MACROECONOMIC DYNAMICS IN TRINIDAD & TOBAGO: IMPLICATIONS FOR MONETARY POLICY IN A VERY SMALL OIL-BASED ECONOMY *

by

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ABSTRACT

The principal objective of this paper is, firstly, the establishment of a dynamic VAR Error Correction (VECM) Model of the Trinidad & Tobago economy using the Structural Cointegrating VAR methodology and, secondly, the use of the resulting model to evaluate the efficacy of monetary policy measures. The results show, in particular, the existence of a stable long-run demand for money relation. The short-run dynamics of the system, within which the long-term relations are embedded, are completely data determined. The basic VAR model, from which the VECM will be derived, is based on seven key variables: the domestic price level, the national income, the exchange rate, the rate of interest, money demand, the foreign price level and the real oil price. The first five are endogenous while the remaining two are exogenous to the system. The determination of both the long-run as well as the dynamic short-run relations between these variables is obtained using quarterly data covering the period 1971-1999.

In the paper, the econometric methodology to be employed is presented and discussed. This is followed by a description of the hypothesized long run relationships existing among the variables as well as a discussion about the associated problems relating to the corresponding data to be used. The long-run relationships are estimated after testing for unit roots and cointegration vectors. The Error Correction form of the model is then derived and evaluated. Generalised Impulse Responses as well as Persistence Profiles based on system wide shocks are determined and the implications of these of monetary policy derived.

Keywords: Structural cointegrating VAR models, long-run relationships, dynamic short-run relations, generalized impulse responses, persistence profiles, monetary policy.

JEL Classification Numbers: C32, C51, E520, O55

1. Introduction

In a recent paper (Watson (2003)), a traditional VAR model of the oil-based Trinidad & Tobago economy is used to examine the transmission mechanism of monetary policy. The results show that this mechanism is coloured by the movement in oil prices. This paper is a follow up to that work. The principal objective here is the establishment of a dynamic VAR Error Correction Model (VECM) of the Trinidad & Tobago economy using the Structural Cointegrating VAR (SCVAR) methodology and the use of the resulting model to evaluate the efficacy of monetary policy measures. Useful methodological references are Pesaran (1997), Pesaran and Smith (1998), Garratt et al. (1998, 1999), Pesaran et al. (1999) and Pesaran and Shin (1999). An extremely important distinguishing feature in the SCVAR approach is the identification, on the basis of economic theory, of stable long-run relationships among the variables. The results will show, in particular, the existence of a stable long-run demand for money relation. The short-run dynamics of the system, within which the long-term relations are embedded, are completely data determined. The basic VAR model, from which the VECM will be derived, is based on seven key variables: the domestic price level, the national income, the exchange rate, the rate of interest, money demand, the foreign price level and the real oil price. The first five are endogenous while the remaining two are exogenous to the system. The determination of both the long-run as well as the dynamic short-run relations between these variables is obtained using quarterly data covering the period 1971-1999.

Economy-wide models of the Trinidad & Tobago have, to date, been constructed using structural econometric models (SEMs). Examples are Hilaire et al. (1990), Watson and Clarke (1997) and Watson and Teelucksingh (2001). All three models use annual data and are estimated using classic least squares procedures[1]. In addition, they are evaluated using standard simulation techniques. SEMs have been severely criticised – see, for instance, Sims (1980) – and alternative approaches, including variants of the VAR approach introduced by Sims, have been sought to respond to the criticism. The SCVAR approach is one such proposed alternative.

In the following section, the econometric methodology to be employed is presented and discussed. This is followed in section 3 by the introduction of two hypothesized long run relations among the seven variables in the model. These are derived on the basis of a priori economic reasoning. In this section there is as well a discussion about the associated problems relating to the corresponding data to be used. In section 4, the long run relations of the model are estimated. This involves pre-tests for unit roots as well as tests for cointegration vectors. We verify that all the variables used are I(1) and that there is sufficient evidence for two cointegrating vectors. The VECM form of the model, which we will call the SCVAR model, is then derived and evaluated. The diagnostics obtained are more than satisfactory. In section 5, persistence profiles based on system wide shocks

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[1] In Watson and Teelucksingh (2001), some attempt is made to use a variant of the Engle-Granger 2-step procedure.

are derived and discussed. These profiles show that there is a rapid return to equilibrium following a system wide shock and the relative speeds appear consistent with economic theory. In section 6, the impulse responses to shocks in the Treasury Bill Rate (the monetary policy instrument) and to the oil price are analysed. In section 7, the monetary policy implications of the model are discussed and in section 8 the paper concludes.

2. Econometric methodology

The model to be used in this paper may be written in the form of a standard VAR like:

$$\mathbf{y_t} = \mu_0 + \mu_1 t + \mathbf{\Psi d}_t + \sum_{j=1}^{p} \mathbf{\Phi}_j \mathbf{y}_{t-j} + \sum_{j=0}^{p} \mathbf{\Gamma}_j \mathbf{x}_{t-j} + \mathbf{u}_t,\ t = 1,2, .., T \qquad (1)$$

where

- Φ_j, j = 1, 2, ..,p are G×G matrices and Γ_j, j = 0, 2, .., p are G×K matrices of fixed coefficients.
- $\mathbf{y}_t$ is a (G×1) vector of endogenous variables
- $\mathbf{x}_t$ is a (K×1) vector of (weakly) exogenous variables
- μ_0 is the (G×1) constant term vector
- μ_1 is a (G×1)vector of fixed coefficients
- t is the trend variable (used also as the time subscript)
- $\mathbf{d}_t$ is a (k×1) vector of "intervention" dummies
- $\mathbf{\Psi}$ is a (G×k) matrix of fixed coefficients
- $\mathbf{u}_t$ is the (G×1) error vector of independently, identically distributed random variables with mean zero and covariance matrix $\mathbf{\Omega}$.

