MONEY, AGGREGATE DEMAND AND OUTPUT IN SMALL OPEN ECONOMIES

by

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I: Money, Aggregate Demand and the Output of Non-Tradables

A number of empirical models have now been developed for small developing economies, incorporating their structural peculiarities to better explain the implications of economic policy (examples include Khan et al. (1991); Addison (1989); Belchere (1988); Taylor (1988) and Edwards (1989)). An important feature of these economies is their openness to international trade, services and finance. To a large extent, this means that the law of one price rules (very approximately). Therefore, on the face of it, policy-makers in small open economies should not be overly concerned about monetary changes. The money supply is largely determined by the balance of payments, prices are ruled by international markets and output depends on domestic prices relative to those in the rest of the world.

In the earliest empirical models designed for developing countries by the IMF output was pre-determined and expansion in the money supply led to offsetting declines in foreign exchange reserves or to price inflation via a depreciation of the exchange rate. Models of this kind are to be found in Polak (1977) and Robichek (1967). The influential model (Khan and Knight, 1991) introduced the direct effects of monetary disequilibrium on prices and output. While the economy might tend to a long-run equilibrium governed by the law of one price, what we observe in practice is the result of an adjustment process governed by reactions to discrepancies between actual and

intended outcomes.

That paper was followed by many other model-building exercises at the IMF, including Addison (1989) and (Barth and Chadha, 1989). Other models have introduced output determination through factor supply Reinhart (1991) and the effects of capital controls. With less than perfect capital mobility there is a possibility of a divergence between domestic and foreign interest rates depending on the degree of monetary expansion (See Haque et al. (1991)).

However, even for very open economies, activities which cannot be traded account for a major proportion of output and the prices of non-tradables may diverge markedly from comparable prices in the rest of the world. In these activities, monetary policy affects aggregate demand, prices and output. To reflect this, many models use the distinction attributed to Salter (1959) and Swan (1960) to specify two types of output: tradables and non-tradables.

Furthermore, the money supply is not entirely at the mercy of the balance of payments. The monetary base may be increased by financing government deficits through money creation. In the absence of non-tradable sectors, such expansion might be self-correcting -wholly or in part. The excess money supply would cause an increase in expenditure on imports, a deterioration of the balance of payments and a contraction in the money supply through the reduction in foreign exchange reserves under a fixed exchange regime. (With a flexible exchange rate, currency depreciation corrects the balance of payments; in both cases the outcomes are not so neat because of credibility effects.) However, in practice, some of the increase in aggregate demand is directed towards non-tradable goods, raising their prices and their output.

Beginning with Samuelson (1964), Balassa (1964), Bhagwati (1984) and others, models have been developed to show the supply implications of the tradable/non-tradable distinction, exploring the implications of differences in productivity growth in the two sectors, different factor intensities, the implications of rates of factor substitution between the two sectors and differences in rates of innovation. The implications for aggregate demand have received less attention even in industrial countries (a recent exception is DeGregorio et al. (1993)) and are virtually ignored in policy discussions in developing countries.

This paper explores the effects of money creation on real output on non-tradables in small open economies. If these effects are significant monetary expansion has important implications for growth and inflation. Our model envisages a market adjustment mechanism for non-tradables, from which we deduce the output of non-tradables as determined by the output of tradables, by money creation and by exogenous factors such as world prices and interest rates. The model is tested using data for Barbados, Jamaica and Trinidad & Tobago.

II: The Model

In order to capture the output effects of aggregate demand, we model the output of non-tradables as the outcome of a simple process of partial adjustment. Suppliers plan output to close the gap between production in the previous period and expected demand. The shapes of the demand and supply curves determine whether prices change more rapidly than output, or vice versa. The expected demand is driven by total output, relative prices and unexpected income in the form of an excess supply of money. Such excess money supply variables are a common feature of models of small open economies (See (Khan and Knight, 1991); (Aghevli and Sassanpour, 1991)).

