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By

Mrs. Janice Christopher-Nicholls

Economist

Central Bank of Trinidad and Tobago

Ms. Leslie Ann Des Vignes

Economist

Central Bank of Trinidad and Tobago

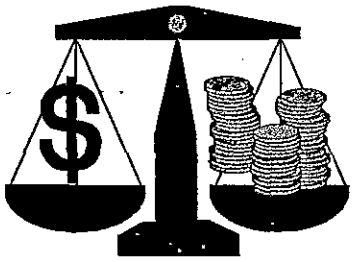
Paper presented at the XXXIV Annual Monetary Studies Conference

Georgetown, Guyana

November 12-16, 2002

CENTRAL BANK OF TRINIDAD AND TOBAGO

RESEARCH DEPARTMENT



MODELLING EXCHANGE RATE PASS-THROUGH AND INFLATION IN TRINIDAD AND TOBAGO

BY

JANICE CHRISTOPHER-NICHOLLS
AND
LESLIE-ANN DES VIGNES

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NOVEMBER 2002

Modelling Exchange Rate Pass-through and Inflation in Trinidad and Tobago[1]

I. Introduction

In the theorectical literature, the degree to which changes in the exchange rate pass through to prices has been an important issue in debates about the appropriateness of monetary policy and exchange rate policy. Its relevance is manifested even more with the emergence of a greater role for inflation rate targeting. A low exchange rate pass-through presents greater freedom for the pursuit of independent monetary policy and an easier implementation of inflation rate targeting. However, there is little or no consensus on the conditions that lead to a low exchange rate pass-through.

Studies by Mann (1986), Wei and Parsley (1995) and Engel and Rogers (1998) which explored the pass-through of exchange rate changes to prices, argued that greater exchange rate volatility may reduce exchange rate pass through to prices since importers may be more willing to adjust profit margins rather than prices. However, they suggest that the response would most likely be different, if firms believed that the exchange rate shock is persistent. Their action would be an adjustment to prices rather than profit margins. These studies also examined the role of aggregate demand and suggested that shifts in aggregate demand together with fluctuations in the exchange rate would alter the profit margins of importers therefore lowering the pass-through. Hence, exchange rate pass-through should be smaller in a country where aggregate demand is of a more volatile nature.

Kim (1998) presented the argument that while the money supply, income and interest rates affected US inflation directly, the exchange rate on the other hand influenced the aggregate price by changing the prices of importables and exportables. He contended that the nature of the good dictated the changes in the dollar price of imports. He argued that for homogenous commodities traded in international markets, a depreciation of the US dollar would increase their prices one on one because of the law of one price. In the case of manufactured goods however, foreign suppliers to the domestic US market

[1] The views expressed in this paper are those of the authors and in no way represent the views of the Central Bank of Trinidad and Tobago. Any errors or misconceptions are their responsibility.

absorb some of the impact of the exchange rate changes and the price will rise by less than the US dollar depreciation. Kim concluded that as long as import prices increase, there would be matching hikes by domestic manufacturers and the extent to which prices of intermediate goods are affected by exchange rate movements, would be reflected in cost increases that will be passed on.

In a more recent paper by Taylor (2000), it was argued that firms set prices for several periods ahead and those prices respond more to increases in costs (due to exchange rate depreciation or other sources) if these cost changes are viewed to be persistent. Taylor articulated the view that a high inflation environment would tend to increase the exchange rate pass-through while a credible low inflation regime would automatically achieve a low pass-through. Two recent studies by Campa and Goldberg (2001) and Ganon and Ihrig (2001) explored the relationship of exchange rate pass-through with monetary policy behaviour and the inflationary environment. The evidence from these studies, though not conclusive, seemed to suggest a positive relationship between higher inflation and exchange rate volatility but argued that the composition of imports was an important determinant of the pass-through effect.

The main objective of this paper is to re-examine using the VAR modelling approach, the relationship between inflation and many of the factors that are known to contribute to inflationary trends in Trinidad and Tobago. The paper also carries out a preliminary investigation of the pass-through of exchange rate to domestic prices. This research follows on the work of Robinson (1998) who examined price behaviour in Jamaica using a VAR model. Robinson found that whereas a decline in the rate of depreciation of the exchange rate had an immediate dampening effect on prices particularly in the first year, contractionary monetary policy had a lag effect of at least two months. Based on his results, Robinson contended that inflationary shocks were long lived in Jamaica and that stabilization policies must take significant recognition of this fact. Explanations of inflationary trends in Trinidad and Tobago have been explored in many research papers and one of the contributions of this paper would be to test using Granger causality, the transmission mechanism between exchange rate, import prices and consumer prices. The argument is that movements in the exchange rate should inevitably affect consumer prices in a small open economy such as Trinidad and Tobago. A change in the exchange rate is transmitted directly to prices or indirectly through changes in the composition of

demand or the levels of aggregate demand. Evidently, a depreciation of the local currency would affect the prices of imported goods, however, the increased cost to producers and retailers would not be reflected entirely or immediately on consumer prices. The extent and the speed of the pass-through would depend on factors such as demand conditions, the cost of adjusting prices and the perception of the duration of the depreciation. However, it must be emphasized that in Trinidad and Tobago as in many other economies, inflation depends ultimately on monetary policy which in turn influences exchange rate fluctuations.

The paper is organized as follows. Section II presents a description of Trinidad and Tobago's inflationary experience while Section III provides a brief review of the empirical studies of inflation for Trinidad and Tobago. Section IV outlines the VAR model and presents an empirical analysis of the time series data. Section V discusses the results and interpretation of the impulse response and the variance decomposition. Section VI provides a conclusion.

