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PRICE CONVERGENCE IN SELECTED CARICOM COUNTRIES

Mr. Nathaniel Samuel/
Dr. Gene Leon

JAMAICA CONFERENCE CENTRE

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by

Gene Leon

Nathaniel Samuel

Wendell Samuel

Introduction

Any endeavor at monetary union among a group of countries must take direct account of the issue of convergence, that is, the drawing together of the economic policies and performances of individual countries. An effective union requires a great deal of harmonization and coordination of the economic policies of member countries. However for such policy correlation to be sustainable the economic performance of the countries must have already achieved some level of convergence. Without this, disparities in economic performance would encourage pressures to depart from the union objectives.

In July 1992 the CARICOM Heads of Government adopted the recommendations of regional Central Bank Governors on the mechanisms to be employed in the establishment of a monetary union within the English-speaking Caribbean.[1] Essentially the procedure entailed a two tiered, stages approach, the final stage of which would involve the institution of a common currency by the year 2000.[2] This paper attempts an empirical investigation of the extent

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[1] The CARICOM Agreement as enacted in the Treaty of Chaguaramas in July 1973 provides a common market and free trade area for its member countries. The countries which make up the CARICOM region are : Antigua & Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St.Kitts & Nevis, St.Lucia, St.Vincent & the Grenadines, and Trinidad & Tobago.

[2]See "The Report on Study of Economic Convergence in the CARICOM Countries", May 1994

to which economic convergence, namely price convergence, has been achieved in the CARICOM region.

The study of convergence is concerned with the relative long run behavior of economic variables (in one country or region relative to the same variables in other countries or regions). It examines whether or not there exists a stable, long run equilibrium relationship among these variables. In light of this many researchers have focussed on the tools of cointegration in testing for convergence in existing monetary schemes.

Hall, Robertson and Wickens (1992) utilize cointegration and time varying parameter analysis (Kalman Filter) in an attempt to measure the degree of convergence of the main EC economies. They find evidence for the convergence of exchange rates but the divergence of interest rates as governments pursued increasingly active interest rate policies over the past decade to promote exchange rate stability. Barro and Sala-i-Martin (1992) also find evidence of convergence across forty eight (48) contiguous US states by utilizing a neo-classical growth model.

Few studies however have addressed the issue of convergence among less developed economies. What is evident from some of these studies is the reference to a dominant or 'core' country towards which the developing economies converge. Honohan (1992) examines convergence of inflation and interest rates for the members of two currency unions in Africa: the Franc and Rand zones. Utilizing a simple error correction framework he discovers that despite short run divergences, the long run trends in inflation and controlled interest rates converge to that in the core country of the union (France in the case of the franc zone, and The Republic of South Africa in the rand zone).

Likewise a recent report on economic convergence in the CARICOM countries undertaken by a joint Central Bank research team found evidence to support nominal convergence (in inflation rates) in countries which have maintained fixed exchange rates, whilst countries with floating exchange rates have tended to diverge in periods of exchange rate instability. Moreover they found strong evidence that the United States (US) economy is the 'core' on which CARICOM countries converge.

These results from the CARICOM region indeed appeal to intuition. The CARICOM countries have practiced some form of economic integration for more than twenty five years starting with the Caribbean Free Trade Area (CARIFTA) in 1968 - some degree of convergence is therefore expected. Furthermore since all of the member countries have had US dollar pegs and the bulk of their trading relations is with the United States, they should all converge to the US economy.

In this paper we use a quarterly vector autoregressive model (VAR) to empirically test whether the inflation rates in each of four CARICOM countries[3] have in fact converged to US inflation rates. We utilize the Johansen procedure to test for cointegration between the variables, making allowance for possible seasonal patterns in the data arising from habitual spending patterns of economic agents. The VAR also enables us to uncover any causal relationships (in the Granger sense) which may exist between US and CARICOM inflation rates and to enquire into the exogeneity of US inflation rates within that structure.

The rest of the paper is divided into three sections. Section I discusses the statistical methodology. Section II presents the empirical results and finally we draw some conclusions in section III.

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[3]These countries are : Jamaica, and Trinidad & Tobago who presently employ floating exchange rate regimes; and Barbados, and Dominica with fixed exchange regimes.

Section I - Statistical Methodology

On an intuitive level the concept of convergence relates to the notion that the difference between two (or more) series becomes arbitrarily small (approaches some constant ε) over time

$$\lim_{t\to\infty}(X_1-X_2)=\varepsilon$$

and that there will be no tendency for the series to drift apart ad infinitum. We may further denote stochastic convergence as

$$E\{\lim_{t\to\infty}(X_1-X_2)\}=\varepsilon$$

where the expected value of the difference between the series approaches some arbitrarily small constant ε over time.

The empirical testing of price convergence however requires the definition of a more operational measure of the concept. Consider a non-stationary time series which can be rendered stationary by differencing d times. That series is then said to be integrated of order d (denoted I(d)) and contains a stochastic rather than a deterministic trend. Thus an I(1) series requires first differencing to render it stationary, or I(0). Normally a linear combination of such I(1) variables would also be I(1). However if a combination can be obtained which is integrated results in an I(0) process then the series are said to be cointegrated.

Cointegration implies that there exists a stable, long run equilibrium relation between the cointegrated series. They do not diverge over time and their difference is of finite variance. A necessary condition for convergence therefore is that the series be cointegrated.