The Demand for Non-Tradables

Income and substitution effects on the demand for non-tradables are represented by real income (y) and relative prices (RP). In addition, the demand shifts in response to unexpected changes in real income ($\hat{y}$):

$$Q^{*}_{n} = a_0(Ey)^{a1}\, RP^{a2}\, y^{a3} \qquad (1)$$

The expected value of real income (Ey) is a weighted average of the output of tradables and non-tradables:

$$Ey = Q_t^{b}\, Q_n^{(1-b)} \qquad (2)$$

The output of tradables is governed by the ruling international price, the supply schedule for tradables and special marketing arrangements for some traded goods. In previous studies we have attempted to estimate an aggregate supply curve for tradables, without success. Supply schedules for the commodities in the tradable basket vary so widely that disaggregation is essential for meaningful results. Since our focus in this paper is demand effects we leave the output of tradables as an exogenus variable, to simplify the exposition and testing.

The relative price is defined as:

$$RP = P_t/P_n \qquad (3)$$

Sources of unexpected real income are stochastic disturbances (u) - which are assumed to have a standard normal distribution - and real money creation $\left(\frac{XMO}{P}\right)$:

$$\hat{y} = \left(\frac{XMO}{P}\right)^{c1} u^{c2} \qquad (4)$$

P is the domestic price index.

Supply of Non-Tradables and the Adjustment Mechanism

The supply of non-tradables in the short-run, when technology and factor proportions

are fixed, is:

$$Q_n = d_o RP^{d1} \quad (5)$$

The supply is adjusted in response to the gap between demand and the output of the previous period:

$$Q_n = Q_n^{(-1)}[Q_n^{(-1)}/Q_n^{(-1)}]^e \quad (6)$$

This results in a change in relative prices, via Equation (5).

The Demand and Supply of Money

Money is created when the supply is greater than demand i.e. when the excess demand for money is greater than unity:

$$XMO = MS/MD \quad (7)$$

The demand for money depends on nominal income (Py) and the interest rate (r) in conventional fashion:

$$MD = fo\ (Py)^{f1} r^{f2} \quad (8)$$

The supply of money is related to the monetary base (MB) by:

$$MS = g_o MB^{g1} \quad (9)$$

The domestic price is the weighted average of the price of tradables and the price of non-tradables:

$$P = P_t^h P_n^{(1-h)} \quad (10)$$

The domestic interest rate is linked to the foreign interest rate (r_f) through an interest parity condition, including allowance for the costs of foreign exchange transactions.

If the differential between domestic and foreign interest rates exceeds transactions costs (CT) capital flows inward or outward through international trade credits and other short-term movement. If the exchange rate remains fixed, the money supply rises or foreign exchange reserves decline; alternatively the exchange rate will depreciate. To avoid these unwanted disturbances the monetary authorities intervene to adjust the domestic interest rate according to the following rule:

$$r = i_o r_f^{i1} CT^{i2} \quad (11)$$

This system reduces to an equation which stipulates the output of non-tradables in terms of the exogenous variables: the output of tradables, the price of tradables, the monetary base, the foreign interest rate and the output of non-tradables in a previous period. In log form the equation is:

$$\text{Ln } Q_n = \alpha_0 + \alpha_1 \ln Q_t + \alpha_2 \ln P_t + \alpha_3 \ln MB + \alpha_4 \ln r_f + \alpha_5 \ln Q_n(-1) \quad (12)$$

Output and prices of tradable goods remain exogenous, but it is now possible for domestic demand management, represented by MB, to affect the output of non-tradables, and, via equation (5), relative prices.

Intuitively, one might expect α_1, α_3 and α_5 to be positive and α_4 to be negative, with the sign of α_2 ambiguous. An increase in output of tradables should raise income levels and increase the demand for non-tradables (α_1); expansion of the monetary base adds unexpected income and increases the demand for non-tradables (α_3). Interest rate increases reduce income below expected levels, depressing the demand for non-tradables (α_4). An increase in the price of tradables causes an appreciation of their relative price and a shift towards greater demand of non-tradables, but it depresses the supply of non-tradables, making the sign of α_2 uncertain.