II. Trinidad and Tobago's Inflationary Experience

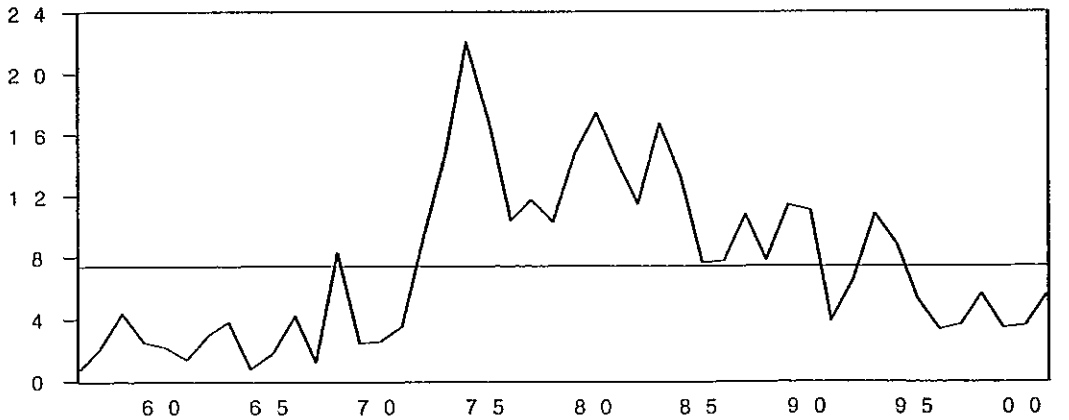
Trinidad and Tobago experienced low inflation over the period 1955 to 1971 with an average inflation rate of 2.8 per cent. During this period, the TT dollar was pegged to the pound sterling and monetary policy was influenced by movement in the interest rates of the United Kingdom. In 1967, the pound sterling came under immense pressure and was devalued by 14.3 per cent. In order to maintain its parity with the pound sterling the TT dollar was subsequently devalued by the same amount. Consequently, in 1968 the first inflationary episode occurred as the inflation rate increased by 8.3 per cent. However, this spurt of inflation was short-lived as the rate declined to 2.4 per cent in 1969 and remained around this level until 1972.

The second surge of inflation occurred over the period 1972 to 1983 and was more pervasive than in 1968. Inflation rose from 3.5 per cent in 1971 to 9.3 per cent in 1972, to 14.8 per cent in 1973 and reached a high of 22 per cent in 1974. A combination of factors contributed to fuelling of inflation over this period. The oil boom which aggravated the excess liquidity situation in the banking system caused an expansionary effect on the money supply. Moreover, import prices were higher, supply conditions were more constrained because of severe drought of 1973 and there was also wage price

inflation. Inflation slowed somewhat after 1975 and by the end of 1983 inflation rate at 16.7 per cent.

Following the decline in the economy in 1983, the country entered a period of extended structural adjustment from 1984 to 1993. During this period, inflation slowed due to the implementation of tighter monetary and fiscal policies, and the recession in Trinidad and Tobago. Monetary policy was now concerned with protection and stabilization of the balance of payments and shifted emphasis away from inflation control. Consequently, there was a 33 per cent devaluation of the TT dollar against the United States dollar in December 1985. However, the pass through to domestic prices was not immediate, since the old exchange rate was maintained for a scheduled list of food, drugs, and other imported items. By 1987 however, with the unification of the exchange rate, inflation reached 10.7 per cent. The TT dollar was devalued again in 1988 and by 1989 the country entered into back to back stand-by arrangements with the IMF. These arrangements sought to reduce the external account deficit, lower the fiscal deficit, achieve an accumulation of foreign exchange reserves and restore economic growth. All these development culminated in the floating of the TT dollar in 1993 and the removal of exchange controls. This resulted in an immediate 25.1 per cent devaluation of the TT dollar and the one time pass through to domestic prices was reflected in an inflation rate of 10.8 per cent.

Chart 1: Inflationary Episodes



More recent trends have indicated that inflation has slowed considerably, averaging 4.3 per cent over the period 1994 to 2001. These seven years were characterized by non-inflationary growth, relatively low unemployment rate, balance of payments surpluses and high and increasing foreign reserves. The main objectives of monetary policy have been price and exchange rate stability, the conditions conducive for sustained growth and development. The low level of inflation can also be attributed to factors such as low world inflation, the relatively tight stance of monetary policy and the fact that government continued to practice fiscal restraint.

III. Empirical Studies of Inflation in Trinidad and Tobago

This section concentrates on empirical research of the inflationary process in Trinidad and Tobago. As discussed in Section II, the 1970s and 1980s were years of double digit inflation compared with the low inflation levels of the 1960s and many of research papers emerged to explain these inflationary trends. It was generally recognized that higher prices were due both to international and domestic developments. The focus therefore was on (i) the mechanisms through which international inflation pressures were transmitted to the Caribbean region (ii) domestic supply conditions such as inelastic supply of key commodities and high markups.[2]

The two earliest studies, St. Cyr (1974) and Ramjeesingh (1974) were clearly rooted in the Structuralist school as both studies explored factors such as the degree of openness of the economy, wages and earnings and import prices. The results of these studies concluded that changes in import prices played the key role in explaining domestic price movements. Indeed, Ramjeesingh's research also looked at the demand-supply mechanism to explain the determinants of price change and found demand side influences were unimportant. These results further entrenched the Structuralist tradition as the explanatory approach to Trinidad and Tobago's inflation.

In the aftermath of the first oil price shock of 1974 and the ensuing inflation and recession in the international community, regional monetary authorities adopted a more active monetary stance. As a consequence, empirical research shifted its focus to the investigation of the influence of monetary factors on inflationary trends. The model specified by Bourne and Persaud (1977) and St. Cyr (1979) incorporated both demand-

[2] The Structuralist interpretation is well discussed in Seers (1962).

pull and cost-push factors to explain the propulsive role of monetary and financial variables.[3] In particular, St. Cyr tested the hypothesis that import prices triggered price increases and increases in wages and salaries and that the money supply performed a permissive role while price expectations reinforced the spiral.

By the 1980s, following the "hybrid" models, Bynoe (1981) explicitly researched the monetarist approach to the balance of payments to examine the inflationary process, modifying this approach to include the role of fiscal policy. She suggested that while import prices were important, there was also an explanatory role for fiscal activity, income and monetary variables. Farrell (1984) assumed that sources of inflation vary over time and that they affected the inflationary process in different ways. The results of this research showed that changes in the exchange rate were statistically significant while import prices were not.