The initial step in testing for cointegration is the establishment of the order of integration of the respective variables. When seasonality is not an issue the standard test for the order of integration of a series X_t is the Augmented Dickey-Fuller test. However with seasonality the order of integration may involve both seasonal and non-seasonal differences. Osbourne et al (1988) propose a test for the order of integration of seasonal data. They define a non-deterministic series X_t to be integrated of order (d,D), denoted $X_t \sim I(d,D)$, if the series has a stationary, invertible Autoregressive Moving Average (ARMA) representation after one period differencing d times and seasonal differencing D times. Hence X_t is I(d,D) if $(1-L)^d(1-L^s)^D X_t = \Delta^d \Delta_s{}^d X_t$ is stationary; L is the lag operator and s is the frequency of the data. Hylleberg et al (1990) provide an alternative definition where X_t is seasonally integrated of order (d^*,D^*), denoted $SI(d^*,D^*)$ if $(1-L)^{d*}S(L)^{D*}X_t$ is stationary, where $S(L) = 1+L+L^2+L^3$ can be likened to a moving average seasonal filter. In reconciling the two definitions it can be clearly shown that SI(2,1) is equivalent to I(1,1) and that the $SI(d^*,D^*)$ definition allows the additional testing possibilities of SI(2,0) and SI(0,1) not available in the I(d,D) definition.

The specific test used for seasonal integration follow Ilmakunnas (1990) and are variants of the Augmented Dickey-Fuller (ADF) and Hyllberg, Engle, Granger and Yoo (1990) (HEGY) tests (see table 3). The HEGY test decomposes the unit root in the seasonal data into a zero frequency root (achieved by using the $Z_{1,t}$ filter); a biannual frequency root (the $Z_{2,t}$ transformation); and finally an annual frequency root which is achieved by the $Z_{3,t}$ transformation. Starting from a null hypothesis of SI(1,1) for a series Z_t, the alternatives of SI(1,0) $\{$ i.e $\pi_1 = 0 \mid \pi_2, \pi_3, \pi_4 \neq 0 \}$; SI(0,1) $\{ \pi_2=\pi_3=\pi_4 = 0 \mid \pi_1 \neq 0 \}$ and SI(0,0) $\{ \pi_1, \pi_2, \pi_3, \pi_4 \neq 0 \}$ can be tested for the individual significance of the coefficients of $Z_{1,t}$ and $Z_{2,t}$ and the joint significance of the two lagged $Z_{3,t}$ terms. This procedure can be applied to the series in levels, or in first difference form in which case the null hypothesis would be SI(2,1) with alternatives SI(2,0), SI(1,1) and SI(1,0). The finite sample distributions for these 't' statistics are non-standard and are tabulated by Monte Carlo experiment in Hylleberg et al (1990).

Having established the order of integration of the respective series it is then possible to test for cointegration at the appropriate frequency. However estimation of a bivariate vector autoregression (VAR) offers some additional possibilities. Firstly within the VAR structure we may explore the causal relationships between CARICOM prices on one hand and US prices on the other. If cointegration has been established then we can test for Granger Causality within a vector error correction model (VEC). Engle and Granger (1987) showed that when two series are cointegrated there must be causation in at least one direction. For the bivariate model there exists a VEC of the form

$$\Delta P_{DM_t} = \sigma + \sum_{j=1}^{k-1} \alpha_j \Delta P_{US_{t-j}} + \sum_{j=1}^{k-1} \beta_j \Delta P_{DM_{t-j}} - \rho \pi_{t-k} + \varepsilon_t$$

$$\Delta P_{US_t} = \theta + \sum_{j=1}^{k-1} \partial_j \Delta P_{US_{t-j}} + \sum_{j=1}^{k-1} \gamma_j \Delta P_{DM_{t-j}} - \lambda \pi_{t-k} + \varepsilon_t^*$$

where $\pi_t = P_{DMt} - \mu P_{USt}$ is the equilibrium relationship between P_{DMt} and P_{USt}.

The joint significance from zero of the α_j terms in equation I and the joint insignificance from zero of the γ_j coefficients in equation II would indicate unidirectional causality from US prices to CARICOM prices. Similarly if as a group the α_j coefficients in equation I are insignificantly different from zero, while the γ_j coefficients in equation II are significantly different from zero, then unidirectional causality from CARICOM prices to US prices is concluded. Bidirectional causality would be indicated by the joint significance of the sets of coefficients of the lagged CARICOM and US terms in both equations. Further, a significant coefficient on the lagged equilibrium residual term π_t in either equation would also imply Granger causality even if the coefficients of the price terms are all insignificant.

The VAR (or VEC) structure would also allow us to draw inferences on the exogeneity of the respective variables within our model. Engle, Hendry and Richard (1983) define a variable X_t to be weakly exogenous for estimating a set of parameters λ if inference on λ conditional on X_t involves no loss of information. In other words given a joint probability density function of two continuous random variables X and Y as $f(y_t,x_t)$, and $g(y_t|x_t)$ - the conditional distribution of y_t given x_t which involves parameters λ, and that $h(x_t)$ is the marginal distribution of X, then we may write

$$f(y_t,x_t) = g(y_t|x_t)*h(x_t)$$

with weak exogeneity implying that $h(x_t)$ does not involve the parameters λ. Under these conditions the parameters of $h(x_t)$ are merely nuisance parameters.

Furthermore Engle et al define x_t to be strongly exogenous if x_t is weakly exogenous and is not Granger caused by any of the endogenous variables in the system.[4]

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[4]A third concept, that of superexogeneity, is also defined. X_t is said to be superexogenous if it is weakly exogenous and the parameters of the conditional distribution are invariant to changes in the marginal distribution of X_t. This concept is related to the Lucas critique which argues that the parameters of a model may be modified by the impact of expectations concerning changes in the policy (exogenous) variables; see R.E.Lucas (1976). See also Leamer (1985) whose definition of superexogeneity does not require weak exogeneity.

The statistical procedure employed therefore is as follows. We first test for the order of seasonal integration and transform the variables to their stationary counterparts. We next test for cointegration between the US price data and each of the CARICOM countries' price data in turn. If the cointegrating matrix is of full rank we estimate the VAR in levels; if the rank is zero we estimate the VAR in first differences. If the rank is less than full we estimate the VEC and test for Granger causality and exogeneity within that structure.

