 1970 to 2010 for 119 countries.[i] The variables are in annual percentage changes. The data sources are the USDA International macroeconomic dataset (historical data files) and the Conference board total economy database 2011.

B. Econometric Methods and Models

We investigate the relationship between y_{it}, the annual growth rate of real output in country i and year t; p_{it}, the annual inflation rate, and e_{it}, the annual growth rate of employment, estimating the following model:

$$y_{it} = \beta_{0i} + \beta_{1i} p_{it} + \beta_{2i} e_{it} + u_{it} \tag{1}$$

where u_{it} is the error term. Since we want to explore the direction of causality as well we also specify the models

$$p_{it} = \beta_{0i} + \beta_{1i} y_{it} + \beta_{2i} e_{it} + u_{it} \tag{2}$$

and

$$e_{it} = \beta_{0i} + \beta_{1i} p_{it} + \beta_{2i} y_{it} + u_{it} \tag{3}$$

As a first step, the order of integration of the series should be established by means of panel unit root tests. Then, if the evidence suggests nonstationarity of the variables, the existence of cointegrating relationships between them should be tested to justify the above specifications. Subsequently, Granger causality tests can also be carried out to analyse the causal linkages between these three variables.

B1. Unit Root Tests

To check the stationarity of the series in the panel under cross-sectional dependence we use first- and second-generation unit root tests (see Im, Pesaran and Shin, (2003). First-generation panel unit roots tests include Levin and Lin (1992,1993), Levin, Lin and Chu (2002), Harris and Tzavalis (1999), Im, Pesaran and Shin (1997, 2002, 2003), Maddala and Wu (1999), Choi (1999, 2001), Hadri (2000), whilst second-generation tests are those of Bai and Ng (2001, 2004), Moon and Perron (2004a), Phillips and Sul (2003a), Pesaran (2003, 2007), Choi (2002), Breitung and Das (2005).

The Levin and Lin (1992, 1993) test takes the form (LLC)

$$\Delta y_{i,t} = \alpha_i + \rho y_{i,t-1} + \sum_{z=1}^{p_i} \beta_{i,z} \Delta y_{i,t-z} + \varepsilon_{i,t} \quad (4)$$

under the unit root null.

The Im, Pesaran and Shin (IPS) test allowing for heterogeneity in ρ_i (Christophe Hurlin, Valerie Mignon, 2006) is specified as follows:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,y-1} + \sum_{z=1}^{p_i} \beta_{i,z} \Delta y_{i,t-z} + \varepsilon_{i,t} \quad (5)$$

Breitung (2000) developed the following t-ratio test for the presence of non-stationarity in the panel data

$$\Delta y_{it} = s_t \left[\Delta y_{it} - \frac{1}{T-t} (\Delta y_{it+1} + \ldots + \Delta y_{iT}) \right] \quad (6)$$

although Moon, Perron and Phillips (2006) pointed out the limitations of this test in terms of asymptotic power properties.

Hadri (2000) proposed a different panel unit root test based on the null of stationarity allowing for individual specific variances and correlation patterns. His test takes the form

$$y_{it} = \delta_{mi} d_{mt} + \varepsilon_{it} \tag{7}$$

Hlouskova and Wagner (2006) showed that Hadri's test tends to reject stationarity most of the times in the presence of autocorrelation. Baum (2001) proposed a more powerful version of this test (under the null that the error process is homoscedastic across the panel or heteroscedastic across countries and there is serial dependence in the disturbances). Maddala and Wu (1999)) proposed a Fisher's type test based on p-values from individual root tests taking the form (ADF)

$$-2\sum_{i=1}^{N}(\ln p_i) \sim \chi^2(2N) \tag{8}$$

while Choi (2001) adopted the following specification (PP):

$$P_m = \frac{1}{2\sqrt{N}} \sum\nolimits_{i=1}^{N} (-2\ln p_i - 2) \tag{9}$$

Finally, Pesaran (2007) suggested using instead a cross-sectionally augmented IPS test (CIPS)

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} t_i^{*}(N,T) \tag{10}$$

which is valid under cross-sectional dependence and individual-specific error serial correlation. Breitung and Westerlund (2009) as well as Eberhardt (2009) discuss panel unit root tests in the presence of parameter heterogeneity, cross-section dependence, and especially the issue of cross-section cointegration.

All unit root test results are presented in Table A1. We find evidence of both stationary and non-stationary individual country series. Using Baum's version of Hadri's test the null of stationarity in our panel is rejected at the 1% level under homoscedastic, heteroscedastic and serial dependence assumptions. Overall, the unit root test results are inconclusive owing to the fact that the panel includes a mixture of I(0) and I(1) series. Breuer and McNown (2003) discuss the low power of panel unit root tests in such a case, and Westerlund (2008) shows that the empirical failure to reject the unit root null does not definitely establish its presence. Because of the mixed unit root test results we test for possible cointegration using Pedroni's (2001) FMOLS and DOLS individual and panel tests. The results (not reported here for reasons of space) overwhelmingly reject the null hypothesis of no cointegration between employment growth, inflation and output growth (only for three countries in the panel the null of no cointegration cannot be rejected). Given the evidence of nonstationarity provided by Hadri's test under heterogeneity and serial correlation and that of cointegration produced by Pedroni's FMOLS and DOLS tests, we carry out further cointegration tests under the assumption that the individual series are I(1).

B2. Testing for Cointegration and Dynamic Panel Data Estimation

We test for the existence of a long-run relationship between employment growth, inflation and output growth using the Nyblom-Harvey, Fisher-Johansen, Pedroni, Westerlund and Kao cointegration tests. The panel cointegration test results are presented in Table A2 with the lag length chosen on the basis of the Akaike information criterion (AIC) with individual intercepts and trends.

Nyblom and Harvey (2000) test for common stochastic trend in the panel under the null of zero common trends as a proxy for cointegration relationship. Their test takes the form

$$\kappa_{\perp} = \frac{1}{T^2}\sum_{t=1}^{T} S_t'\hat{\Xi}^{-1}S_t \xrightarrow{d} \int_0^1 W(s)'W(s)ds \tag{11}$$

to test for common trends among the variables.

Maddala and Wu (1999) develop a Fisher and Johansen test of the form:

$$\Delta Y_{i,t} = \Pi_i y_{i,t-1} + \sum_{k=1}^{n} T_k \Delta Y_{i,t-k} + u_{i,t} \tag{12}$$

Pedroni's (2001) tests for cointegration are based on the estimated residual as follows:

$$e_{it} = \rho_i e_{it-1} + \sum_{j=1}^{p_i} \psi_{ij}\Delta e_{it-1} + \upsilon_{it} \tag{13}$$

Kao (1999) developed a similar residual-based panel cointegration test under the null that the residuals are nonstationary with homogenous variance of the innovation process ε_{it}

$$\hat{\varepsilon}_{it} = \rho\hat{\varepsilon}_{it-1} + \sum_{j=1}^{p} \upsilon_j \Delta\hat{\varepsilon}_{it-j} + v_{it} \tag{14}$$

Persyn (2008) and Westerlund (2007) suggest an error-correction panel cointegration test for the presence of cointegration both at country and panel level:

$$\Delta y_{it} = \delta_i' d_t + \alpha_i y_{it-1} + \lambda_i' x_{it-1} + \sum_{j=1}^{p_i} \alpha_{ij}\Delta y_{it-j} + \sum_{j=0}^{p_i} \gamma_{ij}\Delta x_{it-j} + e_{it} \tag{15}$$