Empirical research on the determinants of inflation in the 1990s for Trinidad and Tobago has been less vigorous while our regional counterparts such as Coppin (1993), Robinson (1998), Cumberbatch (1997) and Allen (2000) have continued to explore the inflationary process in Barbados and Jamaica. Meanwhile the inflationary process in Trinidad and Tobago has been investigated in the 1990s by Christopher-Nicholls (1992) who adopted the Johansen's procedure to analyse the inflation trends from 1955 to 1990 and found import prices to be important. Nicholls et al (1995) explored money price causation in four CARICOM countries and Ayebeyegbe (1996) and Leon et al (1996) estimated the stochastic nature of inflation and inflation convergence for Trinidad and Tobago. Since then, the emphasis of empirical research has shifted to the measurement of core inflation and an examination of an inflation rate targeting framework for Trinidad and Tobago. Even though the TT dollar was floated in 1993, there has been no significant research on the impact of exchange rate movements on inflation. Stanley (1996) attempted to measure core and underlying inflation using the zero weighting technique to exclude non-monetary factors from the series of retail prices index. In one representation he isolated food price fluctuations to obtain a core measure of inflation. Meanwhile Rambarran (2000), on the basis of some preliminary research concluded that if Trinidad and Tobago were to adopt an inflation rate targeting, it would be a means by

[3] These models have been described as "hybrid" models or as articulated by Harberger (1963).

which it could maintain its inflation gains. The evidence suggested that Trinidad and Tobago had already achieved some degree of success in controlling inflation.

IV. A VAR Model and Empirical Analysis

IV.1 VAR Model[4]

The modelling approach used to examine the relationship between inflation and its determinants is a vector autoregression (VAR) model.[5] In essence the approach involves a model of the moving average and autoregressive components of several time series variables which are then used to predict movements in these variables. The econometric literature clearly highlights the usefulness of this approach for forecasting systems since it provides for the causal and feedback relation among time series variables. VAR modelling has been used extensively in the pass-through literature to simulate the dynamic response over time of any variable to disturbances of itself or to other variables in the system.

Consider the following VAR model used to explain the inflationary process in Trinidad and Tobago:

$$\dot{p}_t^d = \alpha_{10} + a_{10}\dot{R}_{1t} + a_{11p}\dot{P}_{1t}^o + \sum_{i=1}^{n=4} b_{1i}\dot{p}_{t-i}^d + \sum_{i=1}^{n=4} c_{1i}\dot{y}_{t-i} + \sum_{i=1}^{n=4} d_{1i}\dot{p}_{t-i}^m + \sum_{i=1}^{n=4} e_{1i}\dot{M}_{t-i}^0 + \sum_{i=1}^{n=4} f_{1i}\dot{p}_{t-i}^e + \mu_{1t}^{\dot{p}_t^d}$$

$$\dot{y}_t = \alpha_{20} + a_{20}\dot{R}_{2t} + a_{21}\dot{P}_{2t}^o + \sum_{i=1}^{n=4} b_{2i}\dot{p}_{t-i}^d + \sum_{i=1}^{n=4} c_{2i}\dot{y}_{t-i} + \sum_{i=1}^{n=4} d_{2i}\dot{p}_{t-i}^m + \sum_{i=1}^{n=4} e_{2i}\dot{M}_{t-i}^0 + \sum_{i=1}^{n=4} f_{2i}\dot{p}_{t-i}^e + \mu_{2t}^{\dot{y}_t}$$

$$\dot{p}_t^m = \alpha_{30} + a_{30}\dot{R}_{3t} + a_{31}\dot{P}_{3t}^o + \sum_{i=1}^{n=4} b_{3i}\dot{p}_{t-i}^d + \sum_{i=1}^{n=4} c_{3i}\dot{y}_{t-i} + \sum_{i=1}^{n=4} d_{3i}\dot{p}_{t-i}^m + \sum_{i=1}^{n=4} e_{3i}\dot{M}_{t-i}^0 + \sum_{i=1}^{n=4} f_{3i}\dot{p}_{t-i}^e + \mu_{3t}^{\dot{p}_t^m}$$

$$\dot{M}_t^0 = \alpha_{40} + a_{40}\dot{R}_{4t} + a_{41}\dot{P}_{4t}^o + \sum_{i=1}^{n=4} b_{4i}\dot{p}_{t-i}^d + \sum_{i=1}^{n=4} c_{4i}\dot{y}_{t-i} + \sum_{i=1}^{n=4} d_{4i}\dot{p}_{t-i}^m + \sum_{i=1}^{n=4} e_{4i}\dot{M}_{t-i}^0 + \sum_{i=1}^{n=4} f_{4i}\dot{p}_{t-i}^e + \mu_{4t}^{\dot{m}_t^2}$$

$$\dot{p}_t^e = \alpha_{50} + a_{50}\dot{R}_{5t} + a_{51p}\dot{P}_{5t}^o + \sum_{i=1}^{n=4} b_{5i}\dot{p}_{t-i}^d + \sum_{i=1}^{n=4} c_{5i}\dot{y}_{t-i} + \sum_{i=1}^{n=4} d_{5i}\dot{p}_{t-i}^m + \sum_{i=1}^{n=4} e_{5i}\dot{M}_{t-i}^0 + \sum_{i=1}^{n=4} f_{5i}\dot{p}_{t-i}^e + \mu_{5t}^{\dot{p}_t^d}$$

where ,

$\dot{p}_t^d$ = changes in domestic prices

$\dot{y}_t$ = changes in Gross Domestic Output (GDP)

$\dot{p}_t^m$ = changes in import prices

$\dot{M}_t^0$ = changes in base money

$\dot{p}_t^e$ = changes in exchange rate

[4] See Watson and Teelucksingh (2002) for a introductory discussion of VAR modeling.

[5] VAR models were developed by Sims (1980) who challenged the validity the theoretical restrictions of the traditional structural form models.