Section II - Empirical Results

In this paper quarterly observations spanning over the period 1957:1 - 1993:4 are utilized. The data set consists of series on the consumer price index (CPI) for the CARICOM countries and on the producer price index (PPI) for the United States. The latter index reflects the price of imported commodities into the CARICOM region from its major trading partner. All the data were obtained from the International Monetary Fund's statistical database and all computations were done using the MicroTSP and Econometric Views statistical programs.

Charts 1 - 5 show the graphs of the various series. The upward trend in the data appears to be partially removed by first differencing. However much variability exists in these differenced series especially in the mid 1970's and late 1970's - early 1980's periods which corresponded to the two major oil shocks. The variability in the Jamaican inflation rate also increased over the 1980's and into the 1990's largely reflecting the instability of the exchange rate over that period. The second order differences all have zero means. This suggests that the trend in the underlying data generating process may be removed by successive differencing of the data.

The HEGY test for the levels suggest that the variables are SI(1,0) as opposed to SI(0,0), and also rejects SI(1,1) for SI(1,0). In addition the first differenced series are SI(1,0) as opposed to SI(2,0). If the testing sequence is started at SI(2,1) the same results are obtained. The tests therefore indicate that the series can be rendered stationary by simple second differencing and also reject the need for any seasonal differencing. This findings supports the conclusions of Downes and Leon (1987) and also of Holder, Leon and Wood (1991) that price data in the CARICOM region are generally SI(2,0). We also find evidence that the price series become SI(1,0) once the effects of the two oil shocks are accounted for. This again finds support in the work of Perron (1989) who obtain similar results for US price data.

With one exception the coefficients on the seasonal dummy variables in the HEGY test were insignificantly different from zero indicating the absence of deterministic seasonality in the data. The exception was in the results from Dominica. We handled this deterministic element by regressing the Dominican inflation rate on the seasonal dummies and utilizing the residuals in the subsequent tests for cointegration.

We utilized the Johansen procedure to test for cointegration within a bivariate model. Specifically we estimated the rank of the cointegrating matrix for the inflation rates of the US and the individual CARICOM countries. We found evidence to support cointegration between US inflation rates and those of Barbados and Dominica. This was some indication of the convergence between these rates. However no cointegration was found between the US, Jamaica and Trinidad and Tobago possibly due to the instability of the exchange rate of the two latter countries over recent periods.

The next step involved the estimation of the VEC model for the cointegrated variables. Our results show that there is unidirectional causality from US inflation to inflation in Barbados and Dominica. Moreover the results imply a long run causal relationship which is indicated by the significance of the error correction term. Without the cointegrating residual neither variable in the bivariate model causes the other.

The VEC results show that the adjustment coefficients are 0.73, 0.93 for the Barbados and Dominica equations respectively. The coefficient of the US variable in the cointegrating equation was 1.29 and 1.46 for the same countries respectively and this was deemed to be satisfactory given that the mark up on imported goods is typically around 25 per cent.

Charts 6 and 7 graph the impulse responses of the inflation rates to innovations of one standard deviation. The responses of regional inflation rates to US innovations are seen to be much larger than responses in the opposite direction. In terms of the variance decompositions, in the long run 93 per cent of the forecast error variance of both Barbados and Dominica inflation rates respectively are accounted for by US inflation innovations. In addition only 4.5 and 6 per cent of US inflation variance is not explained by its own innovations.

Section III - Conclusions

This paper utilized quarterly data spanning the period 1957:1 - 1993:4 to test whether the inflation rates in four CARICOM countries have converged to a US inflation rates. We utilized an initial procedure which tested for seasonal integration and cointegration in the data, and a vector error correction model to uncover any causal relationships and to enquire into the exogeneity of US inflation rates in our model.

The evidence found in the data suggests that convergence has occurred between the US, Barbados and Dominica but not between the US, Jamaica and Trinidad and Tobago. This supports the convergence to a 'core' country hypothesis and demonstrates that economic divergence may occur in the presence of volatile exchange rates. Convergence to a low inflation rate as a goal of a monetary union may be achieved under a floating exchange rate regime once exchange rates are relatively stable.