The test results strongly reject the null of no cointegration in favour of the existence of a long-run relationship between employment growth, inflation and output growth in the panel, consistently with the previously discussed panel FMOLS and DOLS findings. Having established cointegration, we estimate the long-run models (1), (2) and (3) using FMOLS (fully modified OLS), DOLS (dynamic OLS), PMGE (pooled mean group estimator), MG (mean group) and DFE (dynamic fixed effect) methods. Following Pedroni (2001), the FMOLS estimator corrected for heterogeneity (in the fixed effects and the short run) and the OLS estimator adjusted for serial correlation take the form

$$\hat{\beta}^{*}_{NT} - \beta = \left(\sum_{i=1}^{N} \hat{L}^{-2}_{22i} \sum_{t=1}^{T} (x_{it} - \overline{x}_i)^2 \right)^{-1} \sum_{i=1}^{N} \hat{L}^{-1}_{11i} \hat{L}^{-1}_{22i} \left(\sum_{i=1}^{T} (x_{it} - \overline{x}_i) \mu^{*}_{it} - T\hat{\gamma}_i \right) \quad (16)$$

where $\hat{L}_i$ is a lower triangular decomposition of the covariance matrix Ω_I, Γ_I a weighted sum of autocovariances, with $\hat{L}_{11i} = (\Omega_{11i} - \Omega^2_{21i} / \Omega_{22i})^{1/2}$ and $L_{22i} = \Omega^{1/2}_{22i}$ are the long-run standard errors of the conditional process. Here $\hat{\beta}_{NT}$ is a fully modified estimator (FMOLS) with the individual specific mean of the form

$$\mu^{*}_{it} = \mu_{it} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \Delta x_{it}, \hat{\gamma}_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}^{o}_{21i} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} (\hat{\Gamma}_{22i} + \Omega^{o}_{22i}) \quad (17)$$

Pedroni (2001) proposes a dynamic OLS estimator (DOLS) of the form

$$\hat{\beta}_{i,DOLS} = \left[N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} z_{it} z'_{it} \right)^{-1} \left(\sum_{t=1}^{T} z_{it} \overline{y}_{it} \right) \right]_1 \quad (18)$$

where z_{it} is the 2(K+1) x 1 vector of regressors

$$z_{it} = \left\{ (x_{it} - \overline{x}_i), \Delta x_{it-K}, ..., \Delta x_{it+K} \right\}; \tilde{y}_{it} = y_{it} - \overline{y}_i$$

correcting for endogeneity and serial correlation in the panel by including leads and lags of differenced I(1) regressors. Since we are interested not only in the long-run equilibrium relationship but also in short-run and Granger causality relations between the variables we use PMG, MG, DSE and VECM estimations methods as well. Following the approach of Pesaran, Shin (1995) and Smith (1999) for nonstationary dynamic panels with heterogeneous parameters we estimate our dynamic panel using MG, PMG and DSE in the form:

$$\Delta y_{it} = \phi(y_{i,t-1} - \phi_i' X_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta'^*_{ij} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \quad (19)$$

Following Pesaran, Shin and Smith (1999) we estimate an ARDL(2,2,2) model

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}' x_{i,t-j} + \gamma_i' d_t + \varepsilon_{it} \quad (20)$$

where i = 1, 2,…, 119 stands for the country; t = 1,2,…,41 for the time period; x_{it} = (k × 1) and d_t (s × 1) for the vectors of explanatory variables (regressors).

Re-parameterising (19) we obtain an error correction model of the form

$$\Delta y_{it} = \phi_i y_{i,t-1} + \beta_i' x_{it} + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*'} \Delta x_{i,t-j} + \gamma_i' d_t + \varepsilon_{it}$$

where $\phi_i = -(1 - \sum_{j=1}^{p} \lambda_{ij}),\ \beta_i = \sum_{j=0}^{q} \delta_{ij},\ \lambda_{ij}^* = -\sum_{m=j+1}^{p} \lambda_{im},\ j = 1,..., p-1$ (21)

$$\text{and } \delta_{ij}^* = -\sum_{m=j+1}^{q} \delta_{im},\ j = 1,..., q-1,\ i = 1,..., N$$

Following the work of Engle and Granger (1987) we specify a VECM panel model to examine Granger causality relationship between employment growth, inflation and output growth. As in Pedroni (1999, 2004) we estimate the long-run relationship as follows:

$$y_{i,t} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + ... + \beta_{Mi} x_{Mi,t} + e_{i,t} \quad (22)$$

for $t = 1,…,T;\ i = 1,…,N;\ m = 1,…,M$ with T being the number of observations (time), N the number of individual countries in the panel and M the number of regression variables. After estimating (21) and identifying the long-run relationships, we estimate a panel VECM model

$$\Delta y_{it} = \theta_{1i} + \lambda_{1i} EC_{i,t-1} + \sum_{k=1}^{m} \theta_{11ik} \Delta y_{i,t-k} + \sum_{k=1}^{m} \theta_{12ik} \Delta p_{i,t-k} + \sum_{k=1}^{m} \theta_{13ik} \Delta e_{i,t-k} + u_{1it} \quad (23)$$

and then test for multivariate causality with lag length m (SIC=2) to examine the direction (patterns) of causality between the variables in both the short- and the long-run:

- Unidirectional causality between output growth, employment growth and inflation
- Unidirectional causality between inflation, employment growth and output growth
- Bidirectional causality between output growth, employment growth and inflation
- No causality between output growth, employment growth and inflation

Multivariate causality is tested by means of Wald tests (F tests) of the null $H_0:\theta_{12ik},\theta_{13ik}=0,\ H_0:\theta_{22ik},\theta_{23ik}=0,\ H_0:\theta_{31ik},\theta_{32ik}=0$ (i.e., the independent variables do not cause the dependent ones in the model) for all *i* and *k* in (23). To examine the long-run relationship between independent and dependent variables we test $H_0:\lambda_{1i},\lambda_{2i},\lambda_{3i}=0$ for all *i* and *k* in (23) (i.e., no long-run stable relationship between independent and dependent variables in the model).

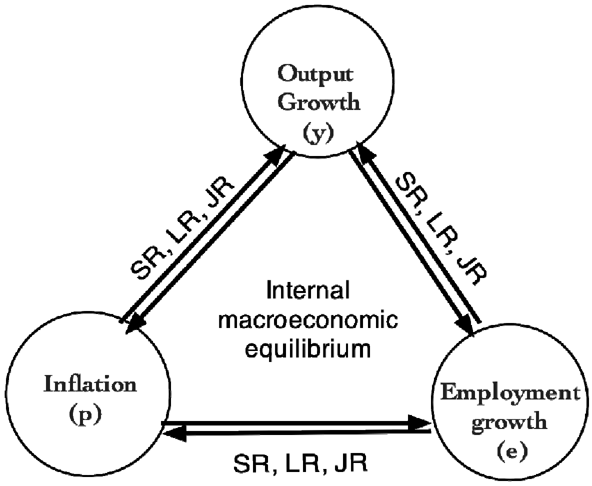
IV. EMPIRICAL RESULTS

In this section we report the results of the PMG, MG, FMOLS, DOLS, Dynamic Fixed Effect and VECM estimation as well as the results of the multivariate Granger causality analysis. Table A3 displays the estimated long-and short-run relationships for individual countries as well as some misspecification tests. The empirical evidence clearly supports the existence of a long-run relationship between employment growth, inflation and output growth in Phillips' tradition in a large panel of countries. This is confirmed by several estimation procedures. The panel results (not presented here) for the FMOLS and DOLS tests for cointegration in heterogeneous panels as in Pedroni (2001) imply that the null $H_0:\beta_i = 0$ of no cointegration between the three variables is rejected both at individual country and panel level, except for Malta (FMOLS does not reject, DOLS reject), Norway, St. Lucia, Ukraine (both FMOLS and DOLS do not reject). The panel FMOLS and DOLS results without time dummies with *t-statistic* = -1589.83 for FMOLS and -1368.77 for DOLS and with time dummies with *t-statistic* = -2722.07 FMOLS and -2141.17 for DOLS strongly support the hypothesis of cointegration.