If the y and x vectors are I(1) and cointegrated, as they will be shown to be in this paper, equation (1) may be re-written as:

$$\Delta\mathbf{y}_t = \mu_0 + \mu_1 t + \mathbf{\Psi d}_t + \mathbf{\Theta f}_t + \alpha\beta'\mathbf{z}_{t-1} + \Pi_0\Delta\mathbf{x}_t + \sum_{j=1}^{p-1} \Pi_j \Delta\mathbf{z}_{t-j} + \mathbf{u}_t \qquad (2)$$

where $\mathbf{z}'_t = (\mathbf{y}'_t, \mathbf{x}'_t)$ and α and β are (Gxr) matrices of full column rank and $\beta'\mathbf{z}_{t-1}$ gives the r linear combinations of $\mathbf{z}$ that are cointegrated.

SCVAR modelling may be carried out in the following 5 steps:

1. A priori specification of the key long run (equilibrium) relationships within the economy, $\beta'\mathbf{z}_t$. In the typical case, these relations will embody overidentifying restrictions. Let the number of such restrictions be equal to q.

2. The data are then used to determine the number of cointegrating relations within the data and to establish in particular if this is equal to the number of relations specified a priori (r).
3. Assuming that the cointegrating rank is indeed equal to r, an exactly identified version of the equilibrium relationships (r restrictions on each equation, i.e. r^2 restrictions in all, $r^2 < q$) is then estimated.
4. The overidentified form of the model which was specified a priori and containing a further ($q-r^2$) restrictions is estimated and the validity of the extra restrictions tested using a Likelihood Ratio Statistic which, under the null, is distributed as a χ^2 with ($q-r^2$) degrees of freedom.
5. The relationships verified in step 4 are then imbedded in an otherwise unrestricted vector error correction (VECM) model like (4). The **x** variables in this context may be interpreted as forcing variables and may eventually be assumed to follow the VAR(s) process:

$$\Delta\mathbf{x}_t = \mathbf{b}_0 + (\mathbf{D}\mathbf{b}_1)t + \mathbf{D}\mathbf{x}_{t-1} + \sum_{j=1}^{s-1}\mathbf{R}_j\Delta\mathbf{x}_{t-j} + \varepsilon_t \qquad (3)$$

The model established may be evaluated on the basis of its persistence profiles (these trace out the speed at which the different relations will return to long-run equilibrium following a system wide shock.) and its impulse responses. These two devices are also extremely useful in evaluating the impact of policy measures.

Traditional VAR modeling, such as that undertaken in Watson (2003), is limited to impulse response analysis and does not seek to derive underlying behavioural equations in the structure. The strategy of the SCVAR approach is quite different in that it allows the short run dynamics to be data determined but at the same time has a coherent long-run equilibrium. A detailed comparison of the SCVAR approach with other approaches to econometric modeling (large scale structural econometric models, unrestricted and structural VARs and dynamic stochastic general equilibrium models) may be found in Garratt et al. (1999).

There is a limit to the amount of variables that may be included in the SCVAR model defined by (2) and (3), a feature it shares with traditional VAR models. Firstly, the **z**-variables must all be I(1) and to establish this may require a considerable pre-testing effort. Secondly, the inclusion of too many variables weakens the power of the cointegration tests. It is for this reason that the basic VAR model, from which the VECM will be derived, is based on only seven key variables: the domestic price level, the national income, the exchange rate, the rate of interest, money demand, the foreign price level and the real oil price. The first five are endogenous while the remaining two are exogenous to the system. This clearly has implications for the issues of direct interest to the policy maker that may be addressed by a SCVAR model. The large SEMs incorporated a host of variables and consequently allowed for the analysis of a host of issues. The track record of these models, however, leaves a lot to be desired and leads one to question the utility of employing these large, multipurpose models that distinguish themselves by being unwieldy and error prone. The SCVAR approach to dealing with meeting the demands of the various users is the development of satellite models which can be attached to a core (such as the one developed in this paper) and used for purposes similar to those of the SEMs. The construction of such satellites is left for a later date.

3. Long-run relations

Trinidad & Tobago is a two-island independent republic with a population of about 1.25 million and a land mass of about 5128 km^2. Its main resource is petroleum (this is likely to remain the case for some time to come) and as a consequence, the price of oil, which is determined independently of Trinidad & Tobago production, is an extremely important (exogenous) variable. In fact, a particular feature of economies like that of Trinidad & Tobago, not unrelated to its small size, is its heavy dependence on the outside world and in particular the absolute necessity to earn foreign exchange as a prerequisite to survival.