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Chart1: Levels of Series

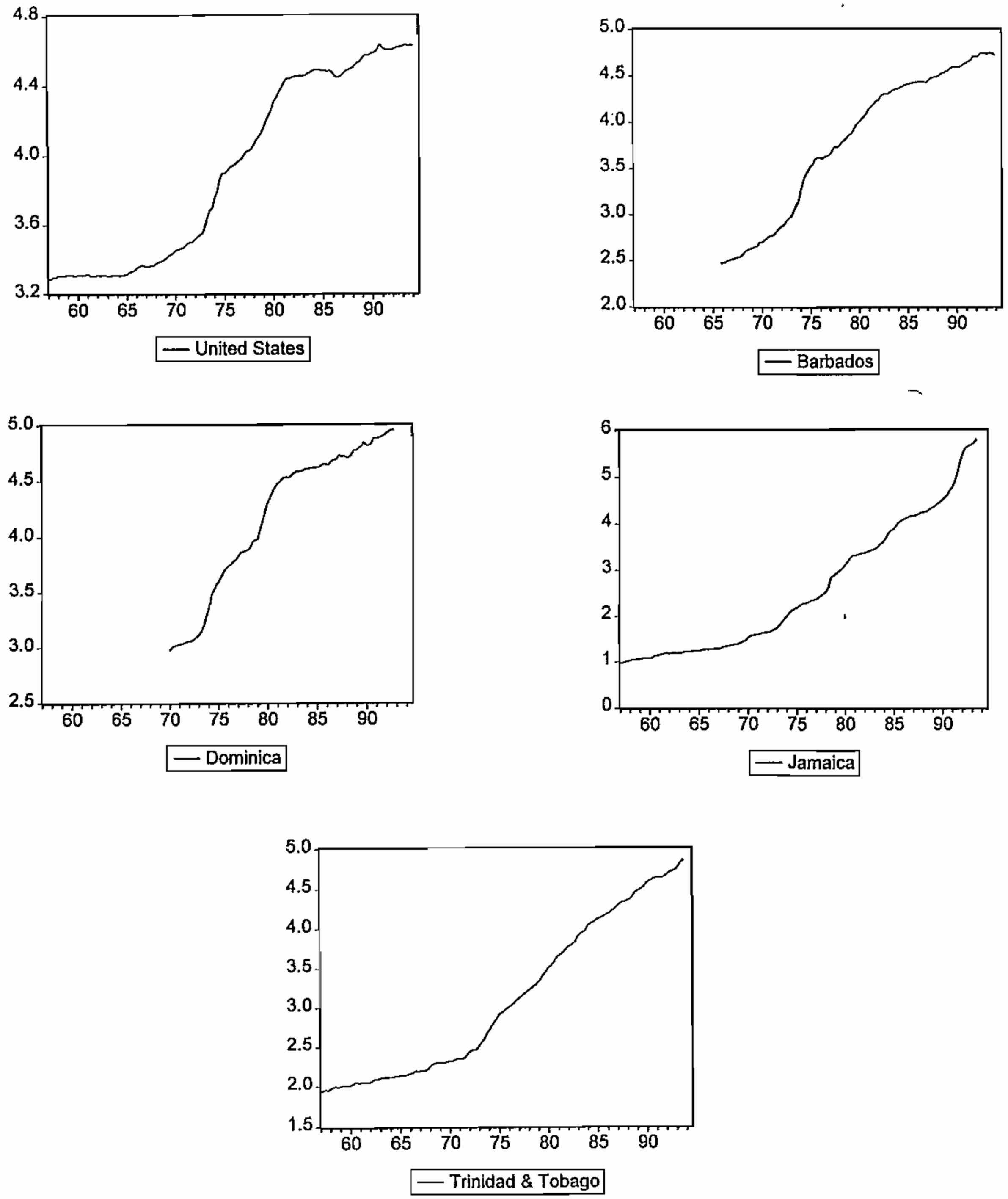

Chart2: First Difference of Series