$\dot{R}_{it}$ = changes in treasury bill rate

$\dot{P}^{o}_{it}$ = changes in oil prices

In Matrix format the model is as follows:-

$$\begin{bmatrix} \dot{p}^{d}_{t} \\ \dot{y}_{t} \\ \dot{p}^{m}_{t} \\ \dot{M}^{0}_{t} \\ \dot{P}^{e}_{t} \end{bmatrix} = \begin{bmatrix} b_{11}\, c_{11}\, d_{11}\, e_{11}\, f_{11} \\ b_{21}\, c_{21}\, d_{21}\, e_{21}\, f_{21} \\ b_{31}\, c_{31}\, d_{31}\, e_{31}\, f_{31} \\ b_{41}\, c_{41}\, d_{41}\, e_{41}\, f_{41} \\ b_{51}\, c_{51}\, d_{51}\, e_{51}\, f_{51} \end{bmatrix} \begin{bmatrix} \dot{p}^{d}_{t-1} \\ \dot{y}_{t-1} \\ \dot{p}^{m}_{t-1} \\ \dot{M}^{0}_{t-1} \\ \dot{P}^{e}_{t-1} \end{bmatrix} + \begin{bmatrix} b_{12}\, c_{12}\, d_{12}\, e_{12}\, f_{12} \\ b_{22}\, c_{22}\, d_{22}\, e_{22}\, f_{22} \\ b_{32}\, c_{32}\, d_{32}\, e_{32}\, f_{32} \\ b_{42}\, c_{42}\, d_{42}\, e_{42}\, f_{42} \\ b_{52}\, c_{52}\, d_{52}\, e_{52}\, f_{52} \end{bmatrix} \begin{bmatrix} \dot{p}^{d}_{t-2} \\ \dot{y}_{t-2} \\ \dot{p}^{m}_{t-2} \\ \dot{M}^{0}_{t-2} \\ \dot{P}^{e}_{t-2} \end{bmatrix} + \begin{bmatrix} b_{13}\, c_{13}\, d_{13}\, e_{13}\, f_{13} \\ b_{23}\, c_{23}\, d_{23}\, e_{23}\, f_{23} \\ b_{33}\, c_{33}\, d_{33}\, e_{33}\, f_{33} \\ b_{43}\, c_{43}\, d_{43}\, e_{43}\, f_{43} \\ b_{53}\, c_{53}\, d_{53}\, e_{53}\, f_{53} \end{bmatrix}$$

$\tilde{y}_t \qquad B_1 \qquad \tilde{y}_{t-1} \qquad B_2 \qquad \tilde{y}_{t-2} \qquad B_3$

$$\begin{bmatrix} \dot{p}^{d}_{t-3} \\ \dot{y}_{t-3} \\ \dot{p}^{m}_{t-3} \\ \dot{M}^{0}_{t-3} \\ \dot{P}^{e}_{t-3} \end{bmatrix} + \begin{bmatrix} b_{14}\, c_{14}\, d_{14}\, e_{14}\, f_{14} \\ b_{24}\, c_{24}\, d_{24}\, e_{24}\, f_{24} \\ b_{34}\, c_{34}\, d_{34}\, e_{34}\, f_{34} \\ b_{44}\, c_{44}\, d_{44}\, e_{44}\, f_{44} \\ b_{54}\, c_{54}\, d_{54}\, e_{54}\, f_{54} \end{bmatrix} \begin{bmatrix} \dot{p}^{d}_{t-4} \\ \dot{y}_{t-4} \\ \dot{p}^{m}_{t-4} \\ \dot{M}^{0}_{t-4} \\ \dot{P}^{e}_{t-4} \end{bmatrix} + \begin{bmatrix} a_{10}\, a_{11} \\ a_{20}\, a_{21} \\ a_{30}\, a_{31} \\ a_{40}\, a_{41} \\ a_{50}\, a_{51} \end{bmatrix} \begin{bmatrix} \dot{R}_t \\ \dot{P}^{o}_{t} \end{bmatrix} + \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \\ \alpha_{40} \\ \alpha_{50} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ \mu_{5t} \end{bmatrix}$$

$\tilde{y}_{t-3} \qquad B_4 \qquad \tilde{y}_{t-4} \qquad A_1 \qquad Z_t \qquad A_0 \qquad E_t$

Simplified further the VAR model in matrix representation is as follows:-

$$\tilde{y}_t = A_0 + A_1 Z_t + B_1 \tilde{y}_{t-1} + \ldots + B_4 \tilde{y}_{t-4} + E_t$$

where $\tilde{y}$ is a vector of five endogenous variables, A_1 is a vector of two exogenous variables and B are matrices of coefficients to be estimated and E is a vector of random errors that are contemporaneously correlated with each other but uncorrelated with their own lagged values and uncorrelated with all the right hand side variables.

Empirical Analysis

This section examines graphically the relationship between inflation and the exchange rate, import prices, money supply and output. Chart 2 shows a strong relationship between exchange rates and inflation as the exchange rate shocks of 1967, 1976, 1985, 1988 and 1993 filtered through to domestic prices. Meanwhile, from Chart 3 we see that in the period 1971 to 1983, higher import prices brought on by accelerated world inflation had a positive influence on domestic price inflation. Moreover, Chart 4 shows that strong growth in base money over the period 1971 to 1983 coincided with the highest inflation rate in 1974. In terms of real output, between 1971 and 1983, the