For these and other reasons, Trinidad & Tobago has been described as a small open petroleum economy in the spirit of Seers (1964). The term "small" may be misleading as a description of such economies and perhaps the term "micro" or "very small" may be more appropriate. The economy of Trinidad & Tobago is certainly much smaller than that of the United Kingdom, which Garratt et al (1998) describe as a small open economy.

There are (at least) two fundamental challenges to applying the SCVAR approach to model the Trinidad & Tobago macroeconomy. In the first place, there is a serious body of economists that challenges the applicability of standard macroeconomic theory to in determining the long-run relations in such an economy. Furthermore, there is no general agreement about what constitutes an acceptable economic theory that may be applied. See Célimène and Watson (1991). The second problem is one of data, or rather the general absence of it. And data deficiency is not limited only to questions of data quality. Data might be, above all, deficient in quantity and it is this aspect of data deficiency - the quantity aspect - that is the principal preoccupation here. Data series required for a macroeconometric model of even the most modest size might be either non existent, or plagued by missing values, or too short, or, finally, of inappropriate frequency even when the requirements are as modest as those of a SCVAR model. We will deal with the theoretical and data issues in turn.

3.1 Theoretical issues

Notwithstanding the absence of a generally acceptable theoretical framework, there is a considerable amount of agreement that the seven variables identified constitute a set of key economic variables in the Trinidad and Tobago macroeconomy. Prominent among these is the overall level of economic activity, measured usually by the level of national income (and sometimes by the associated level of employment). Indeed, the government of Trinidad & Tobago is an active economic agent, intervening through fiscal and monetary measures to attain goals consistent with a level of national income that is compatible with full, or close to full, employment. A large part of the modelling effort in previously constructed SEM models of the Trinidad & Tobago economy is dedicated to explaining the evolution of this variable. The experience of other countries similar to those of Trinidad & Tobago shows that such a goal may be difficult if not impossible to attain in an environment of a volatile exchange rate. The question then arises about the existence of a stable exchange rate function.

The Purchasing Power Parity (PPP) theorem links the exchange rate (ER, the cost in TT dollars of one unit of foreign currency) to domestic prices (P) and foreign prices (P*) in the following manner:

$$ER = A \frac{P}{P^*}$$

where A is a fixed proportionality factor. Movement in any one of the variables results in movements in one or both of the remaining variables in order to re-establish the equality. Taking logarithms and re-arranging may yield:

$$er - p + p^* - a_0 = 0$$

where the lower case letters indicate the logarithm and $a_0 = \ln A$. This is the long-run relationship proposed by the theorem. However, at any point in time t, the system may be in disequilibrium such that:

$$er_t - p_t + p_t^* - a_0 = \varepsilon_{1t}$$

where ε_{1t} is the disequilibrium error.

Implicit in the PPP theorem is that the home currency is acceptable in the settlement of international transactions. This is the case for so-called hard currencies like the US dollar or the British pound but it is certainly not the case for the Trinidad & Tobago dollar. The existence of a stock of foreign exchange in the form of a hard currency (or gold) is a pre-requisite to the participation of Trinidad & Tobago (and similar countries) in the international market place. The ability to acquire such foreign exchange will therefore be an important determinant of the exchange rate. The best indicator of such ability in the Trinidad & Tobago case is the price of oil. In this paper, it is proposed to consider the effects of the oil price through the following modification of the PPP equation:

$$(er_t - p_t) = a_0 + a_6 p_t^* + a_7 (p_t^0 - p_t^*) + \varepsilon_{1t} \qquad (4)$$

We shall refer to equation (4) as the exchange rate relation. It implicitly defines a new variable $(er_t - p_t)$ which measures the (logarithmic) ratio of the exchange rate, expressed in the domestic currency, to domestic prices. The PPP theorem cannot be rejected if equation (4) is a cointegrating relationship and $a_6 = -1$, $a_7 = 0$.

The smooth functioning of the economy assumes the existence of a fairly stable demand for money function. We begin with a classic formulation:

$$\frac{M}{P} = f(S, R)$$

where the demand for real balances, $\frac{M}{P}$, is a function of a scale variable, S, and the opportunity cost of holding money, R (usually represented by an appropriate interest rate). M stands for the selected monetary aggregate in nominal terms and P for the price level. The following specification is widely used:

$$m_t = b_0 + b_1 p_t + b_2 y_t + b_3 r_t + \varepsilon_{2t} \qquad (5)$$

We shall refer to equation (5) as the money demand relation. All variables in it are once again expressed in logarithmic form and:

m_t = Stock of money

y_t = National income (scale variable)

r_t = Interest rate on an alternative asset (opportunity cost variable).

Here again, ε_{2t} may be interpreted as the disequilibrium error. It is in many respects a standard demand-for-money function showing money demand as a function of price, income and the interest rate. b_1 and b_2 are expected to be positive and b_3 negative. If b_1 is equal to 1 (this hypothesis is easily tested), then the demand for money is a demand for real balances. There is some theoretical justification that, in the long run, the income elasticity of money is unity (b_2=1). For small countries such as Trinidad & Tobago, however, it may be argued that it could be greater than 1 because income is more volatile and that volatility increases because of the uncertainties of the oil market. Sriram (2001) reports values greater than unity in a host of empirical studies on developing countries.. This may also be related to the fact that the financial markets in such countries are still undeveloped so that money is a superior good. In this paper, the hypothesis that b_2=1 (unit income elasticity) will be tested although it is expected that $b_2 \geq 1$.