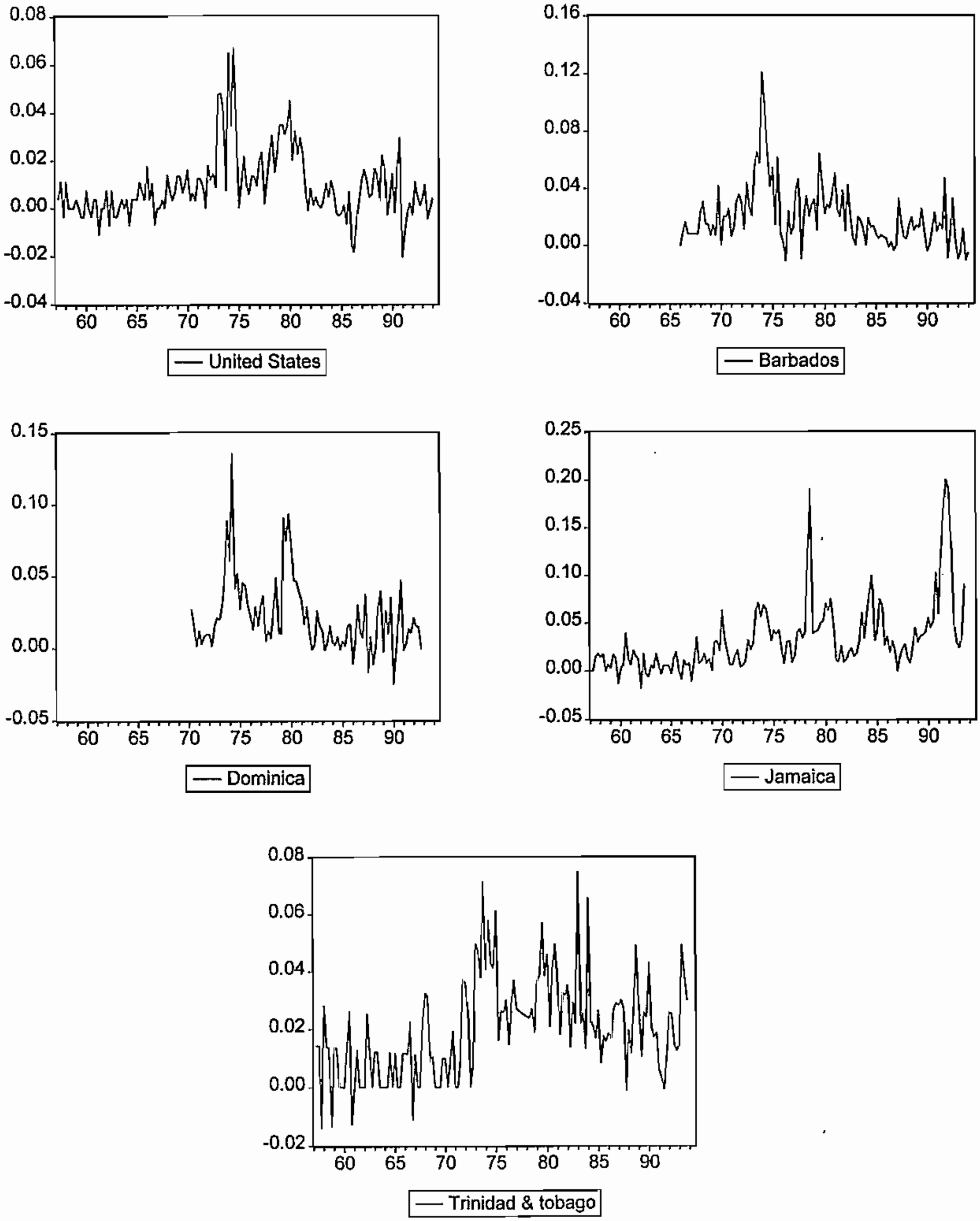

Chart3: Second Difference of Series

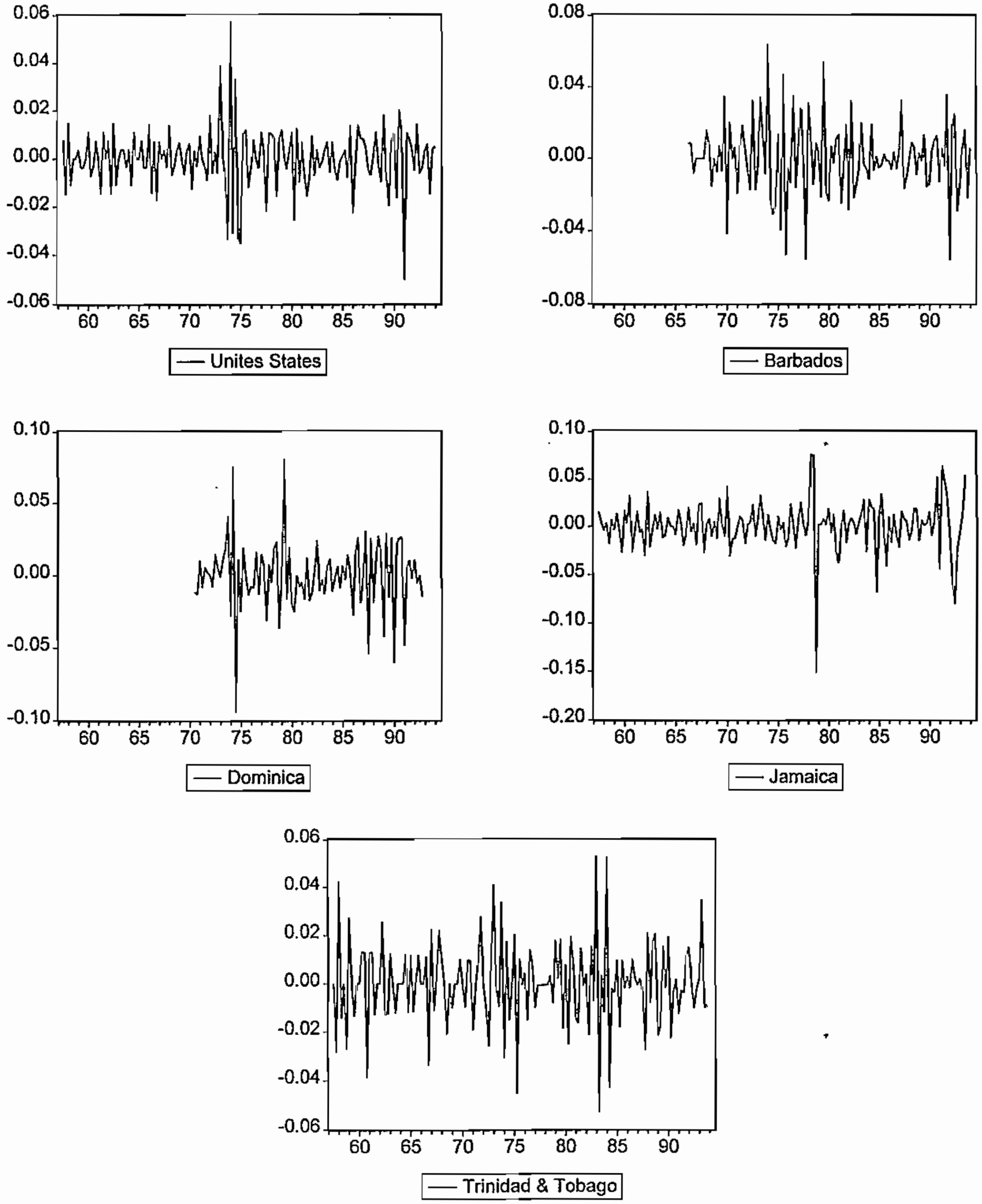