Those turn out to be plausible directions of influence, but there are circumstances that might produce other outcomes. In terms of the structural coefficients, the reduced form coefficients are:

$$\alpha_0 = A_0/B \quad (13)$$

$$\alpha_1 = A_1 b/B \quad (14)$$

$$\alpha_2 = -A_2 h/B \quad (15)$$

$$\alpha_3 = A_3/B \quad (16)$$

$$\alpha_4 = -A_4/B \quad (17)$$

The new coefficients are defined in terms of the structural coefficients as follows:

$$A_0 = e(a_o + a_3c_2u + a_3c_1g_o - a_3c_1fo) - ea_3c_1f_2(i_o + i_2CT) - [ea_2 + A_2(1-h)]d_o/d_1 \quad (18)$$

$$A_1 = e(a - a_3c_3c_1f_1) \quad (19)$$

$$A_2 = ea_3c_1(1 + f_1)h \quad (20)$$

$$A_3 = ea_3c_1g_1 \quad (21)$$

$$A_4 = ea_3c_1f_2i_1 \quad (22)$$

$$B = 1 - A_1(1-b) - [ea_2 + A_2(1-h)]/d_1 \quad (23)$$

A_1 measures the direct impact of income changes on the demand for non-tradables, attenuated by the fact that an increase in income raises the demand for money and reduces excess money. The results should be a positive relationship between income and the demand for non-tradables. A_2 and A_3 are positive: both include the speed of adjustment of non-tradables to expected demand (e) and the elasticity of that demand with respect to monetary shocks (a_3 and c_1). A_2 also includes the elasticity of money with respect to income (f_1) and A_3 includes the money multiplier (g_1). These are all positive.

A_4 may be negative because of f_2, the elasticity of money demand with respect to

interest rates. Since the coefficient α_4 already carries a negative sign in equation (17) interest rate increases may intensify the demand for non-tradables. Interest rate increases depresses the demand for money, increasing excess supply and the demand for non-tradables. B, the denominator of all the α's, is (the inverse of) a multiplier which captures the feedback

effects that an increase in non-tradable output has on the demand for non-tradables, through its impact on income and on the relative price of tradables.

Data Definitions, Sources & Trends

The line of demarcation between tradable activities and nontradable is sharply delineated in island economies such as Barbados, Jamaica and Trinidad and Tobago. In the standard sectoral breakdown of national accounts it is easy to distinguish those sectors whose activities cannot be traded across borders in significant amounts, except at prohibitive costs. The tradable sector in Barbados comprises agriculture, manufacturing and tourism, with the addition of bauxite and alumina in Jamaica, while in the case of Trinidad and Tobago the petroleum sector replaces tourism. The remaining economic activities - the construction industry, government, retail business and financial services - comprise the nontradable sector. The sectoral breakdown of Gross Domestic Product (GDP) for the three countries is available, in constant and real values, from various issues of the Central Bank of Barbados' Annual Statistical Digest, the World Bank's Annual Tables and the national accounts tables of the Central Statistical Offices' Annual Statistical Digests[1].

The international interest rate (fint) is the London interbank rate obtained from International Financial Statistics (IFS), while 'Base Money' (MB) for Barbados and Trinidad and Tobago and 'Money' for Jamaica are to be found in the Annual Statistical Digest for each country. The data was collected on an annual basis spanning the periods

1966-1991 for Barbados and 1968-1991 for Jamaica and Trinidad. The regression equations were estimated and tested using Micro TSP and ex post simulations carried out.

The Barbados economy grew for all but 6 years of the thirty year period, but the growth rate was somewhat erratic. There were recessions during the periods 1968-1974, 1979-1982 and 1989-1991, when output declined by 2%, 6.8% and 7%, respectively. (Haynes and Holder, 1985) identified the fourfold increase in oil prices as the reason for the first period of recession. Worrell (1982) added that the slowing of growth in the world economy had detrimental effects on the tourism and distributive sectors. Rising transport costs, stagnation in the main export markets and capital outflows reduced the capacity to import, in an economy which is dependent on imports. External factors also contributed to the less severe recession between 1981 and 1984; high unemployment and deflationary policies of industrial countries weakened demand in the tourism and manufacturing sectors. In addition, increased protectionism by regional trading partners, and growing arrears of debt owed to Barbados under the Caricom Multilateral Clearing Facility depressed industrial exports and the appreciation of the Barbados dollar against the sterling reduced the local currency value of sugar earnings. Fiscal mismanagement and

lagging productivity growth were the principal reasons for the 1989-1991 crisis. During the the two later recessions output in the nontraded sectors slowed and contracted in line with the traded sector. At other times while growth in both sectors followed the same trend growth in the traded output was more erratic. Since the oil crisis the price of tradables has not changed significantly and appears to have moved inversely to any changes in the nontraded sector. The 1968-1974 recession was accompanied by a sharp contraction in the monetary base, but there have been no similar movements in the subsequent recessions.