The overall SCVAR model will embed these two long-run relations in a system containing 5 endogenous variables (p_t, y_t, r_t, (er_t - p_t), and h_t) and two forcing (exogenous) variables: the foreign price level (p_t^*) and the real oil price, denoted ($p_t^0 - p_t^*$) where p_t^0 is the (nominal) oil price.

3.2 Data issues

The model outlined above contains 7 distinct variables for which data must be collected. Each one presents its own distinct problems which must be resolved before we can proceed. The data for the national price level almost selects itself: the retail price index, published monthly and in timely fashion by the Central Statistical Office, is the only price index available on a quarterly basis. It is well known that this and similar indices world-wide measure the movement in a fairly rudimentary basket of goods and services and so may be quite inappropriate for representing general price movements.

The exchange rate is measured as the rate of the TT dollar against the US dollar and the level of foreign prices is taken to be prices prevailing in the US as measured by the US consumer price index. This is because of the pre-eminence of the US in the trading relations of Trinidad & Tobago. Even before the attainment of independence from Britain in 1962, the USA was by far Trinidad & Tobago's major trading partner. The TT dollar was pegged to the £ sterling until 1976 when it was pegged to the US dollar. It remained attached at a fixed rate to the US dollars (with intervening devaluations) until 1993 when a floating rate regime was introduced. Since then, the Central Bank has played a major role in stabilising the value of the TT dollar against the US dollar by making appropriate interventions. The TT dollar keeps a fairly steady rate against the US dollar over relatively prolonged periods of time, even in the period of so-called liberalisation, largely because of this intervention.

There is no existing quarterly series for GDP in Trinidad & Tobago. However, since 1982, the Central Bank has been publishing a quarterly real GDP index. A quarterly series for real GDP is computed in two steps. In a first step, annual constant price data for the period 1971 to 1981 are converted to quarterly data using a procedure proposed by Goldstein and Khan (1976). Secondly, GDP growth rates derived from the Central Bank Quarterly (real) GDP index were applied from 1982, first quarter, to 1999, fourth quarter (using the value for 1981, fourth quarter, as an initial value) to generate quarterly GDP series from 1982 to 1999.

The remaining variables present fewer difficulties. The stock of money is obtained as M_{1a} (the sum of currency in circulation, demand and savings deposits) which is available monthly from the publications of the Central Bank of Trinidad & Tobago. For all practical purposes, money so defined is non-interest bearing. The interest rate used is based on the Treasury Bill rate R_t, also published monthly by the Central Bank of Trinidad & Tobago, and calculated as follows:

$$0.25 \log (1 + R_t/100)$$

In Watson (2003), the Treasury Bill Rate is shown to be the monetary policy instrument of choice (in preference, in particular, to the Required Reserves Ratio). Finally, the oil price is the US price per barrel of a combination of the spot price of Arabian Light Crude and the West Texan Intermediate.

4. Estimation of the long-run relations

The estimation method to be employed requires that each of the variables in the system be I(1). Dickey-Pantula tests were carried out on each of the variables, p_t, y_t, r_t, m_t, (er_t - p_t), p_t^* and $(p_t^0 - p_t^*)$ under the null hypothesis that they were all I(1). The Dickey-Fuller t-statistics obtained, and displayed in Table 1 below, show that the null hypothesis cannot be rejected in all the cases considered.

Table 1
Dickey-Pantula Tests

Variable	p_t	y_t	r_t	m_t	$(er_t - p_t)$	p_t^*	$(p_t^0 - p_t^*)$
DF statistic	0.4323	-1.8041	-2.0816	-1.9166	-1.3794	-1.1087	-2.6218

99% critical value for the Dickey-Fuller statistic (level) = -4.04
95% critical value for the Dickey-Fuller statistic (level) = -3.45
90% critical value for the Dickey-Fuller statistic (level) = -3.15

The test includes a constant and a trend term. The order of the test equation is chosen on the basis of the AIC criterion and only the statistic satisfying that criterion is shown here. To discount the possibility that any of these series is I(0) with structural break, the Perron (1989) test was also applied. The conclusion that all the variables are I(1) did not change.

The AIC criterion is used to select the underlying VAR for cointegraion analysis and we decide on a VAR(2) model. Using this model with unrestricted intercepts and no trends, and using the foreign price level and the real oil price as a forcing variables, cointegration analysis is carried out. The summary results of this analysis appear in Table 2 below:

Table 2

Tests for Cointegration Rank

(a) Maximum Eigenvalue Statistic

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r = 1	57.3681	39.8500	37.1500
r<= 1	r = 2	27.3978	33.8700	31.3000
r<= 2	r = 3	22.6381	27.7500	25.2100
r<= 3	r = 4	10.1842	21.0700	18.7800
r<= 4	r = 5	3.5829	14.3500	12.2700

(b) Trace Statistic

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r>= 1	121.1712	92.4200	87.9300
r<= 1	r>= 2	63.8030	68.0600	63.5700
r<= 2	r>= 3	36.4052	46.4400	42.6700
r<= 3	r>= 4	13.7671	28.4200	25.6300
r<= 4	r = 5	3.5829	14.3500	12.2700

At the 10% significance level, the Trace Statistic leads to the conclusion that there are exactly 2 cointegrating vectors. This we take as sufficient evidence to support the conclusion that there are exactly two cointegrating vectors, which accords with the existence of the two hypothesized relations proposed above.