Chart4: Fourth Difference of Series

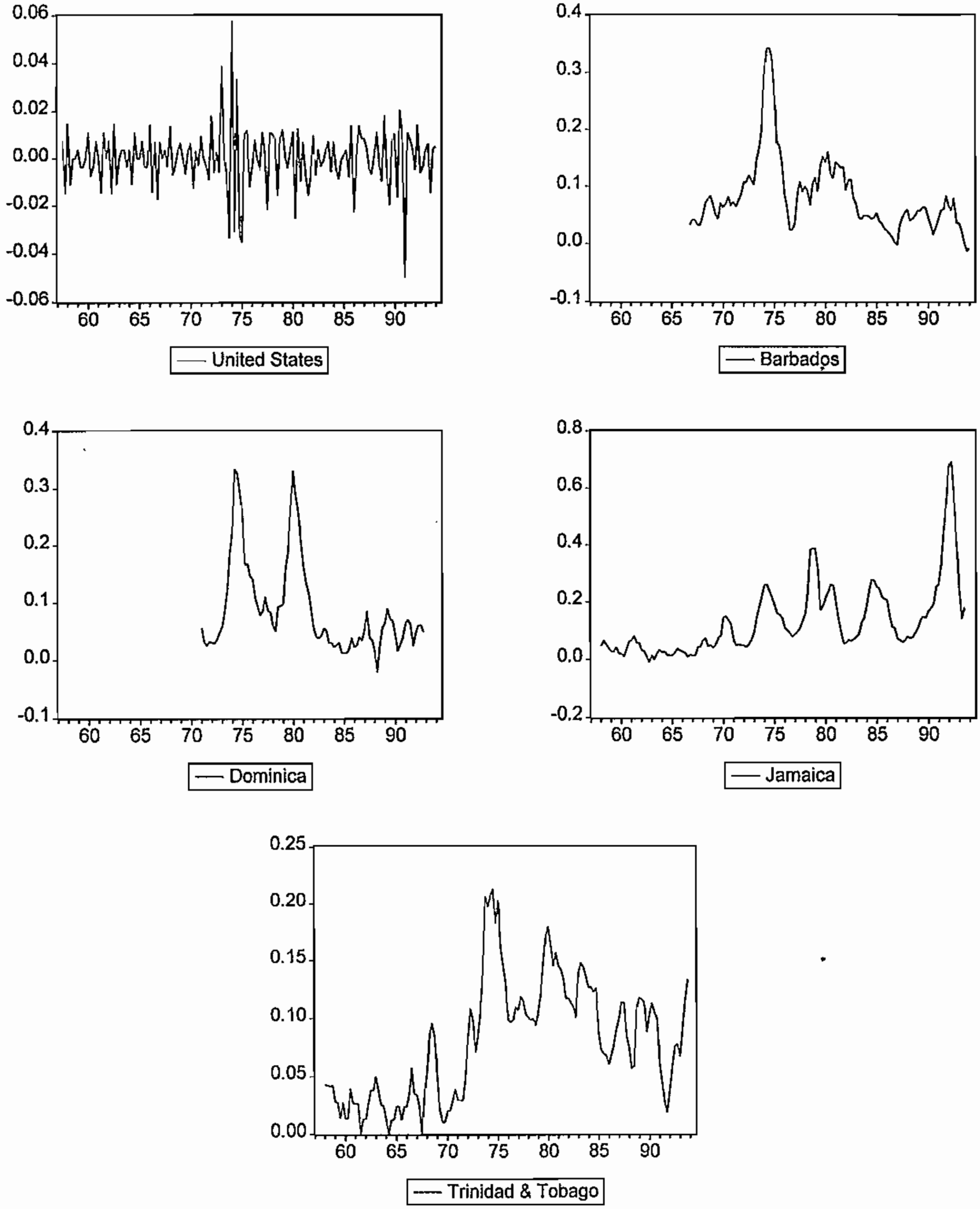

Chart5: First of the Fourth Difference of Series

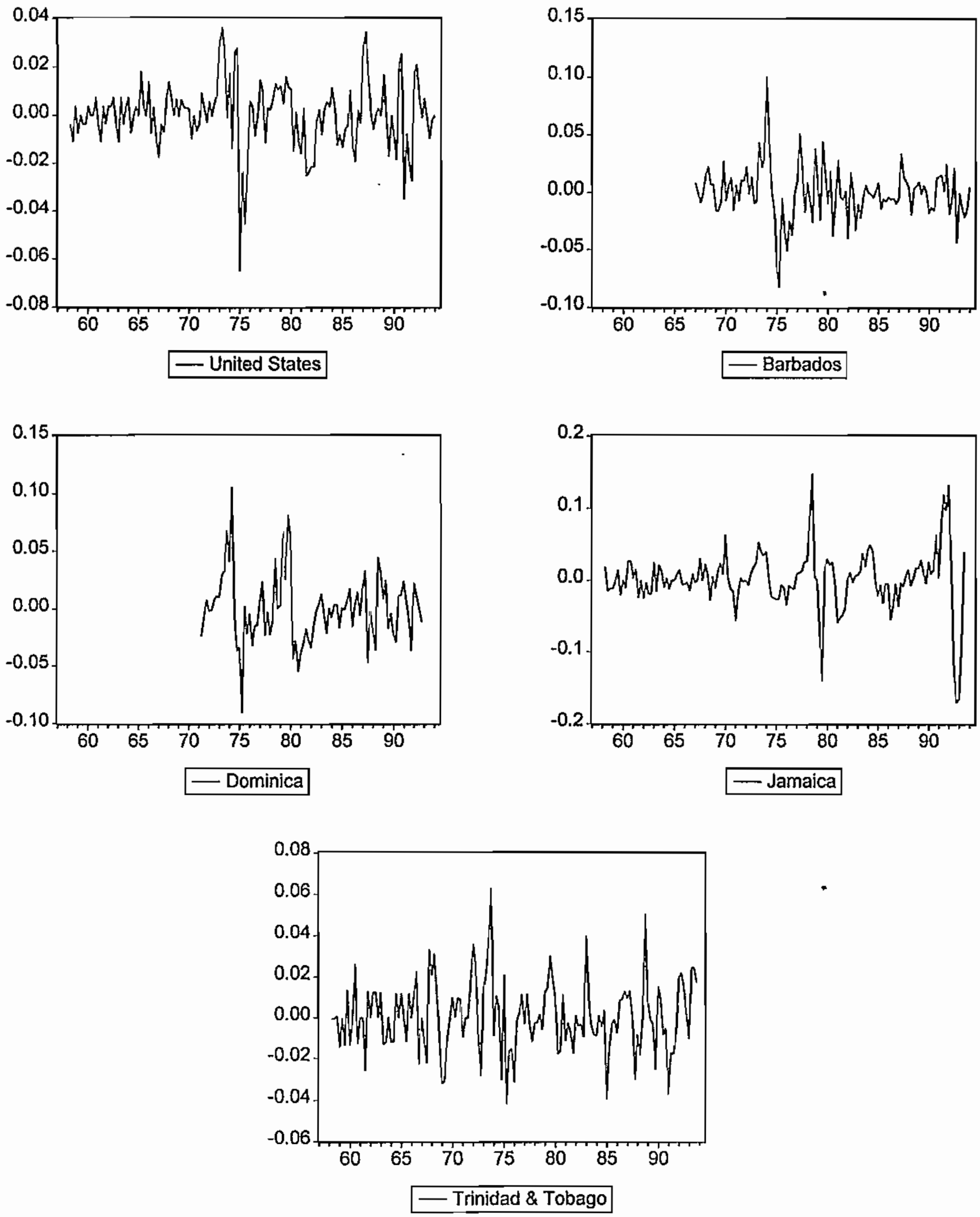