The fully modified OLS estimates of the cointegration relationship are reported in Table A3 (individual country level) and Table 1 (panel FMOLS). In the case of the panel FMOLS and DOLS (without time trend) analysis the estimated coefficient for inflation is 0.0253 and 0.0294 respectively and is statistically significant in both cases, although with a positive effect on output growth. Panel unit root tests show that the series in the panel share common stochastic trends, and therefore omitting the trend component would generate a bias in both the FMOLS and DOLS estimates. With the inclusion of a time trend the estimated impact of inflation on output growth is, as expected, negative (FMOLS: -0.0087; DOLS: -0.0091) and statistically significant at the 1% level. Employment growth (without a time trend) has a positive effect (FMOLS=0.3469 and DOLS= 0.0968) on output growth that is statistically significant at the 1% level. Its impact on output growth (with a time trend included) is also statistically significant and positive (even larger, with the FMOLS estimate equal to 0.4592 and the DOLS one to 0.3528). At country level, inflation is found to have a negative effect on output growth (in 71 countries) ranging from -0.000 to 0.299 at the 1% significance level. It is noteworthy that this negative impact is mostly present in developing and transition economies, whilst it is positive in most OECD countries (except the UK and the US). Employment growth has a positive and statistically significant impact on output growth at country level (for 85 countries) with coefficient values ranging from 0.000 to 2.217 (Russia). The panel long-run coefficient estimates using MGE and DFE are statistically significant with values for inflation of -0.023 (PMGE) and -0.027 (DFE) respectively, supporting the idea that inflation has a negative effect on output growth. The long-run coefficient for inflation using MGE is not statistically significant. The Hausman test statistic for choosing between the PMGE and MGE estimators is equal to 3.43, indicating that PMGE is to be preferred as being more efficient under the null that the long-run coefficients are homogenous. Table A3 shows that the PMGE long-run coefficients are in fact statistically significant at country level for both inflation and employment growth. The latter affects output growth positively with statistically significant coefficients of 0.4431 for PMGE and 0.5227 for DFE. The panel VECM results do not differ substantially from the PMGE, MGE, DFE, FMOLS and DOLS ones, with the estimated long-run coefficients being -0.0012 for inflation of -0.0012 and 0.3001 for employment growth (all statistically significant at the 1% level).

Overall, the long-run coefficients for inflation and employment growth converge to the PMGE values of -0.002 and 0.443 respectively. This is an important finding for two reasons. First, it supports empirically the existence of a long-run relationship between employment growth, inflation and output growth as postulated by Phillips (1962) in his Golden Triangle theory. Second, it provides policy-makers with an estimate of the inflation and employment growth effects on output growth. The cointegration results appear to be very robust. For instance, the error correction equations (23) estimates (see Table A3) indicate that λ is statistically significant and negative for all countries in the panel. The same holds for the panel VECM as can be seen from Table 2 (except for the positive values of λ when (p) is the dependent variable). This confirms the existence of a long-run relationship between the three variables. Having already found long-run causality (as implied by the EC coefficients) we are also interested in examining the direction of causality between the variables (see Table 2 and Figure 1).

Figure 1 Panel Data Granger Causality Relations (ECM estimates) for Employment Growth, Inflation and Output Growth



It can be seen that the estimates of equation (23) imply bidirectional (and statistically significant at the 1% level) Granger causality between inflation and output growth ***(p→y, y→p)***, and employment growth and output growth as well as inflation ***(e→y, y→e, e→p, p→e)*** in both the short- and long- run. The only exception is the unidirectional short-run causality running from inflation to output growth ***(p→y)***. This is consistent with Phillips' idea that employment growth, inflation and output growth are both policy instruments and targets driven by some kind of mutually self-reinforcing process (bidirectional causality).

Table 1 Panel Short- and Long-Run Estimates (dependent variable Δy)

	PMGE	MGE	FMOLS	DOLS	DFE
Long-Run Coefficients					
(p)	***-0.0023***	-0.0021	***0.0253***	***0.0294***	***-0.0027***
(e)	***0.4431***	*0.2125*	***0.3469***	***0.0968***	***0.5227***
Error Correction	***-0.6642***	***-0.7701***			***-0.6627***
Short-Run Coefficients					
(Δp)	-0.0013	0.0000			-0.0001
(Δe)	-0.3268	-0.2715			*-0.0531*

constant	***1.8409***	***2.8223***			***1.7320***
Long-Run Coefficients			*with time trend*		
(Δp)			***-0.0087***	***-0.0091***	
(Δe)			***0.4592***	***0.3528***	
Hausman Test	3.43 (0.1798)				

Note: coefficients in bold indicate significance at the 1%, 5% level; coefficients in italics indicate significance at the 10% level.

Table 2 Wald F-test results from panel VECM

Dependent variable	*(△y)*			*(△p)*			*(△e)*		
	SR	*LR*	*JR*	*SR*	*LR*	*JR*	*SR*	*LR*	*JR*
(constant)		***3.0866***			-54.983			***0.2590***	
($\triangle y_{t-1}$)		***-0.1356***			***-9.7825***			***0.0850***	
($\triangle y_{t-2}$)		***-0.0537***			***-10.563***			***0.0230***	
($\triangle p_{t-1}$)		***-0.0012***			***-0.4073***			-0.0000	
($\triangle p_{t-2}$)		***-0.0009***			***-0.2550***			-0.0000	
($\triangle e_{t-1}$)		***0.3001***			***-8.6596***			***-0.6149***	
($\triangle e_{t-2}$)		***0.0961***			***-14.272***			***-0.2736***	
(EC_{t-1})		***-0.4392***			***7.4018***			***-0.0440***	
Causality directions		***p→y***			***y→p***			***y→e***	
	31.1	***-29.3***	***287.3***	***50.2***	***6.31***	***34.2***	***52.4***	***-5.65***	***35.0***
		e→y			***e→p***			***p→e***	
	59.4	***-29.3***	***303.0***	***21.0***	***6.31***	***24.1***	0.48	***-5.65***	***12.3***

Notes: LR, SR, JR and EC stand for long-run, short-run, and joint (both short- and long-run) causality and error-correction coefficients respectively; y→p means that variable y does not Granger cause variable p; coefficients in bold indicate significance at the 1%, 5% level; coefficients in italics indicate significance at the 10% level.

V. CONCLUSIONS

In his 1962 article Phillips stressed the importance for policy makers of acquiring information about the nature of the quantitative relationship between employment growth, inflation and output growth in order to take appropriate policy measures. Since then many studies have analysed this relationship, but surprisingly only a few have estimated it allowing for simultaneity (see Raurich and Sorolla, 2000, and Scott and McKean, 1964). To our knowledge, the present paper is the most extensive empirical investigation of this topic, being based on a panel of 119 countries over the time period 1970-2010, and also applying cutting-edge panel econometrics allowing for possible heterogeneity and nonstationarity to examine the existence of long-run relationships between these variables and to obtain accurate estimates of the long-run coefficients at both country and panel level. Further, it investigates causality linkages between these series. Its findings confirm the existence of a long-run relationship as outlined in Phillips' Golden Triangle theory, and also give useful guidance to policy makers on the size of the various effects, enabling them to devise more accurate policies to achieve their targets.

APPENDIX

Table A1 Panel unit root tests

Variables	LLC		IPS		Breitung	Hadri		ADF		PP	
	F	T	F	T	FT	F	T	F	T	F	T
y	-22.03**	-20.86**	-25.87**	-23.05**	-20.12**	**4.34****	**11.42****	-25.08**	-21.51**	-32.41**	-32.03**
p	-11.48**	-15.13**	-17.02**	-17.17**	-15.53**	**13.04****	**14.81****	-16.83**	-16.64**	-22.42**	-22.24**
e	-9.44**	-7.74**	-19.96**	-16.59**	-8.49**	**11.65****	**9.61****	-19.13**	-15.23**	-25.02**	-25.94**

Notes: Variables in levels, *,** indicate 5%, 1% rejection levels. LLC, IPS, Breitung, ADF and PP test for a unit root in the model. Hadri test for stationarity in the model.