The next step is to estimate the relations subject to exactly identifying restrictions, in this case 4 (2 per cointegrating vector identified). The equations corresponding to the exactly identified system that were successfully estimated are:

$$(er_t - p_t) = a_0 + a_2 y_t + a_3 r_t + a_4 m_t + a_6 p_t^* + a_7 (p_t^0 - p_t^*) + \varepsilon_{1t} \qquad (4')$$

$$m_t = b_0 + b_1 p_t + b_2 y_t + b_3 r_t + b_5 (er_t - p_t) + b_6 p_t^* + \varepsilon_{2t} \qquad (5')$$

The next step is to test the overidentifying restrictions implied by the system (4) and (5). The equations are estimated as:

$$(er_t - p_t) = 1.846 - \underset{(0.044)}{0.845}\ p_t^* - \underset{(0.0293)}{0.228}\,(p_t^0 - p_t^*) + \hat{\varepsilon}_{1t} \qquad (4'')$$

$$m_t = -0.2842 - \underset{(0.149)}{1.183}\ p_t + \underset{(0.446)}{1.115}\ y_t - \underset{(19.95)}{55.39}\ r_t + \hat{\varepsilon}_{2t} \qquad (5'')$$

The value of the LR statistic is calculated as 6.595 with a corresponding p-value of 0.253. The restrictions implied by equations (4'') and (5'') therefore cannot be rejected. The long run relations of the model, defined by equations (4)-(5), are therefore properly specified.

Standard errors (asymptotic) are shown in parentheses. All coefficients are significant and correctly signed. In equation (4''), the significance of the oil price variable seems to augur strongly against the PPP hypothesis which would be verified if this coefficient were equal to zero and, if, in addition, the foreign price coefficient were equal to –1. We tested for these restrictions and obtained an LR statistic of 47.6, with a corresponding p-value very close to zero. The PPP hypothesis is therefore roundly rejected.

In equation (5''), two interesting hypotheses are that (1) the price coefficient is unity (demand for money is a demand for real balances) and that (2) the income coefficient is unity. These two hypotheses were tested one at a time and then together. When tested individually, neither the hypothesis of real balances nor the unit income elasticity hypothesis could be rejected (p-values, respectively, of 0.192 and 0.354). However, when tested together, the joint restriction was roundly rejected (p-value of 0.003). Given the ambiguity of these results, we retain the long-run system defined by equations (4'') and (5'').

The Error Correction model embedding these two relations as error correction terms, which constitutes the SCVAR model, was then estimated. Selected results of this exercise are shown in Table 4 below. These include the coefficient values associated with the error correction terms and the forcing variable in each equation, together with the corresponding p-values, as well as some measures of goodness of fit of the individual equations.

Table 4

Error Correction Form of the SCVAR Model (Extracts)

Equation	Δp_t	Δy_t	Δr_t	Δm_t	$\Delta(er_t - p_t)$
$\hat{\varepsilon}_{1,\,t-1}$	0.0429 [0.011]	-0.0205 [0.027]	0.0009 [0.439]	0.2218 [0.000]	-0.1543 [0.004]
$\hat{\varepsilon}_{2,\,t-1}$	-0.0019 [0.840]	0.0162 [0.002]	-0.0017 [0.011]	-0.0173 [0.469]	-0.0204 [0.487]
Δp^*_{t-1}	0.4413 [0.020]	-0.0224 [0.827]	-0.0295 [0.026]	-0.8485 [0.077]	0.0667 [0.909]
$\Delta(p^o_{t-1} - p^*_{t-2})$	0.0142 [0.255]	0.0015 [0.824]	0.0009 [0.292]	-0.0243 [0.443]	0.0107 [0.782]
$\overline{R}^2$	0.245	0.656	0.146	0.277	0.084
p- value for $\chi^2_{SC}(4)$	0.241	0.000	0.024	0.089	0.903
p- value for $\chi^2_{FF}(1)$	0.384	0.086	0.504	0.523	0.002
p- value for $\chi^2_{N}(2)$	0.000	0.000	0.000	0.003	0.000
p- value for $\chi^2_{H}(1)$	0.411	0.222	0.787	0.103	0.854

The error correction terms $\hat{\varepsilon}_{1,\,t-1}$ and $\hat{\varepsilon}_{2,\,t-1}$ are derived from equations (4'') and (5'').

The diagnostics are χ^2 statistics for serial correlation (SC), functional form (FF), normality (N) and heteroscedasticity (H).
The figures shown in squared parentheses are the p-values associated with the corresponding coefficient estimates.

The overall results appear to be acceptable. The $\overline{R}^2$ values are reasonable given the fact that the regressions explain variations in the changes of the endogenous variables in the model. The long run relations make an important contribution in each of the equations and are significant at the 5% level in at least one instance in each equation. The exchange rate relation is highly significant in four of the five equations making up the model and the money relation is significant in two. Of the long run forcing variables, the foreign (US) price level is significant in three of the five equations but the oil price variable does not intervene significantly in any. The Trinidad & Tobago economy responds to movements in this variable over the longer term, through mainly its influence on the exchange rate (equation 4'' above).