After peaking in 1973, the Jamaican economy sunk into deep recession from which there was no real recovery during the 1970s. A few years of barely positive growth were followed by a period of decline. Despite IMF agreements for the period 1977-1980 another recession set in by 1980. The economy recovered briefly between 1981 and 1983 and but in 1984 declined by 2%. Economists are divided as to the cause, citing a number of influences: external and internal structural flaws, balance of payments disequilibria, and excessive government spending (see Boyd (1988)). Since 1986 the economy has stabilised with modest growth in the nontradable sector accompanied by a fluctuating traded sector. Trends in the traded sector (highly dependent on the bauxite industry) were very similar to those for the nontraded except for 1974 and 1989 when output moved in opposite directions. For most years, nontraded output and the price of tradables moved inversely to each other. The monetary base and the interest rate, however, do not exhibit any strong correlations with non-tradable output.

Economic growth for Trinidad and Tobago was slow for the 1968-1973 period. However, in 1974, the rise in oil prices and changes in the petroleum tax regime propelled the country into a boom. For the period 1974-1979 overall GDP growth averaged 6.2% per year. After peaking in 1982, oil prices fell the following year resulting in a decline in the traded sector. In spite of this the non-oil sector continued to grow as a result of the sustained high levels of government expenditure (see Farrell (1990)). Since then, both sectors have followed a fairly steady upward path. Although the traded and nontraded sectors in Trinidad and Tobago move in the same direction they do not follow one another as closely as in Jamaica. This is particularly so during the 1976-1983 period when the traded sector powered by the petroleum industry benefitted from the oil price hikes in 1973 and 1979. Nontraded output moves in opposite directions to trends in the monetary base and in the same directions as the price of tradables after 1974 and the international interest rate.

Tests

All the variables to be used in our tests exhibit some serial correlation - that is, every observation seems related in some way to that of a previous year. Under these circumstances it is impossible to determine how accurate are any apparent correlation between variables; what appears to be strong correlation may be spurious. Econometricians have tried to find ways around the problem, most recently by suggesting re-specification of relationships (typically by use of first and second differences of variables), the technique of cointegration and error correction. Unfortunately the new techniques are not

always sufficiently powerful to offer a solution, as in the present case. Most of the variables did not appear to be stationary, even after first, second and third differencing. Consequently the data offers no guidance on the choice of log levels or first differences and we therefore report on both specifications. Dummy variables were introduced to distinguish between those years when nontradable output declined and years when nontradable output expanded. This enables us to explore possible asymmetries: for example, nontradable output may be more responsive to monetary expansion than to contraction because suppliers reduce prices in an effort to sustain sales during periods of contraction. Therefore, the dummy variable 'dumb' was included for the periods 1968-1974 and 1974-1979 for Jamaica and Trinidad and Tobago, respectively. Dumb for Barbados was equal to 1 for the recessionary periods already mentioned. The dummies were multiplied by the explanatory variables and included in the equations. Four equations are reported for each country: the first and second in levels, the third and fourth in changes in variables. Equations 2 and 4 introduce asymmetries in the impact of the explanatory variables on the output of nontradables.

A number of standard diagnostics were carried out and the results reported in appendix A. The adjusted R-squared statistic, R^2, measures goodness of fit and the Durbin Watson test first order autocorrelation. However the DW is not reliable in situations where there are lagged dependent variables among the regressors. The LMSC is the Breusche-Godfrey Lagrange multiplier test for autocorrelated disturbances while the Ljung-Box Q statistic (QSTAT) is a small sample test for autocorrelation and partial autocorrelation of the residuals for 10 lags. The Auto Regressive Conditional Heteroscedasticity (ARCH) test is based on the regression of squared residuals on lagged squared residuals. The correctness of the functional form and normality are tested for by the Ramsey Reset test and the Jarque-Bera statistic (NORM).