Table A2 Panel cointegration tests

Dependent variable	Nyblom-Harvey		Fisher -Johansen		Pedroni		Westerlund		Kao
	F	T	Trace	Max	F	T	F	T	F
Y	7.48**	5.96**	1589**	1175**	-30.91**	-35.03**	-18.78**	-24.265**	-13.77**
P	7.48**	5.96**	1317**	1214**	-17.45**	-18.36**	-11.41**	-20.15**	-18.92**
E	6.82**	5.97**	1130**	954**	-39.83**	-48.44**	-13.28**	-19.27**	-12.29**

Notes: Variables in levels, *,** indicate 5%, 1% rejection levels.

Table A3 Individual Short- and Long-Run Estimates (Dependent Variable Δy_{it})

		Albania	Algeria	Angola	Argentina	Armenia	Australia	Austria	Azerbaijan	Bahrain	Bangladesh	Barbados	Belarus	Belgium	BIH	Brazil	Bulgaria	Burkina F.	Cambodia	Cameron	Canada
	PMGE																				
	(p)	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(e)	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443
	MGE																				
	(p)	-0.046	0.1035	-0.000	-0.001	0.004	-0.039	0.176	-0.020	0.042	-0.024	-0.096	-0.010	0.170	0.001	-0.001	-0.003	-0.226	-0.210	0.258	-0.045
	(e)	-0.311	-2.366	0.016	0.664	0.238	0.502	0.495	-0.765	-0.824	-0.017	0.523	-0.175	0.771	1.240	0.679	0.804	0.411	0.104	-4.764	0.771
	FMOLS																				
	(p)	-0.057	0.060	-0.001	-0.003	-0.002	-0.041	0.356	-0.028	0.075	0.225	-0.062	-0.008	0.320	0.003	-0.001	-0.007	-0.088	-0.142	0.138	-0.073
	(e)	-0.269	-2.251	0.889	0.803	0.088	0.488	0.532	-1.488	-0.861	-0.144	0.615	0.206	1.180	1.762	0.746	0.873	0.982	0.028	-5.162	1.142
	DOLS																				
LR	(p)	-0.072	0.075	-0.006	-0.002	-0.014	-0.038	0.213	-0.047	0.203	-0.496	0.031	-0.021	0.248	0.002	-0.001	-0.014	0.348	-0.311	0.083	-0.070
	(e)	-0.541	-2.554	3.726	2.275	-0.959	0.423	-0.609	-2.986	-0.922	-0.383	0.656	-2.237	0.725	-2.007	1.427	0.868	2.865	0.000	-6.797	1.145
	VECM																				
	(p)	-0.049	0.046	0.000	-0.004	-0.000	-0.084	0.325	-0.023	0.012	-0.158	-0.084	-0.007	0.299	0.002	-0.001	-0.006	-0.157	-0.084	0.106	-0.128
	(e)	-0.051	-2.190	-0.899	0.647	0.504	0.438	0.625	-0.819	-0.693	-0.614	0.540	0.751	1.097	2.405	0.500	0.787	0.683	0.024	-5.058	1.143
	PMGE	-0.964	-1.168	-0.426	-0.873	-0.447	-1.244	-0.782	-0.159	-0.512	-0.723	-0.849	-0.450	-0.928	-0.422	-0.619	-0.676	-1.114	-0.651	-0.527	-0.512
ECC	MG	-1.337	-1.404	-0.437	-0.869	-0.414	-1.287	-0.855	-0.232	-0.900	-0.738	-0.885	-0.631	-1.057	-0.450	-0.643	-0.829	-1.143	-0.774	-0.826	-0.608
	VECM	-0.925	-1.380	-0.442	-0.833	-0.498	-1.134	-0.884	-0.318	-0.897	-0.742	-0.891	-0.646	-0.978	-0.463	-0.661	-0.918	-1.090	-0.768	-0.849	-0.610
	PMGE																				
	(Δp)	-0.738	-0.074	0.000	-0.004	0.001	-0.137	0044	-0.009	-0.039	-0.364	-0.037	-0.003	0.144	0.001	-0.000	-0.001	0.098	0.035	0.025	-0.013
	(Δe)	-0.042	-3.574	-11.33	0.120	0.865	0.182	0.275	0.435	-0.179	-1.201	0.114	1.034	0.883	2.934	0.026	0.275	11.04	-0.140	-7.302	0.833
	c	3.001	2.454	2.030	2.200	1.475	2.987	1.656	0.487	0.871	2.173	0.746	1.487	1.873	3.287	2.176	1.418	2.582	2.948	1.540	1.056
	MGE																				
SR	(Δp)	-0.080	-0.179	-0.000	-0.004	-0.000	-0.130	0.002	-0.006	-0.011	-0.342	0.004	0.000	0.051	0.000	-0.000	-0.001	0.226	0.120	-0.114	0.051
	(Δe)	0.353	-2.688	-10.91	0.026	0.844	0.116	0.211	0.439	0.443	-1.051	0.063	0.873	0.711	2.741	-0.054	0.035	10.40	-0.037	-4.469	0.660
	c	5.656	16.541	2.293	1.774	0.833	3.245	1.241	1.691	6.781	3.144	1.230	2.943	1.237	2.875	1.625	1.913	4.048	5.732	12.376	0.988
	VECM																				
	(Δp)	0.006	0.056	0.000	-0.004	0.001	-0.341	0.088	-0.010	-0.077	-0.399	-0.127	-0.005	0.190	0.000	-0.002	-0.000	-0.019	-0.003	0.069	-0.266
	(Δe)	0.320	-5.616	-11.21	0.506	1.060	0.171	0.616	0.493	-0.197	-1.448	0.315	1.142	1.121	3.439	0.226	0.497	6.000	0.015	-11.73	1.105
	c	4.079	11.640	6.656	2.734	2.870	2.891	0.925	7.576	6.939	6.445	1.526	3.905	0.614	5.367	3.228	2.444	3.025	6.503	16.59	1.324

(continued)