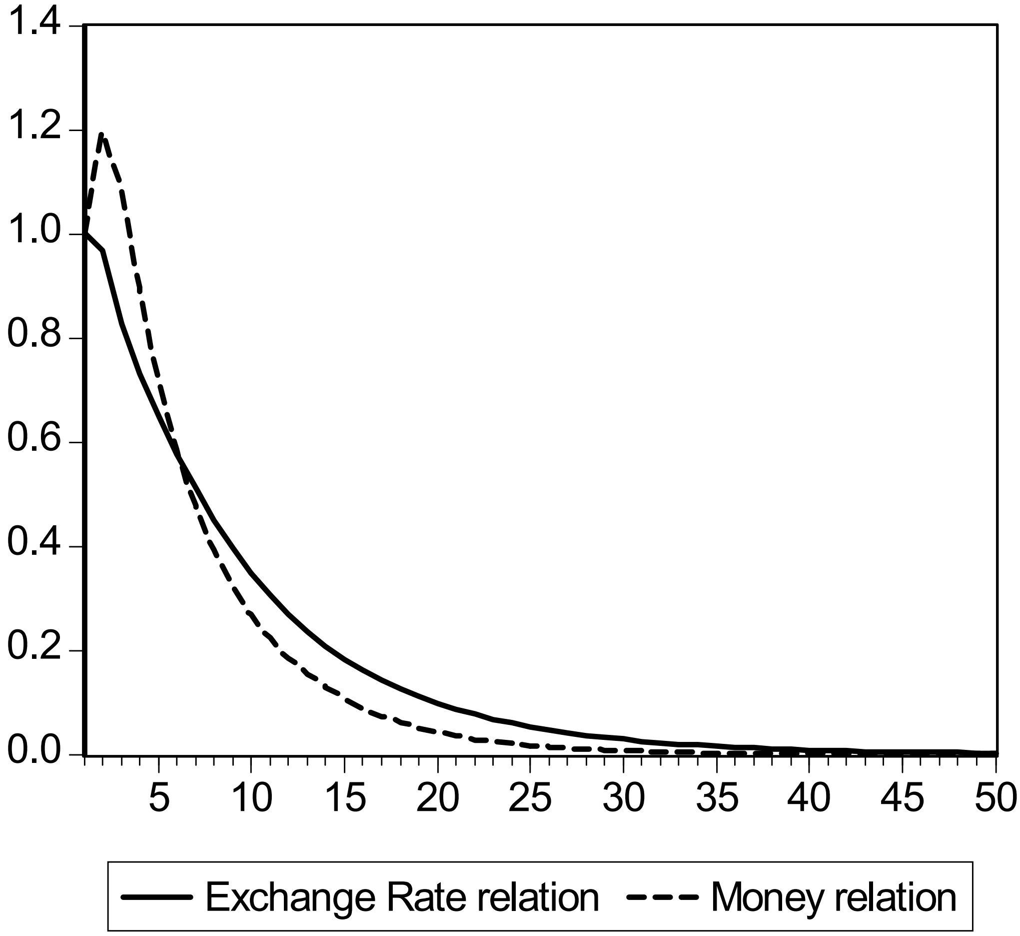
The diagnostic statistics show that serial correlation is rejected in two of the five equations. Three of the five equations also show that the functional form is properly specified and none of the five shows evidence of heteroscedasticity. Normality, however, is rejected in all cases.

5. Persistence Profiles

Persistence profiles show the speed at which the different long-run relations will return to equilibrium following a system wide shock and are indicators of the stability of these long-run relations. For determination of the persistence profiles it is assumed that the oil price and foreign price level variables are strictly exogenous and are modelled using the form of equation (3). Figure 3 below shows the persistence profiles of the two long run relations in the model.