Barbados (equations 1-4) The R squared values for equations 1 and 2 exceeded 0.9. However we can draw no inference from the t statistics and the Durbin Watson test statistics due to nonstationarity and the presence of the lagged dependent variable. Generally, signs of the variables appear to conform to a priori notions. There seems to be a strong inertia in the output of nontradables as evidenced by the impact of the lagged changes in nontradables. When Qn rises in one period, it tends to rise in the next as well. Output of tradables has relatively strong impact on nontradables; in the equations with changes, that impact is noticeable during recessions. While the influence of the price of tradables is small in equations 1 and 3, it appears that there was an underlying tendency for increases in tradable prices to depress nontradable output, but that this tendency was obscured by the fact that tradable prices apparently increase during recessions. This results in a smaller negative coefficient for the tradable price during recessionary periods, revealing the underlying negative relationship (see equations 2 and 4). Similarly, the positive relationship between the monetary base and nontradables is reduced when the monetary base declines during recessionary times. The influence of the international interest rate is negligible for all equations.

For equations 1 and 2 , all the relevant diagnostic tests performed well indicating no problems with the data. The Breusche-Godfrey Lagrange multiplier test statistic and the Ljung-Box Q-statistic for serial correlation were well below their respective critical values of 3.84 and 18.3. Similarly, the results of the ARCH test and the Normality test indicate that the residuals from the estimated equation are drawn from a population that is normally distributed ,with a variance that remains constant over time. In equations 3 and 4, however, the test statistic for the ARCH test is greater than the chi-squared value of 3.84, suggesting that the estimate may not have these desirable properties.

Jamaica (equations 5-8) In equations 5 and 6, the results were quite similar to those for Barbados and the coefficients conformed to a priori notions. Again there was quite a strong serial effect of the lagged dependent variable for the equations in levels but not for the equations in changes. The tradables sector also has a noticeable impact but during recessions it tends to move in the opposite direction almost obscuring the underlying positive relationship. The price of tradables depresses the nontradable output in both levels and changes. During recessions the coefficient becomes even larger . The monetary base also has an expansionary effect, except during recessions, when monetary expansion can result in some loss in output (see dumb in equation 8). Although fint produces a negative response in equation 7 and 8, it continues to have an almost negligible relationship with nontraded output.

The Ramsey reset test for equations 5 and 6 indicates that there might be a misspecification error. This test does not suggest whether the source of misspecification is serial correlation, heteroscedasticity or non-normal disturbances; all other tests performed fell well outside the critical regions. In equation 7, however, the LMSC and the QSTAT exceeded the critical values at the 95% confidence level, suggesting the presence of serial correlation. Additionally, in equation 8, the chi-squared value for the ARCH test indicates that the error variance is not constant over time.

Trinidad and Tobago (equations 9-12) For all the equations there was a particularly strong carryover from the previous year's output; the impact of traded output was much weaker. However during a recession tradable output has a contractionary effect (see equation 10). Unlike Jamaica and Barbados the price of tradables has an expansionary influence except during low economic activity when it depresses nontradable output (see equations 10 and 12). The monetary base produces a negative response in changes to nontradable output; however this underlying relation is obscured by a positive coefficient during recessionary times (see equation 10)

In equation 12 all the diagnostic tests indicated that by differencing and the introduction of the dummy variables all problems associated with time series were solved for Trinidad. In equations 9 and 10, QSTAT and LMSC produced conflicting results as to whether one or more of the data series are related. While these results may have improved in equation 11 when the variables were differenced and the dummies added, the chi-squared value for

the histogram test indicated that the data violated the assumption of normal distribution $N(0,\delta^2 I)$.