Chart 2: Inflation versus ER Depreciation

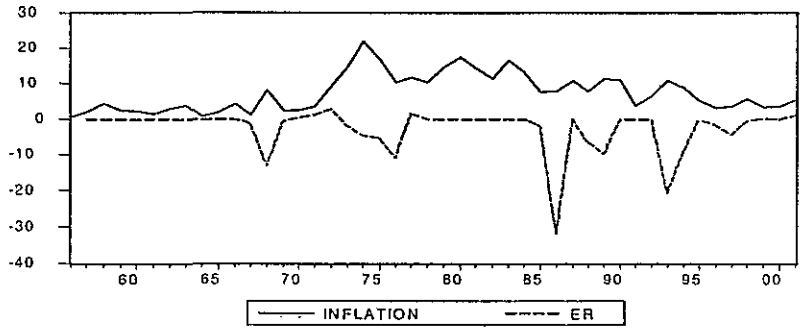


Chart 3: Inflation versus Import Prices

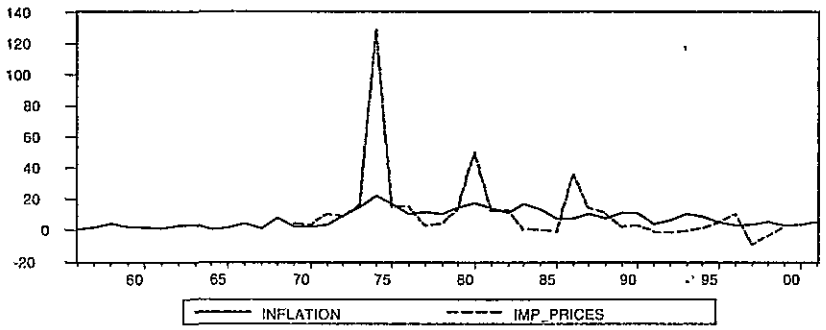


Chart 4: Inflation Versus M0

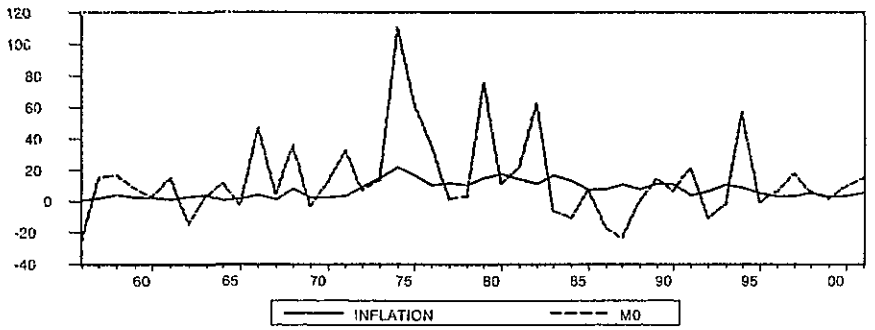
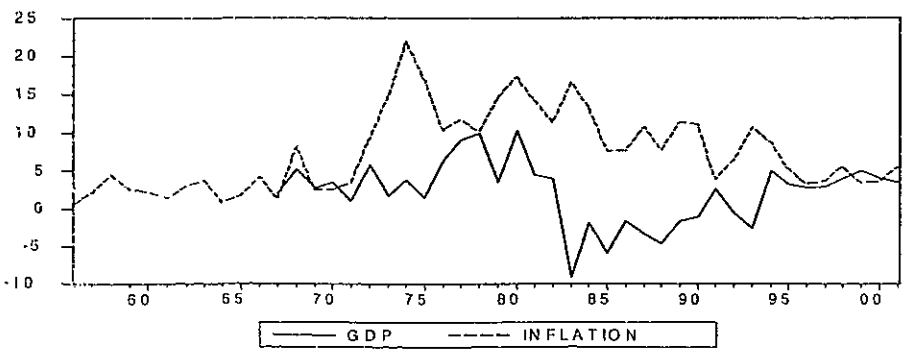


Chart 5: Inflation versus GDP



economy grew at much slower rates compared with inflation while negative growth between the years 1984 to 1993, corresponded with a slowing of the inflation rate. In more recent years 1994 to 2001, both inflation and output have been trending in propinquity.

Variable Selection

The data used in the VAR model were quarterly spanning the period 1982:1 to 2001:4. All the variables in the model with the exception of the treasury bill rate are logarithmic transforms. The five endogenous variables are the Index of Retail Prices (RPI), the Index of Gross Domestic Product (GDP), base money (M0), the nominal effective exchange rate (TWNEER) and United States export prices (USEXPR). The exogenous variables are the treasury bill rate and oil prices.

Lag Length Selection

Following the now established Johansen procedure, it was desirable to first investigate the lag length of endogenous variables of the unrestricted VAR and the order of integration of the variables. The lag length was selected using the lag order selection criteria displayed in Table 1 below. Although four of the selection criteria pointed to a lag length of 1, the lag length of 4 selected by the LR criterion was used in the model since the Akaike Information Criterion (AIC) and the Schwartz Criterion were lower when the VAR was estimated using 4 lags.

Table 1: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	245.6998	NA	1.08E-09	-6.457528	-6.143766	-6.332488
1	899.5513	1182.307	3.57E-17	-23.68634*	-22.58817*	-23.24870*
2	919.0516	32.58954	4.20E-17	-23.53566	-21.65309	-22.78542
3	930.4197	17.44148	6.27E-17	-23.16218	-20.49521	-22.09935
4	957.9318	38.44158*	6.17E-17	-23.23101	-19.77963	-21.85557
5	982.0548	30.40158	6.90E-17	-23.20698	-18.97120	-21.51895
6	1010.239	31.65940	7.23E-17	-23.29423	-18.27404	-21.29360
7	1026.517	16.05509	1.12E-16	-23.05527	-17.25068	-20.74204

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Order of Integration

Checking the stability of the VAR model revealed that the model did not satisfy the stability condition suggesting that the variables in the model were non-stationary. Each variable in the model was therefore subjected to the ADF test for unit roots. The results of the ADF test are displayed below (see Table 2) and all the variables in the model were found to be I(1)s which means that they must be difference once to become stationary.