Figure 3

Persistence Profiles of the effect of a system-wide shock



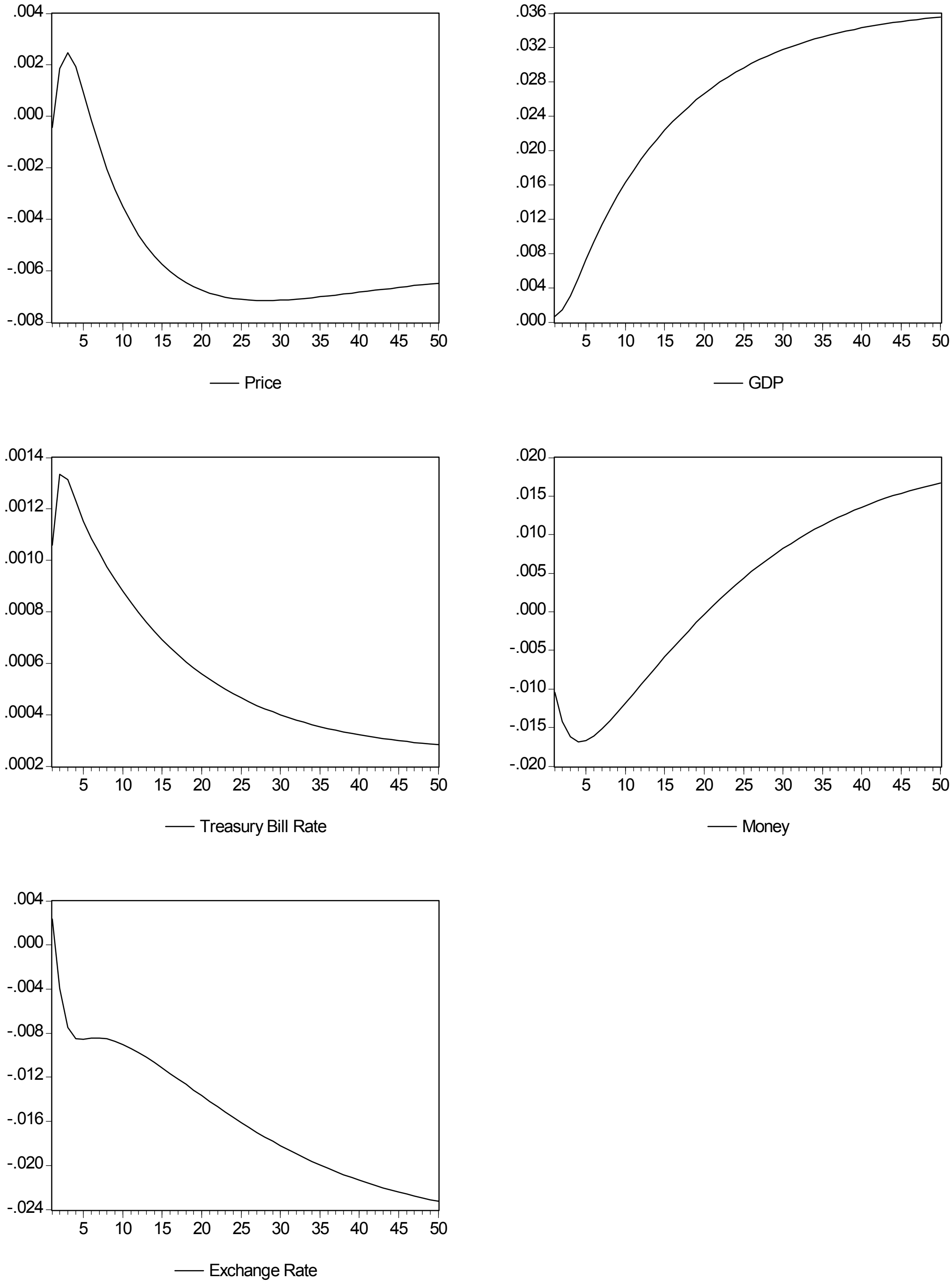
Garratt et al. (1998) define a half-life measure that describes the horizon over which the profile falls to 0.5. Given that the profile starts at 1 and falls to zero, this gives a simple indication of the speed of adjustment of a profile and makes it easy to compare the response rate of the different profiles. The two relations tend to return rather rapidly to their equilibria following a shock, indicating fairly stable long-run relations in the system. A relatively faster response comes from the money relation whose half-life is a little more than six quarters while that of the exchange rate relation is a little more than seven quarters.

6. Impulse responses

Under this heading, we will take a look at the response of the endogenous variables in the system to shocks, firstly, in the monetary policy instrument, the Treasury Bill rate, and, secondly, to oil prices. These responses are shown, respectively, in Figures 4 and 5 below.

Figure 4

Generalised Impulse Responses following a one S.D. shock to the Treasury Bill Rate

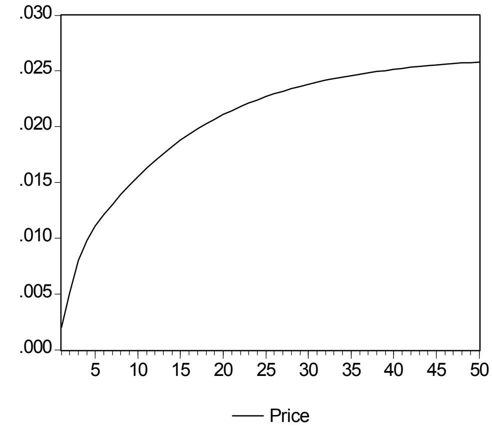


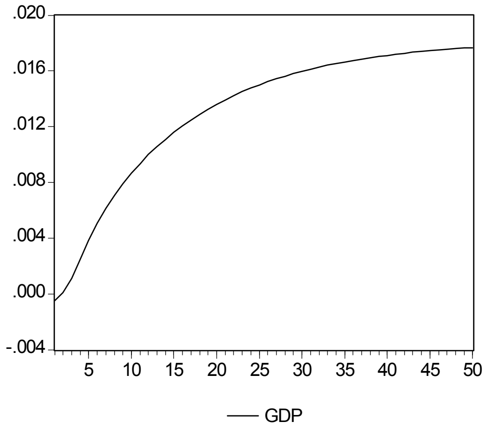
Following the initial shock to the Treasury Bill Rate, it rises over the following three quarters and then begins a steady decline downward to a position just above its "no shock" point. As is expected the demand for money falls off initially as the Treasury Bill Rate rises and then it increases as the bill rate falls. Prices follow an almost identical pattern as that set by the Treasury Bill Rate, as if prices were being determined as a mark-up on the bill rate. Prices in fact fall below the “no shock” point. All this shows that the Treasury Bill Rate is a good instrument for controlling the rate of inflation.