Chart 6

Response to One S.D. Innovations

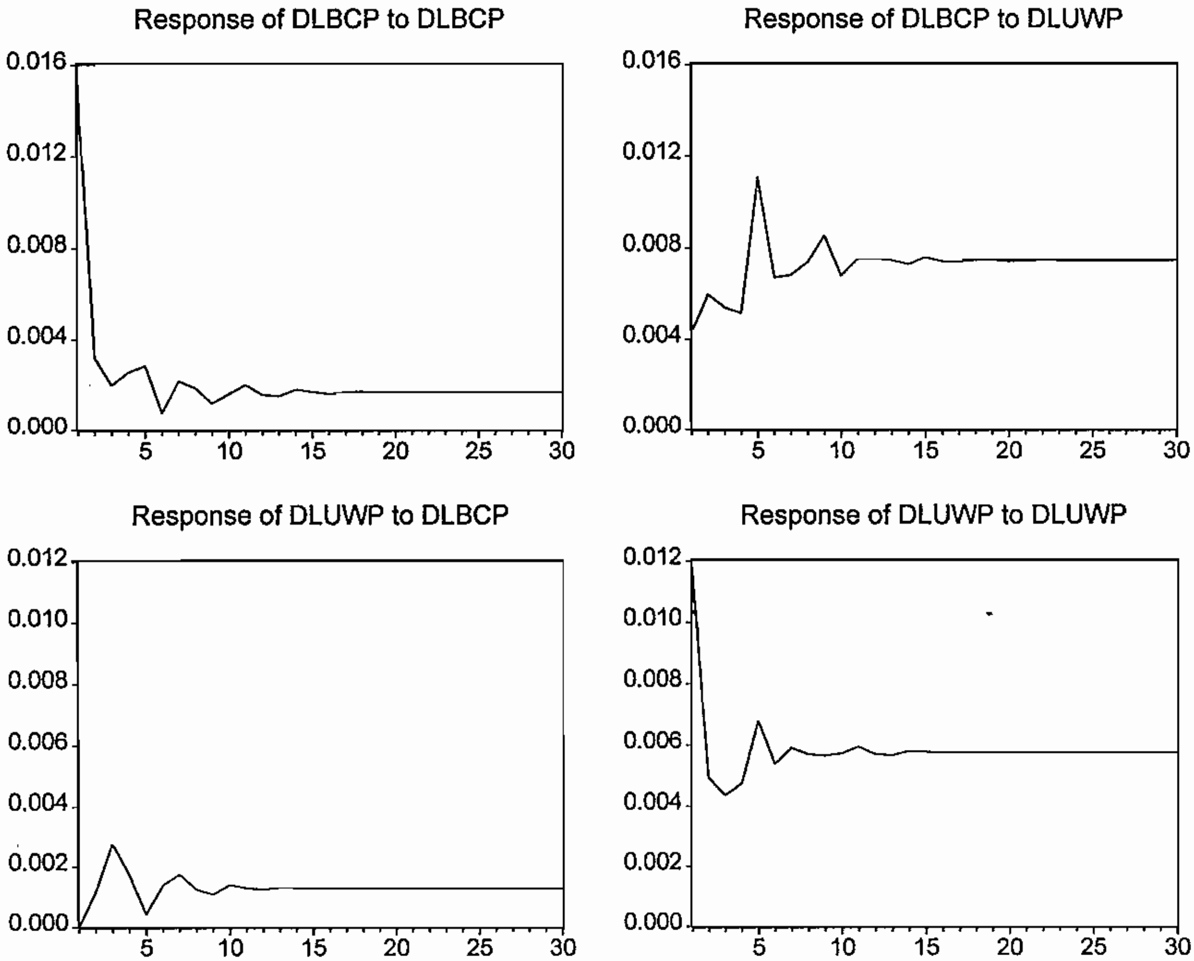

Chart 7
Variance Decomposition