Table 2: Augmented Dickey Fuller – Unit Roots Test

Including Trend & Intercept

Variables	Level	First Difference
LRPI	-0.664052	-3.908691
LM0	-1.808989	-4.075151
LTWNEER	-2.410937	-3.959335
T_BILL_RATE	0.123678	-4.734156
LQGDPT	-1.518741	-4.129075
LUSEXPR	-2.205011	-3.529475
LAUVOILWTI	-3.257145	-4.634281

Mackinnon critical value for rejection of hypothesis of a unit root (5% critical value = -3.4696)

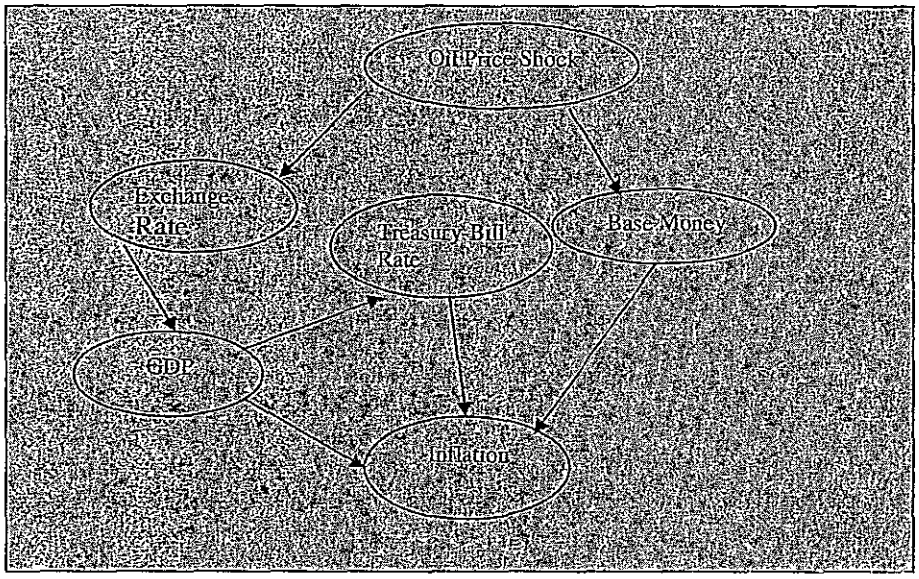
Granger Causality

The graphical analysis showed that the variables are correlated with inflation. However, correlation does not imply causation. To establish the transmission path between inflation and its determinants, the VAR pairwise Granger Causality test was performed. The results for the period 1982 to 2001, showed Granger causality (unidirectional) from base money, GDP and the treasury bill rate to inflation. At the same time, the oil price which is exogenous in the VAR model, Granger caused (unidirectional) base money and the exchange rate. Interestingly, there was no causality between import prices and inflation over the period. (See Appendix 1)

To examine whether these causal results varied in different time periods, the Granger test was applied to the individual periods 1982-1993 and 1994-2001. In the sub-period 1982-1993, oil price, import prices and exchange rate are found to Granger cause changes in base money which in turn causes inflation. In the sub-period 1994 to 2001 oil prices, import prices and GDP were found to cause exchange rate movements and oil prices, import prices and exchange rate Granger cause GDP. We can therefore identify causal

feed back between GDP and the exchange rate and in turn a causal link between GDP, and inflation. In terms of base money, no causal link to inflation was observed during this period.

Granger Causality: 1982-2001



Cointegration Test and VECM

The Johansen cointegration procedure was used to test for cointegration of the non-stationary variables. Since there are seven variables in the VAR model at most six cointegrating equations could be expected. The results of the trace test based on an intercept and trend are displayed in Appendix 2. The trace test statistic confirmed that there was one cointegrating relation. The presence of this cointegrating relation means that the unrestricted VAR is not applicable and a vector error correction model (VECM) must be specified.[6] The VECM has a cointegration relation built into the specification so that it restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegrating term is known as the error correction term since the deviation from the long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

[6] The VECM is a restricted VAR designed for use with non-stationary series that are known to be cointegrated

The VECM was specified using one cointegrating equation, four lags of the differenced endogenous variables and the two exogenous variables. The Lagrange Multiplier test was carried out on the residuals of the VECM and revealed that there was no serial correlation present up to four lags.