		Centr.Afr.R	Chile	China	Colombia	Congo	Cote d'Ivore	Croatia	Costa Rica	Cyprus	Czech Rep.	Denmark	Ecuador	Egypt	Estonia	Ethiopia	Finland	France	Georgia	Germany	Ghana
LR	PMGE																				
	(p)	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***
	(e)	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***
	MGE																				
	(p)	0.127	**-0.018**	-0.118	-0.079	-0.045	-0.051	0.268	**-0.002**	0.426	*-0.228*	0.129	-0.075	0.052	-0.028	0.080	0.075	**0.130**	0.010	0.190	-0.019
	(e)	0.252	0.410	-0.942	0.318	-2.481	***0.836***	-0.197	***1.056***	-0.794	***1.405***	0.655	1.195	-2.020	-0.068	2.145	***0.717***	***0.966***	4.815	0.219	0.760
	FMOLS																				
	(p)	***0.137***	***-0.017***	***0.075***	***0.015***	***-0.144***	***-0.089***	***0.240***	***-0.002***	0.546	***-0.185***	***0.210***	***-0.088***	***0.065***	***-0.030***	***-0.073***	***0.116***	***0.181***	***-0.002***	***0.380***	***-0.085***
	(e)	0.188	***0.266***	***-0.601***	***0.147***	***-3.778***	0.712	-0.245	***0.243***	***-0.361***	1.250	1.512	0.887	-1.312	1.232	3.183	0.988	1.485	***1.814***	0.922	0.794
	DOLS																				
	(p)	***0.162***	***-0.065***	***0.248***	***-0.046***	***-0.235***	***-0.141***	***0.595***	***-0.004***	0.444	***0.317***	***0.064***	***-0.125***	***0.004***	***-0.082***	***0.5761***	***0.056***	***0.138***	***-0.007***	***0.464***	***-0.134***
	(e)	0.086	1.220	***-1.109***	***0.220***	***-6.825***	0.918	***-1.059***	1.523	***-1.626***	***3.555***	***3.872***	0.547	-2.537	0.954	***5.064***	***0.802***	1.171	0.162	1.842	1.518
	VECM																				
	(p)	0.126	**-0.017**	0.041	0.007	-0.143	***-0.096***	0.140	***-0.001***	0.312	*-0.216*	**0.232**	*-0.068*	0.078	-0.014	*-0.159*	0.076	***0.140***	***-0.002***	*0.245*	0.005
	(e)	0.050	0.247	0.094	0.088	*-3.397*	***0.650***	0.003	0.160	-0.190	***1.107***	***1.314***	**0.795**	-1.677	***1.406***	0.761	***1.099***	***1.478***	***1.631***	***0.864***	-0.260
ECC	PMGE	***-1.092***	***-0.719***	***-0.750***	***-0.495***	***-0.430***	***-0.608***	***-0.497***	***-0.631***	***-0.531***	***-0.830***	***-0.544***	***-0.693***	***-0.442***	***-0.441***	***-0.567***	***-0.679***	***-0.403***	***-0.227***	***-0.961***	***-0.720***
	MG	***-1.181***	***-0.831***	***-0.722***	***-0.506***	***-0.469***	***-0.896***	***-0.555***	***-0.667***	***-0.639***	***-1.042***	***-0.592***	***-0.792***	***-0.462***	*-0.381*	***-0.566***	***-0.823***	***-0.552***	-0.154	***-0.994***	***-0.759***
	VECM	***-1.164***	***-0.836***	***-0.726***	***-0.554***	***-0.473***	***-0.895***	***-0.613***	***-0.659***	***-0.705***	***-1.014***	***-0.615***	***-0.805***	***-0.475***	***-0.525***	***-0.663***	***-0.686***	***-0.558***	***-0.488***	***-0.979***	***-0.666***
SR	PMGE																				
	(Δp)	***0.096***	-0.005	0.107	-0.042	*-0.173*	***-0.096***	-0.109	0.000	-0.226	0.148	**0.364**	-0.010	0.114	0.040	***-0.220***	0.097	**-0.109**	***-0.001***	**0.467**	*-0.012*
	(Δe)	-0.722	**-0.100**	0.177	-0.116	1.255	0.165	1.335	-0.056	0.072	-0.041	***0.858***	0.177	*-2.289*	***1.231***	***-8.238***	***1.114***	***1.443***	***0.673***	***0.498***	***-5.654***
	c	***0.051***	***2.446***	***6.147***	**1.290**	1.458	***1.736***	0.350	***1.627***	***2.549***	***1.983***	***1.479***	**1.849**	***1.943***	*1.269*	**1.601**	***1.813***	***0.777***	0.236	***1.774***	*1.150*
	MGE																				
	(Δp)	0.023	0.000	0.141	-0.020	-0.147	-0.055	*-0.185*	0.001	-0.353	0.205	*0.328*	0.0393	0.092	0.054	***-0.248***	0.048	**-0.151**	***-0.002***	*0.504*	-0.011
	(Δe)	-0.561	-0.131	0.214	-0.091	-0.604	-0.099	1.078	*-0.233*	0.482	**-0.752**	**0.776**	-0.096	-1.715	***1.357***	**-8.287**	***0.979***	***1.246***	0.148	**0.685**	**-5.439**
	c	-0.135	**3.581**	***8.108***	**2.211**	5.835	2.002	0.655	**1.567**	2.924	***3.328***	1.150	1.650	4.470	1.098	-1.624	***1.779***	**0.580**	-0.622	**1.357**	0.919
	VECM																				
	(Δp)	0.058	-0.005	-0.082	-0.081	*-0.201*	***-0.127***	-0.124	**-0.000**	-0.326	-0.040	*0.409*	-0.008	0.126	**0.112**	***-0.276***	0.047	*-0.122*	***-0.001***	0.334	-0.003
	(Δe)	-0.691	0.238	-0.896	0.004	-2.255	**0.388**	3.112	0.000	-0.062	*0.756*	***1.227***	0.523	**-3.181**	***1.348***	***-11.05***	***1.469***	***1.771***	***0.801***	***0.811***	*-5.564*
	c	0.505	***4.532***	8.840	***3.587***	***15.90***	***3.683***	1.666	***2.672***	***4.337***	***3.198***	1.045	*3.323*	8.559	***3.142***	2.447	***2.082***	***0.875***	*2.508*	*0.927*	3.780

(continued)

		Greece	Guatemala	Hungary	Iceland	India	Indonesia	Iran	Iraq	Ireland	Israel	Italy	Jamaica	Japan	Jordan	Kazakhstan	Kenya	Korea South	Kuwait	Kyrgyzstan	Latvia
LR	PMGE																				
	(p)	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(e)	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443
	MGE																				
	(p)	-0.210	0.414	-0.134	-0.003	-0.016	-0.176	0.026	-0.027	0.069	0.001	0.110	-0.021	0.067	0.442	-0.016	-0.290	-0.100	-0.258	-0.025	-0.118
	(e)	0.252	1.227	0.623	1.182	-2.104	0.213	0.463	2.369	0.955	1.049	0.217	0.761	1.031	-0.328	-0.953	-0.787	1.519	0.595	0.278	0.581
	FMOLS																				
	(p)	-0.132	0.009	-0.103	-0.005	-0.068	-0.169	-0.097	0.020	0.082	0.001	0.151	0.023	0.078	0.299	-0.011	-0.295	-0.074	-0.625	-0.021	-0.121
	(e)	0.395	0.650	0.813	1.251	-2.009	0.035	0.049	-1.703	1.015	1.080	0.684	0.383	1.862	-0.902	-0.202	-0.675	1.535	-0.094	0.305	0.978
	DOLS																				
	(p)	0.212	-0.077	-0.065	-0.029	-0.129	-0.058	-0.304	0.106	0.071	0.004	0.143	0.137	0.147	1.040	-0.010	-0.134	-0.146	-0.059	-0.045	-0.092
	(e)	-1.490	1.563	1.252	1.908	-1.739	0.685	-1.590	-17.53	1.093	1.064	0.183	0.407	1.422	-1.564	1.460	-2.200	2.400	-0.746	-1.858	1.534
	VECM																				
	(p)	-0.191	0.007	-0.120	-0.002	-0.027	-0.191	-0.049	0.005	0.089	-0.001	0.153	-0.017	0.0274	0.053	-0.009	-0.012	-0.110	-0.615	-0.017	-0.133
	(e)	0.305	0.500	0.789	1.095	-1.915	-0.092	-0.258	1.645	0.970	0.925	0.640	0.297	2.026	-0.609	-0.254	-1.131	1.430	-0.052	0.368	0.874
ECC	PMGE	-0.454	-0.363	-0.734	-0.537	-0.852	-0.391	-0.808	-0.637	-0.636	-0.680	-0.798	-0.812	-0.575	-0.529	-0.189	-0.838	-0.623	-0.968	-0.452	-0.367
	MG	-0.581	-0.374	-0.920	-0.736	-1.087	-0.469	-0.797	-0.635	-0.973	-0.745	-0.931	-0.796	-0.708	-0.611	-0.349	-0.934	-1.023	-0.978	-0.961	-0.701
	VECM	-0.700	-0.382	-0.826	-0.807	-1.013	-0.483	-0.773	-0.638	-1.005	-0.796	-0.832	-0.803	-0.757	-0.603	-0.454	-0.918	-1.071	-0.961	-0.992	-0.699
SR	PMGE																				
	(Δp)	-0.344	-0.007	-0.146	0.027	-0.066	-0.189	-0.064	0.002	0.203	-0.005	0.158	-0.007	-0.131	-0.336	-0.003	0.100	-0.188	-0.554	-0.001	-0.095
	(Δe)	0.018	0.029	0.830	0.436	-1.912	-0.249	-1.669	0.595	0.321	0.060	1.040	-0.087	1.628	-0.888	-0.371	6.777	0.650	-0.415	-0.139	0.766
	c	0.772	0.703	1.999	1.398	3.851	1.843	1.452	3.038	2.599	2.171	1.359	0.136	1.414	2.428	0.491	2.912	3.437	-1.053	0.403	0.983
	MGE																				
	(Δp)	-0.238	-0.010	-0.071	0.020	-0.076	-0.138	-0.072	0.010	0.086	-0.006	0.142	-0.002	-0.133	-0.488	0.001	0.164	-0.105	-0.432	0.010	-0.041
	(Δe)	0.087	-0.112	0.743	0.058	-0.935	-0.208	-1.668	0.187	-0.035	-0.176	1.112	-0.209	1.408	-0.811	-0.147	7.588	-0.225	-0.490	-0.642	0.568
	c	2.608	-0.393	3.882	1.085	11.73	3.503	0.972	-0.063	2.722	0.931	0.915	-0.070	1.451	3.151	2.202	10.71	3.917	-1.035	2.949	3.344
	VECM																				
	(Δp)	-0.494	-0.006	-0.255	0.049	0.033	-0.237	0.103	-0.006	0.176	-0.007	0.174	-0.062	-0.333	-0.405	-0.003	0.141	-0.295	-0.755	-0.003	-0.114
	(Δe)	0.034	0.171	0.672	0.718	-1.857	-0.200	-0.520	1.425	0.562	0.173	1.189	0.292	1.801	-0.665	-0.374	6.169	1.095	-0.232	-0.034	0.769
	c	4.669	1.857	4.094	1.711	10.29	8.603	4.856	0.598	2.619	1.835	0.497	1.048	1.969	9.893	4.313	8.938	4.186	4.599	2.341	5.239