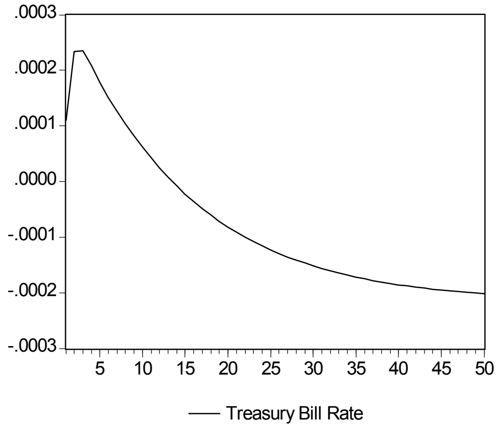
The responses of GDP and the exchange rate to the Treasury Bill rate shock are very interesting and my even appear counter intuitive (but, as we shall see below, there is a possible logical and economically meaningful explanation). GDP increases following the shock, even when the Treasury Bill Rate is rising, and the exchange rate appreciates even when the Treasury Bill Rate is falling. The explanation for this apparent anomaly is perhaps better obtained by examining the impulse responses resulting from an oil price shock, shown in Figure 5 below.

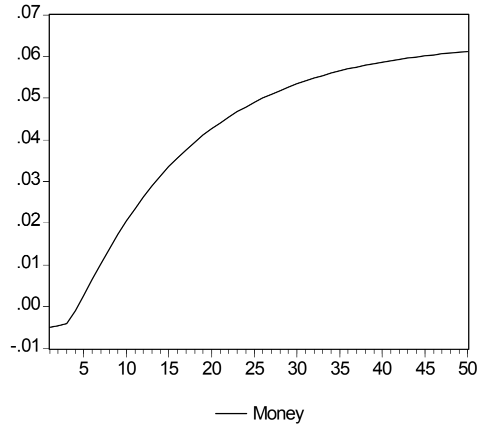
Figure 5

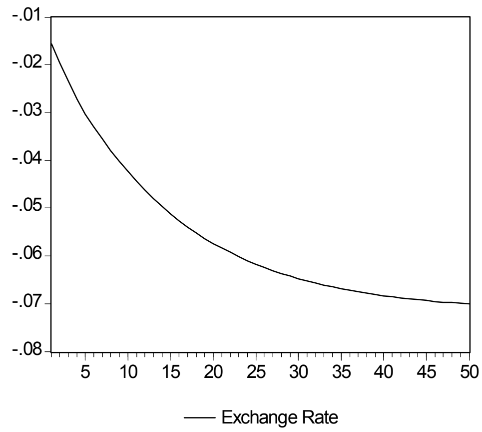
Generalised Impulse Responses following a one S.D. shock to the oil price











Following the oil shock, the exchange rate appreciates. Prices rise, as does real output (GDP). All this is expected. The Treasury Bill Rate rises at first in an attempt to mop up excess liquidity in the system and so attenuate spending and defend the national currency. There is some success but there is a pronounced increase in prices. The Monetary Authorities respond by lowering the Treasury Bill Rate, which results in a slowdown in this inflation rate but prices still remain higher than they would be in the absence of the oil shock. The lower interest rate also provides incentives to investment (and concomitant GDP growth).

7. Lessons for monetary policy

There is ample evidence of a stable long run money demand relationship and an exchange rate relationship, notwithstanding the uncertainties associated with the oil price. System wide shocks will result in movement away from the long-run equilibria but, as shown by the Persistence profiles, there is a fairly rapid return to equilibrium. The impulse responses, however, show that the monetary authorities have only limited ability to manage the macroeconomic environment. The external environment, on the other hand, and in particular the price of oil, is a major determinant of economic activity in the country.

This tells us that monetary policy in Trinidad & Tobago has limited potential, perhaps none at all, for achieving major objectives like sustained economic growth or for moving the economy from one point to another. The macroeconomic fundamentals are determined by the international environment and, in particular, by the price of oil. But this is not to say that monetary policy does not have a role, indeed an extremely important role, to play. For a given level of economic activity, it can and will play a major role maintaining the stability of prices and the exchange rate. Such stability is an extremely important element in maintaining a social and economic climate conducive to the proper conduct of economic activity, including entrepreneurial initiatives that are important to the diversification of the economy and to ending the chronic, even unhealthy dependence, on a precarious international environment characterised mainly by the uncertain price of oil.

8. Conclusion

The two main objectives of this paper were, firstly, the establishment of a dynamic VAR Error Correction (VECM) model of the Trinidad & Tobago economy using the Structural Cointegrating VAR methodology and, secondly, the use of the resulting model to evaluate the efficacy of monetary policy measures. The model is well established and contains two stable long-run relations – an exchange rate relation and a money demand equation. The PPP theorem is not verified in the case of Trinidad & Tobago. Rather, the price of oil, through its influence on the accumulation of foreign exchange reserves, is a major determinant of the exchange rate. The demand for money seems to be for nominal rather than real balances although only marginally so.

Monetrary policy has its place but is of limited applicability. The tone of the economy is set by the oil price that fixes the parameters of economic activity. Monetary policy may be used to do fine tuning provided but will not be able to forestall a change in macroeconomic fundamentals. It will, however, smooth out minor fluctuations and maintain an environment of stability so conducive to the conduct of economic activity.

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