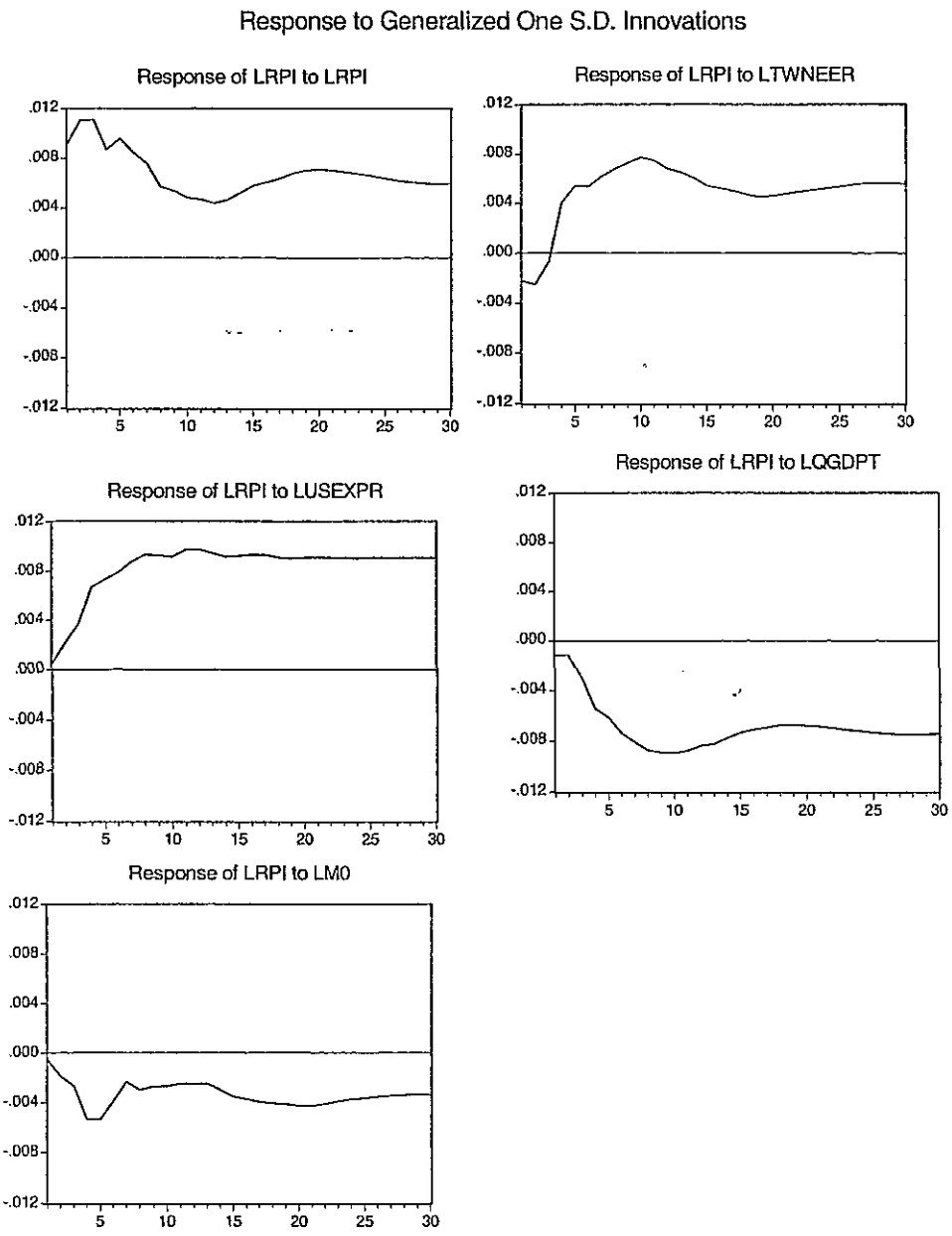
V. Results

Impulse Response Function and variance Decomposition

The impulse response function traces the response of an endogenous variable to a change in one of the innovations. In other words an impulse response function describes the response of an endogenous variable to a unit change in one of the innovations. The following graphs show the response of inflation to a unit change in each of the other endogenous variables in the model.

A positive shock to the nominal effective exchange rate implies that there is a depreciation in the value of the Trinidad and Tobago (TT) dollar and as a result the costs of imported goods can be expected to increase. The shock to the exchange rate leads initially to a 0.2 per cent decline in domestic prices. The effect of the shock is not felt until the fourth quarter when the price level begins to rise. The pass through effect of the exchange rate is quite large and persists up to quarter 10 (two and half years) before diminishing. However, the inflation rate does not return to its original equilibrium but levels off at a new equilibrium. The initial decline in prices could be an indication that importers have inventories so that the exchange rate shock is not felt immediately. However, by the third quarter when inventories have been depleted, the effects of the shocks are then incorporated into the mark-ups on goods and services.

A shock to import prices passed through immediately to domestic prices and is long lived. A one standard deviation increase in import price leads to a steady rise in domestic inflation which grows to 1 per cent by quarter ten and then levels off at this rate to a new equilibrium level. These results are in keeping with cost-push theories which view the impact of import prices on production costs as filtering through to the pricing of final products and resulting in inflation. With respect to GDP, a unit increase leads to a decline in domestic prices and the price level converges to a new lower equilibrium.



A price shock reflects the impact of expectations on inflation. If it is the perception that the price change would prevail, then firms would include their expectations in the mark-up of future prices. In contrast, if firms are optimistic that the price level would not change, then prices would not increase. The initial price shock represents a 0.9 per cent increase in the price level, the effects of which continue to be felt until the third quarter. However, by the fourth quarter (one year), expectations of price increases begin to

weaken and the price level begins to decline. However, the initial shock is long-lived and prices gravitate to a new equilibrium level approximately 0.6 per cent above the pre-shock level.

Finally, a monetary shock to the system led to a decline in the price level in the short run and to a new equilibrium level in the long-run. This result is contrary to the monetarist theory on inflation since an increase in the money supply is usually associated with a rising price level.

An analysis of the variance decomposition of inflation gives an indication of the relative importance of shocks of all the endogenous variables in the model. The variance decomposition of LRPI is highlighted below and indicates that the shocks of import prices, exchange rate, RPI and GDP are important in determining the variability in inflation. The import price shock accounted for a significant proportion of the variation in domestic prices. The importance of import price shocks to variation's in inflation increased over the time horizon, from 1.2 per cent in period two to 27.8 per cent by period 30.

Table 3
Variance Decomposition of LRPI

Period	S.E.	LRPI	LTWNEER	LM0	LQGDPT	LUSEXPR
1	0.009217	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.014529	98.15439	0.008089	0.611262	0.022443	1.203813
3	0.018833	93.40851	1.187174	1.508748	0.891624	3.003946
4	0.023340	74.67239	8.023304	5.317047	4.384831	7.602432
5	0.028118	63.20631	13.53793	6.764358	6.291010	10.20039
6	0.031935	56.11281	16.11669	6.489208	8.835261	12.44603
7	0.035505	49.96163	18.33006	5.574280	11.10233	15.03169
8	0.038769	44.06404	19.99189	5.198442	13.57668	17.16896
9	0.041842	39.45638	21.54352	4.838485	15.52213	18.63948
10	0.044726	35.68098	23.00687	4.560021	17.06324	19.68890
11	0.047438	32.67730	23.90799	4.301679	18.10644	21.00659
12	0.049790	30.42987	24.31199	4.132984	18.89881	22.22634
13	0.051953	28.73800	24.59679	3.998030	19.51687	23.15031
14	0.053928	27.59218	24.74856	3.979736	19.85594	23.82359
15	0.055790	26.83644	24.68037	4.062439	19.98829	24.43247
16	0.057598	26.28062	24.53978	4.184813	19.98916	25.00562
17	0.059369	25.88733	24.38637	4.323728	19.91584	25.48673
18	0.061059	25.69783	24.18136	4.472561	19.80295	25.84530
19	0.062694	25.62736	23.95823	4.618808	19.69022	26.10539
20	0.064320	25.55477	23.76772	4.764339	19.58791	26.32526
21	0.065931	25.44834	23.62051	4.898443	19.50415	26.52856
22	0.067506	25.31234	23.52173	4.995076	19.45902	26.71184
23	0.069041	25.14582	23.47102	5.051838	19.45732	26.87400
24	0.070540	24.94628	23.44912	5.086114	19.49424	27.02425
25	0.072006	24.71460	23.45142	5.105252	19.56057	27.16816
26	0.073448	24.45566	23.48206	5.111101	19.64332	27.30787
27	0.074863	24.18709	23.52790	5.106911	19.73047	27.44762
28	0.076244	23.92585	23.57298	5.096410	19.81828	27.58648
29	0.077593	23.67956	23.61345	5.084009	19.90345	27.71953
30	0.078914	23.45402	23.64684	5.075515	19.97875	27.84487