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		Lithuania	Luxemb.	Macedonia	Madagascar	Malawi	Malaysia	Mali	Malta	Mexico	Moldova	Morocco	Mozamb.	Myanmar	Netherlands	New Zealand	Niger	Nigeria	Norway	Oman	Pakistan
LR	PMGE																				
	(p)	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(e)	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443
	MGE																				
	(p)	-0.040	-0.250	-0.002	-0.064	0.008	-0.058	0.081	0.408	-0.047	-0.017	0.177	0.039	-0.015	0.237	-0.045	0.089	-0.008	0.174	0.398	0.003
	(e)	-0.226	0.410	0.247	0.001	-0.179	1.930	1.463	0.176	1.420	-0.060	-0.839	-0.149	0.056	0.833	0.047	0.871	-4.158	0.228	0.902	0.062
	FMOLS																				
	(p)	-0.053	-0.021	-0.001	-0.092	-0.015	0.238	-0.009	0.588	-0.050	-0.020	0.349	-0.074	-0.043	0.288	-0.028	0.021	-0.070	0.206	0.322	0.000
	(e)	0.613	0.917	0.431	1.343	-0.260	1.133	1.420	1.348	1.428	-0.057	-2.060	0.689	0.100	1.137	0.223	1.117	-2.069	0.596	1.057	0.003
	DOLS																				
	(p)	-0.110	0.170	-0.003	-0.157	-0.003	0.378	0.402	1.602	-0.058	-0.034	0.308	-0.179	-0.001	0.212	-0.078	0.127	-0.210	0.240	-0.150	-0.000
	(e)	0.088	1.504	-0.027	5.543	-1.287	1.512	2.428	0.535	1.485	-0.732	-1.690	3.549	-0.229	1.309	0.441	2.008	3.366	0.295	2.116	0.774
	VECM																				
	(p)	-0.040	-0.375	-0.001	-0.075	0.029	0.196	-0.072	0.324	-0.046	-0.013	0.301	-0.000	-0.054	0.254	-0.020	0.003	-0.060	0.063	0.331	0.016
	(e)	0.729	0.365	0.522	-2.467	-0.029	1.076	0.966	1.385	1.436	0.077	-2.080	-0.160	0.076	1.092	0.1784	0.174	-4.733	0.640	0.702	-0.077
ECC	PMGE	-0.501	-1.015	-0.846	-0.677	-1.249	-0.957	-0.880	-0.307	-0.584	-0.679	-1.246	-0.466	-1.018	-0.733	-0.481	-0.850	-0.684	-0.610	-0.747	-0.810
	MG	-0.545	-1.050	-0.835	0.696	-1.273	-1.146	-0.895	-0.339	-1.118	-1.019	-1.309	-0.465	-1.042	-0.984	-0.607	-0.855	-0.709	-0.647	-0.767	-0.856
	VECM	-0.790	-0.841	-0.931	-0.964	-1.191	-1.065	-0.961	-0.435	-1.114	-1.124	-1.264	-0.522	-1.033	-0.844	-0.619	-0.951	-0.753	-0.598	-0.792	-0.865
SR	PMGE																				
	(Δp)	-0.006	-0.238	0.000	-0.005	-0.028	0.386	-0.126	0.040	-0.022	0.003	0.053	0.000	-0.092	0.004	-0.009	-0.105	-0.094	-0.248	0.085	0.080
	(Δe)	0.449	1.250	0.324	-17.21	-0.112	0.061	1.912	0.746	0.910	-0.031	-1.536	-2.794	-0.770	0.953	0.024	-6.545	-6.198	0.682	-0.920	-0.277
	c	1.088	3.115	1.106	0.600	3.921	4.863	2.399	1.318	1.251	0.447	3.628	1.784	4.372	1.347	0.757	0.623	1.620	1.440	3.060	3.055
	MGE																				
	(Δp)	0.004	-0.075	0.000	0.015	-0.049	0.467	-0.168	-0.023	0.006	0.010	-0.073	0.000	-0.088	-0.122	0.005	-0.146	-0.089	-0.267	-0.044	0.077
	(Δe)	0.612	1.105	0.417	-16.95	0.254	-0.900	-2.313	0.857	-0.122	0.085	-0.577	-2.806	-0.552	0.756	0.105	-6.422	-4.322	0.799	-1.266	-0.120
	c	1.486	4.404	1.277	2.102	5.940	0.935	0.430	1.053	0.287	1.982	7.014	2.034	5.707	0.503	1.663	-1.016	10.37	1.106	0.887	4.101
	VECM																				
	(Δp)	-0.001	-0.741	-0.000	-0.004	0.177	0.165	-0.020	0.020	-0.014	0.007	0.209	0.000	-0.089	0.086	-0.013	-0.074	-0.118	-0.331	0.331	0.111
	(Δe)	0.349	0.134	0.562	-24.00	-0.362	0.605	-6.361	0.804	1.525	0.193	-3.893	-3.510	-0.926	1.229	0.135	-11.29	-13.59	0.633	0.702	-0.163
	c	2.795	4.665	0.997	9.839	3.823	2.441	1.954	2.800	0.235	2.242	7.986	5.021	6.057	0.164	2.061	1.402	17.85	1.819	2.460	5.262

(continued)