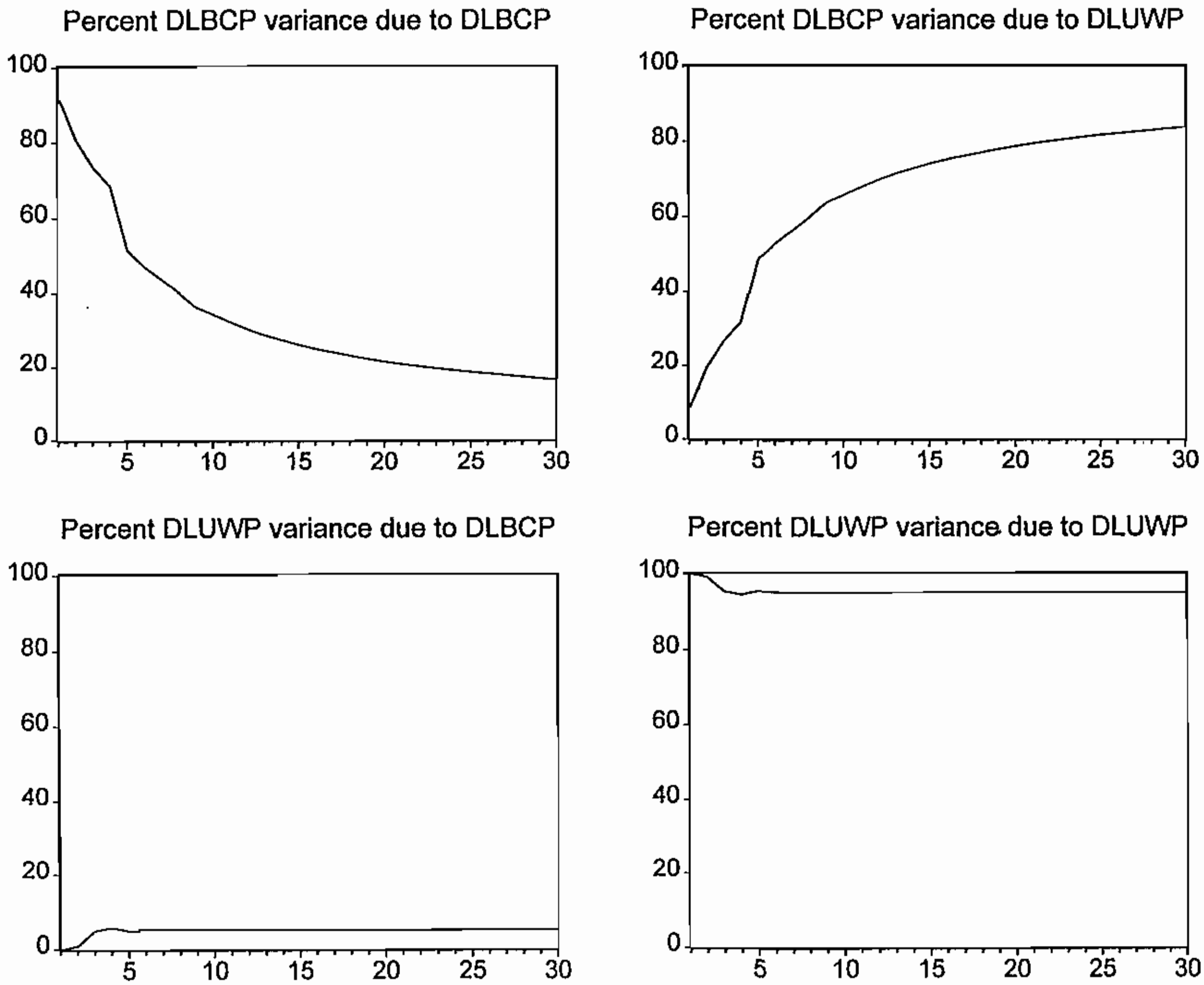

Chart 8

Response to One S.D. Innovations

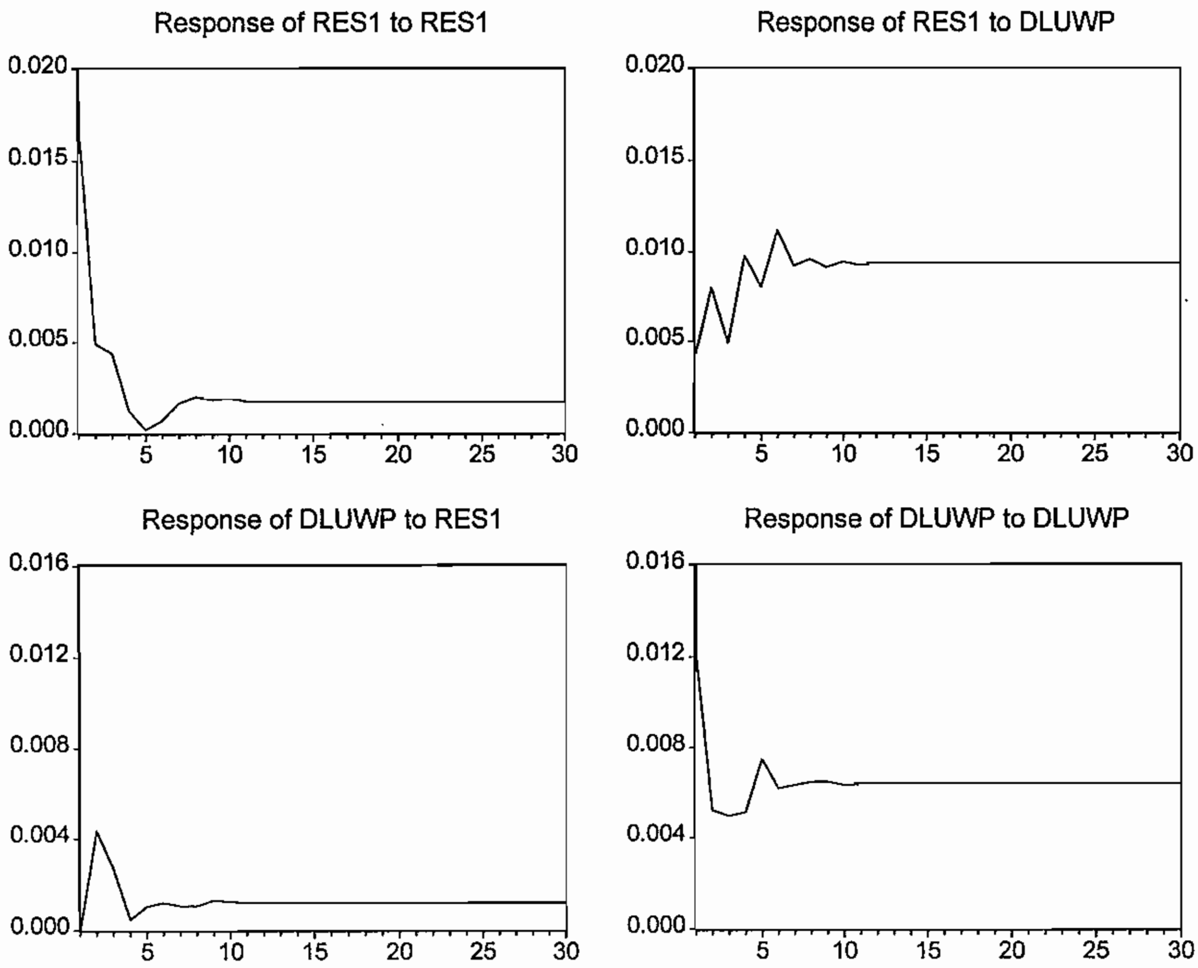

Chart 9
Variance Decomposition