Cholesky Ordering: LRPI LTWNEER LM0 LQGDPT LUSEXPR

Furthermore, exchange rate shocks also contributed significantly to the variability in domestic prices. In fact over period 4 to period 15 exchange rate shocks contributed the most to the variability in prices. Growth in GDP also contributed to the variability in inflation with the percentage contribution to the variability increasing from 4.3 percent in period 4 to 20 per cent by period 30. Base money was the least important in influencing inflation, its percentage contribution in each period remained under 10 per cent.

Conclusion

The preliminary results show that the exchange rate has a high pass through effect to inflation in Trinidad and Tobago. Thus a depreciation of the exchange rate has a dampening effect on output which in turn constrains aggregate supply and in the presence of strong aggregate demand pushes up the inflation rate. Interestingly, the results of this study also suggest that over the period 1982 to 2001, the hybrid approach to the explanation of inflation remains relevant in the case of the Trinidad and Tobago. For example, an oil price shock has both a demand-pull and cost-push influence on the inflationary process. The demand-pull influence arises from the expansion of the money supply, while the cost push influence works through the exchange rate.

In terms of the policy considerations, the preliminary results of this paper seem to suggest that because of the high exchange rate pass-through, any policy targeting inflation requires both active exchange rate and monetary policies. Indeed, a concentration on strictly monetary policy alone without the supporting exchange rate management tools may not have the desired effect of controlling inflation.

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APPENDIX 1

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests
Sample: 1982:1 2001:4
Included observations: 72

Dependent variable: LRPI

Exclude	Chi-sq	df	Prob.
LTWNEER	3.231900	4	0.5198
LM0	14.39858	4	0.0061
LQGDPT	10.24623	4	0.0365
LUSEXPR	3.300763	4	0.5088
LAUVOILWTI	2.560061	4	0.6339
T_BILL_RAT	10.94984	4	0.0271
E01			
All	49.05507	24	0.0019

Dependent variable: LTWNEER

Exclude	Chi-sq	df	Prob.
LRPI	2.342308	4	0.6731
LM0	3.894024	4	0.4205
LQGDPT	1.809759	4	0.7707
LUSEXPR	2.922938	4	0.5708
LAUVOILWTI	8.376498	4	0.0787
T_BILL_RAT	1.548401	4	0.8180
E01			
All	29.48813	24	0.2023

Dependent variable: LM0

Exclude	Chi-sq	df	Prob.
LRPI	5.315800	4	0.2564
LTWNEER	1.269577	4	0.8665
LQGDPT	4.937734	4	0.2937
LUSEXPR	0.863844	4	0.9297
LAUVOILWTI	10.98472	4	0.0267
T_BILL_RAT	1.323594	4	0.8574
E01			
All	43.40198	24	0.0089

Dependent variable: LQGDPT

Exclude	Chi-sq	df	Prob.
LRPI	5.167347	4	0.2706
LTWNEER	11.84852	4	0.0185
LM0	5.926757	4	0.2047
LUSEXPR	3.373713	4	0.4973
LAUVOILWTI	1.125508	4	0.8902
T_BILL_RAT	2.358629	4	0.6701
E01			
All	59.92222	24	0.0001

APPENDIX 1 (Cont'd)

Dependent variable: LUSEXPR

Exclude	Chi-sq	df	Prob.
LRPI	18.43118	4	0.0010
LTWNEER	7.268710	4	0.1224
LM0	6.637453	4	0.1563
LQGDPT	2.053439	4	0.7259
LAUVOILWTI	1.878513	4	0.7581
T_BILL_RAT E01	20.84486	4	0.0003
All	45.28414	24	0.0054

Dependent variable: LAUVOILWTI

Exclude	Chi-sq	df	Prob.
LRPI	0.258583	4	0.9923
LTWNEER	6.537938	4	0.1624
LM0	1.731410	4	0.7850
LQGDPT	4.221477	4	0.3769
LUSEXPR	5.443318	4	0.2448
T_BILL_RAT E01	0.667755	4	0.9552
All	30.93769	24	0.1556

Dependent variable: T_BILL_RATE01

Exclude	Chi-sq	df	Prob.
LRPI	4.635685	4	0.3268
LTWNEER	0.961174	4	0.9156
LM0	6.428945	4	0.1693
LQGDPT	12.16005	4	0.0162
LUSEXPR	7.394330	4	0.1165
LAUVOILWTI	0.798736	4	0.9386
All	27.15512	24	0.2973

APPENDIX 2

Included observations: 75 after adjusting endpoints
Trend assumption: Linear deterministic trend (restricted)
Series: LRPI LTWNEER LM0 LQGDPT LUSEXPR
Exogenous series: LAUVOILWTI T_BILL_RATE01
Warning: Critical values assume no exogenous series
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.491244	106.0341	87.31	96.58
At most 1	0.347820	55.35006	62.99	70.05
At most 2	0.156445	23.29244	42.44	48.45
At most 3	0.093412	10.53269	25.32	30.45
At most 4	0.041483	3.177618	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.491244	50.68403	37.52	42.36
At most 1 *	0.347820	32.05762	31.46	36.65
At most 2	0.156445	12.75975	25.54	30.34
At most 3	0.093412	7.355070	18.96	23.65
At most 4	0.041483	3.177618	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at the 5% level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 1% level