		Peru	Philippines	Poland	Portugal	Romania	Russia	St. Lucia	Saudi Arabia	Senegal	Serbia	Singapore	Slovakia	Slovenia	South Africa	Spain	Sri Lanka	Sudan	Sweden	Switzerland	Syria
LR	PMGE																				
	(p)	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(e)	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443
	MGE																				
	(p)	-0.001	-0.495	-0.012	0.033	0.006	-0.008	-0.136	0.616	0.102	-0.000	-0.064	-0.254	0.032	-0.217	0.088	0.069	0.038	0.218	-0.165	0.032
	(e)	-0.665	1.177	0.143	-1.369	-0.047	2.236	0.234	-0.240	1.983	-0.360	0.144	1.037	0.483	-0.770	0.726	-0.060	2.588	0.434	-0.526	-0.789
	FMOLS																				
	(p)	-0.002	-0.179	0.000	0.069	-0.044	-0.008	-0.086	0.554	0.057	0.000	0.235	-0.318	0.030	-0.185	0.169	0.085	0.015	0.311	-0.026	-0.012
	(e)	-0.254	0.033	0.540	0.469	-0.422	2.217	0.237	-0.209	2.991	0.355	0.198	1.059	0.493	-0.455	0.794	-0.065	2.000	0.545	-0.116	-0.952
	DOLS																				
	(p)	-0.001	-0.309	-0.008	0.043	-0.062	-0.016	-0.036	0.562	-0.060	0.000	0.090	-0.931	-0.110	-0.238	0.096	0.079	-0.186	0.308	-0.255	0.010
	(e)	0.487	0.954	0.166	1.399	-0.344	1.114	1.236	0.159	2.747	0.238	1.176	0.869	-0.087	-0.061	0.598	-0.413	-11.39	-1.277	-0.007	-0.347
	VECM																				
	(p)	-0.001	-0.191	0.003	0.012	-0.043	-0.007	-0.084	0.534	0.070	-0.000	0.146	-0.174	0.233	-0.183	0.118	0.067	0.009	0.279	0.097	0.022
	(e)	-0.353	0.001	0.658	0.312	-0.320	2.436	0.191	-0.513	1.139	0.368	0.136	1.094	0.575	-0.495	0.745	0.011	2.495	0.652	-0.001	-0.322
ECC	PMGE	-0.686	-0.351	-0.707	-0.547	-0.435	-0.329	-1.125	-0.362	-1.193	-0.948	-0.851	-0.527	-0.883	-0.612	-0.400	-0.576	-0.554	-0.918	-0.708	-1.110
	MG	-0.823	-0.447	-0.664	-0.396	-0.416	-0.789	-1.121	-0.427	-1.190	-0.934	-0.812	-0.817	-0.873	-0.892	-0.508	-0.889	-0.611	-0.956	-0.722	-1.131
	VECM	-0.850	-0.514	-0.677	-0.613	-0.447	-0.793	-1.093	-0.526	-1.128	-0.943	-0.790	-0.915	-0.851	-0.825	-0.587	-0.910	-0.689	-0.948	-0.785	-1.122
SR	PMGE																				
	(Δp)	-0.000	-0.126	0.012	-0.201	-0.040	-0.003	0.478	0.195	-0.028	0.001	0.262	0.163	-0.034	-0.078	-0.018	0.017	-0.082	0.417	0.277	-0.078
	(Δe)	-0.172	-0.094	0.291	0.207	-0.061	1.972	-0.165	-3.103	2.814	0.245	-0.147	0.445	0.299	0.159	0.509	-0.024	0.417	0.046	-0.218	-0.577
	c	1.911	0.924	2.444	1.151	1.010	0.646	3.402	0.495	2.183	2.652	4.693	1.481	2.469	0.710	0.961	2.382	2.122	4.052	1.262	4.297
	MGE																				
	(Δp)	-0.000	-0.025	0.017	-0.175	-0.040	0.000	0.524	0.013	-0.088	0.000	0.287	0.231	-0.041	0.116	-0.030	-0.264	-0.084	0.297	0.497	-0.090
	(Δe)	0.411	-0.321	0.332	0.538	0.051	0.716	-0.042	-2.995	1.609	0.619	-0.021	0.138	0.258	0.882	0.372	0.096	-0.525	0.146	0.050	0.077
	c	4.428	2.612	2.558	1.345	0.661	1.644	4.637	1.674	-3.818	2.699	5.564	3.728	2.111	6.206	0.726	3.653	-1.963	3.099	2.304	9.369
	VECM																				
	(Δp)	0.000	-0.169	0.013	-0.215	-0.031	-0.005	0.008	0.057	0.118	-0.000	0.107	0.324	0.172	-0.318	-0.074	0.014	-0.094	0.332	0.455	-0.074
	(Δe)	-0.345	-0.021	0.756	0.248	0.013	2.374	0.066	-4.031	-5.971	0.448	-0.019	0.595	0.547	0.148	0.755	0.152	0.512	0.581	-0.296	1.644
	c	4.751	5.900	3.205	2.504	3.111	1.876	3.856	6.179	-0.442	2.647	6.409	3.849	2.459	5.827	1.248	3.998	-1.924	2.878	1.861	6.342

(continued)

		Taiwan	Tajikistan	Tanzania	Thailand	Trin.&Tob.	Tunisia	Turkey	Turkmenistan	Uganda	Ukraine	United A.E.	UK	USA	Uruguay	Uzbekistan	Venezuela	Vietnam	Yemen	Zambia
LR	PMGE																			
	(p)	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***	***-0.002***
	(e)	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***	***0.443***
	MGE																			
	(p)	-0.159	***-0.025***	0.027	-0.121	-0.036	0.029	-0.039	***-0.010***	-0.007	***-0.008***	0.322	-0.062	***-0.195***	0.027	***-0.011***	-0.001	-1.094	-0.046	-0.000
	(e)	***2.158***	-0.427	-3.825	*0.750*	***1.505***	0.533	-0.022	-1.655	3.055	0.586	**0.557**	*0.379*	***1.143***	0.454	**-1.764**	0.583	-1.411	-0.147	***-2.964***
	FMOLS																			
	(p)	***-0.071***	***-0.022***	***-0.107***	***0.103***	***0.148***	***-0.088***	***-0.029***	***-0.010***	***-0.034***	***-0.004***	0.495	***-0.039***	***-0.224***	***-0.003***	***-0.011***	***-0.017***	***-0.138***	***0.019***	***0.000***
	(e)	**1.738**	0.296	0.457	**0.461**	1.555	0.876	***-0.380***	**-1.409**	3.362	2.311	**0.489**	**0.547**	**1.219**	**0.429**	**-0.953**	0.466	*-0.516*	**-0.282**	***-2.911***
	DOLS																			
	(p)	***0.225***	***-0.037***	***-0.247***	***0.366***	***0.219***	***-0.128***	***-0.019***	***-0.017***	***-0.045***	***-0.012***	0.029	***-0.033***	***-0.183***	***-0.015***	***-0.018***	***-0.018***	***-0.949***	***0.337***	***0.005***
	(e)	1.523	***-1.127***	3.976	0.084	***2.192***	1.003	0.179	***-6.542***	***3.244***	0.626	***0.300***	***0.542***	1.152	1.497	***-1.720***	0.318	***-4.290***	-0.277	***-2.031***
	VECM																			
	(p)	-0.086	***-0.017***	**-0.061**	0.043	0.046	0.050	*-0.038*	***-0.009***	***-0.031***	**-0.002**	0.583	-0.086	***-0.259***	0.002	***-0.008***	-0.018	-0.095	-0.028	0.005
	(e)	***1.832***	0.411	-0.559	**0.410**	***1.258***	0.549	-0.424	-0.594	***2.936***	***2.124***	**0.474**	***0.509***	***1.254***	*0.308*	-0.494	**0.558**	-0.262	-0.324	***-3.246***
ECC	PMGE	***-1.073***	***-0.317***	**-0.204**	***-0.554***	***-0.594***	***-1.126***	***-0.926***	**-0.248**	***-0.385***	***-0.404***	***-0.831***	***-0.908***	***-0.684***	***-0.646***	***-0.344***	***-0.725***	-0.099	***-0337***	***-0.866***
	MG	***-1.293***	***-0.811***	***-0.274***	***-0.543***	***-0.692***	***-1.132***	***-1.042***	***-0.394***	***-0.439***	***-0.508***	***-0.844***	***-0.917***	***-1.271***	***-0.633***	***-0.506***	***-0.725***	*-0.118*	***-0.357***	***-1.304***
	VECM	***-1.285***	***-1.006***	***-0.336***	***-0.544***	***-0.683***	***-1.100***	***-1.064***	***-0.422***	***-0.536***	***-0.581***	***-0.841***	***-0.850***	***-1.183***	***-0.610***	***-0.537***	***-0.727***	*-0.122*	***-0.367***	***-1.238***
SR	PMGE																			
	(Δp)	0.041	0.000	-0.029	0.072	0.178	0.226	-0.049	-0.003	-0.013	0.001	0.640	-0.124	-0.077	-0.039	**-0.003**	*-0.084*	-0.045	-0.055	0.028
	(Δe)	0.445	*0.670*	-0.459	0.080	**0.545**	0.783	***0.550***	-0.242	-1.348	1.050	-0.171	**0.305**	***0.881***	-0.090	0.752	0.108	-0.085	-0.254	-3.194
	c	***6.415***	0.096	**0.652**	***2.771***	***2.359***	***4.314***	***3.510***	0.821	***1.354***	0.512	1.049	***1.842***	***1.597***	**1.496**	*0.741*	0.539	0.510	0.192	0.852
	MGE																			
	(Δp)	0.056	**0.009**	-0.034	0.105	0.193	0.219	-0.019	-0.000	-0.013	***0.002***	0.493	-0.087	0.008	-0.041	-0.000	-0.084	0.021	-0.046	*0.040*
	(Δe)	*-1.150*	**0.660**	0.248	0.001	0.105	0.727	0.323	0.140	-1.944	0.858	-0.227	*0.307*	-0.013	-0.087	***1.316***	0.056	0.018	-0.238	2.443
	c	**3.825**	**3.891**	*4.167*	**2.742**	1.758	3.805	***6.260***	4.247	-1.780	1.232	-0.972	***2.245***	***2.762***	0.644	***4.685***	0.209	*1.923*	1.227	***13.91***
	VECM																			
	(Δp)	-0.058	0.000	-0.026	-0.017	0.128	0.303	-0.082	*-0.004*	-0.004	0.000	0.728	-0.158	***-0.379***	-0.007	**-0.004**	-0.085	-0.054	-0.066	0.022
	(Δe)	**1.665**	***0.854***	-0.785	**0.281**	***0.980***	0.202	**0.624**	-0.225	-1.706	***1.412***	0.189	**0.431**	***1.272***	0.087	0.610	*0.582*	-0.058	-0.213	***-9.546***
	c	**3.409**	2.094	**6.768**	***5.040***	1.965	3.221	***6.461***	***7.080***	-2.899	1.490	-1.501	***2.626***	***2.286***	*2.069*	***5.195***	1.142	***6.419***	*3.490*	***11.34***

Notes: LR, SR, and EC stand for long-run and short-run causality and error-correction coefficients respectively; coefficients in bold indicate significance at the 1%, 5% level; coefficients in italics indicate significance at the 10% level.

REFERENCES

Acemoglu, D., and A. Scott, "Asymmetries in the cyclical behaviour of UK labour markets," The Economic Journal, 104 (1994), 1303-1323.

Adams, C., and D.T. Coe, "A systems approach to estimating the natural rate of unemployment and potential output for the United States," Staff Papers-International Monetary Fund, 37 (1990), 232-293.

Aguiar, A., and M.M.F. Martins, "Testing the significance and the non-linearity of the Phillips trade-off in the euro area," Empirical Economics, 30 (2005), 665-691.

Altig, D., T.J. Fitzgerald, and P. Rupert, "Okun's law revisited: should we worry about low unemployment?," Economic Commentary, (1997).

Apergis, N., and A. Rezitis, "An examination of Okun's law: evidence from regional areas in Greece," Applied Economics, 35 (2003), 1147-1151.

Breitung, J., and S. Das, "Panel unit root tests under cross-sectional dependence," Statistica Neerlandica, 59 (2005), 414-433.

Engle, R.F., and C.W.J. Granger, "Co-integration and error correction: representation, estimation, and testing," Econometrica: Journal of the Econometric Society, (1987), 251-276.

Friedman, M., "The role of monetary policy," A, (1968).

Friedman, Milton, *A Monetary History of the United States, 1867-1960* (Princeton University Press, 1971).

Gordon, R.J., "The Phillips Curve Now and Then," (National Bureau of Economic Research Cambridge, Mass., USA, 1991).

Gordon, R.J., G. Perry, F. Modigliani, A. Okun, M. Wachter, P. Kouri, E. Phelps, and C. Sims, "Can the Inflation of the 1970s be Explained?," Brookings Papers on Economic Activity, 1977 (1977), 253-279.

Hooker, M.A., "Are oil shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime," Journal of Money, Credit and Banking, 34 (2002), 540-561.

Im, K.S., M.H. Pesaran, and Y. Shin, "Testing for unit roots in heterogeneous panels* 1," Journal of Econometrics, 115 (2003), 53-74.

Kao, C., "Spurious regression and residual-based tests for cointegration in panel data," Journal of Econometrics, 90 (1999), 1-44.

Lorenzoni, G., ""A Theory of Demand Shocks."," The American Economic Review, 99 (2010), 2050-2084.

Maddala, G.S., and S. Wu, "A comparative study of unit root tests with panel data and a new simple test," Oxford Bulletin of Economics and statistics, 61 (1999), 631-652.

Nakov, A.A., and A. Pescatori, "Oil and the great moderation," The Economic Journal, 120 (2010), 131-156.

Nickell, S., "Unemployment: questions and some answers," The Economic Journal, 108 (1998), 802-816.

Nyblom, J., and A. Harvey, "Tests of common stochastic trends," Econometric Theory, 16 (2000), 176-199.

Okun, A.M., "Postwar Macroeconomic Performance," The American Economy in Transition, (1980), 162-169.

Pedroni, P., "Critical values for cointegration tests in heterogeneous panels with multiple regressors," Oxford Bulletin of Economics and statistics, 61 (1999), 653-670.

Pedroni, P., "Purchasing power parity tests in cointegrated panels," Review of Economics and Statistics, 83 (2001), 727-731.

Pedroni, P., "Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis," Econometric Theory, 20 (2004), 597-625.
Persyn, D., and J. Westerlund, "Error-correction-based cointegration tests for panel data," Stata Journal, 8 (2008), 232-241.
Pesaran, M.H., "A simple panel unit root test in the presence of cross section dependence," Journal of Applied Econometrics, 22 (2007), 265-312.
Pesaran, M.H., Y. Shin, and R.P. Smith, "Pooled mean group estimation of dynamic heterogeneous panels," Journal of the American Statistical Association, 94 (1999), 621-634.
Pesaran, M.H., and R. Smith, "Estimating long-run relationships from dynamic heterogeneous panels," Journal of Econometrics, 68 (1995), 79-113.
Phelps, E.S., "Phillips curves, expectations of inflation and optimal unemployment over time," Economica, (1967), 254-281.
Phelps, E.S., and G. Zoega, "Natural rate Theory and OECD Unemployment," The Economic Journal, 108 (1998), 782-801.
Phillips, A.W., "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," Economica, 25 (1958), 17.
Phillips, A.W., "Employment, Inflation and Growth," Economica, 29 (1962), 1-16.
Samuelson, P.A., "Thoughts about the Phillips curve," (Federal Reserve Bank of Boston, 2008).
Targetti, F., *Nicholas Kaldor: the economics and politics of capitalism as a dynamic system* (Oxford University Press, USA, 1992).
Thirlwall, A.P., "Okun's law and the natural rate of growth," Southern Economic Journal, (1969), 87-89.
Westerlund, J., "Testing for error correction in panel data," Oxford Bulletin of Economics and statistics, 69 (2007), 709.

[i] The countries included in the panel are the following: Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Bosna & Hercegovina, Brazil, Bulgaria, Burkina Faso, Cambodia, Cameron, Canada, Central African Republic, Chile, China, Colombia, Congo, Democratic Republic of Costa Rica, Cote d'Ivore, Croatia, Cyprus, Czech Republic, Denmark, Ecuador, Egypt, Estonia, Ethiopia, Finland, France, Georgia, Germany, Ghana, Greece, Guatemala, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea South, Kuwait, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Mali, Malta, Mexico, Moldova, Morocco, Mozambique, Myanmar, The Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Pakistan, Peru, The Philippines, Poland, Portugal, Romania, Russia, St.Lucia, Saudi Arabia, Senegal, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Taiwan, Tajikistan, Tanzania, Thailand, Trinidad & Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, USA, Uruguay, Uzbekistan, Venezuela, Vietnam, Yemen, Zambia.