Expost Simulations

Each equation was simulated over the estimation period and the results are provided in Appendix B. The quantitative measures include the correlation coefficient (CC) which measures the degree to which the predicted matches the actual and the root mean squared error (RMSE) which calculates the deviation. Stekler (1991) points out that the RMSE itself has little meaning and should be measured against some standard like the standard deviation. Thus the ratio of RMSE to the standard deviation has been computed; a value of 0.2 is an indication of a good performance. Theil's Inequality Coefficient (U) is useful for historical simulations and a value close to zero is indication of good predictive performance. The three proportions of inequality have also been included: the proportions due to bias (UB), due to coefficient variation (URB) and due to residual variance (URV). They measure systematic error, the degree of variability and unsystematic error respectively. Ideally, UB and URB should be near 0 and URV, one.

All the tests suggest that for equations 1 and 2 are quite good at tracking nontraded output over time in the Barbados environment. For equations 3 and 4, however, the correlation coefficients are way below an acceptable level of performance while the URB indicates that the equations are inadequate in picking up turning points.

Overall the Jamaica results were acceptable although the equations specified in differences were much weaker than those in levels; the CC for equations 7 and 8 was approximately 0.8 but the STD ratio and U were unacceptable at approximately 0.6 and 0.5 respectively.

Results for Trinidad (equations 9 and 10) were also very good. The CC were close to 1 at 0.99 ant U were close to zero. The CC for equations 11 and 12 however did not exceed 0.9 and the Theil Inequality Coefficients were over 0.5. Further, results for URB and URV indicate that the equations are incapable of capturing turning points in the data and unsystematic error.

Conclusion

Money does seem to matter for small open economies, though the results of this study, bearing in mind the qualifications, suggest that its impact on the demand for non-tradables is modest. In no instance does monetary expansion seem to be the predominant factor in the growth of non-tradable output, but it always seems to have some effect. That is what we would expect: the main impact of monetary expansion is on the balance of payments, with the impact on domestic output of secondary magnitude. This is a matter of some importance to policy-makers, and merits further exploration with a wider range of countries and refinements in the data.

Footnotes

1. In Jamaica the data do not permit us to separate construction and installation out of the tradable sector. Fortunately, it appears to constitute a small proportion of GDP.

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APPENDIX A

BARBADOS

1. $\ln Qn = 0.840 + 0.139\ln Qt - 0.084\ln Pt + 0.078\ln MB$

(1.285) (1.662)(-2.83) (2.855)

$+ 0.0005FINT + 0.747\ln Qn_{-1}$

(0.207) (8.167)

$R^2 = 0.964 DW=1.771 LMSC[\chi^2(1)] = 0.142$

$QSTAT[\chi^2(10)]= 4.88 NORM[\chi^2(2)]=0.991$

$ARCH[\chi^2(1)]=0.016 RESET[F(1,18)]=0.006$

2. $\ln Qn = 0.878 + 0.195\ln Qt + 0.007Dumqt - 0.123\ln Pt + 0.079Dumpt$

(1.018) (1.898) (0.142) (0.676)(0.433)

$+ 0.116\ln MB - 0.075Dumb + 0.003FINT - 0.005Dumfint$

(0.808) (-0.547)(0.555) (-0.750)

$+ 0.687\ln Qn_{-1}$

(5.917)

$R^2 = 0.963$ DW = 1.721 $LMSC[\chi^2(1)] = 0.106$

$QSTAT[\chi^2(10)] = 5.10 NORM[\chi^2(2)] = 0.708$

$ARCH[\chi^2(1)] = 2.351 RESET[F(1,18)] = 2.963$

3. $\Delta Qn = 0.012 + 0.164\Delta\ln Qt - 0.081\Delta\ln Pt + 0.031\Delta\ln MB$

(0.459) (1.497) (-1.666)(1.166)

$+ 0.0003FINT + 0.173\Delta\ln Qn_{-1}$

(0.129) (0.786)

$R^2 = 0.129 DW = 1.664 LMSC[\chi^2(1)] = 0.198$

$QSTAT[\chi^2(10)] = 3.64 NORM[\chi^2(2)] = 0.039$

$ARCH[\chi^2(1)] = 9.632 RESET[F(1,18)] = 0.039$

4. $\Delta Qn = 0.044 + 0.002\Delta\ln Qt + 0.173Dumqt - 0.519\Delta\ln Pt + 0.461Dumpt$

(1.361) (0.009) (0.594) (-1.751) (1.529)

$+ 0.213\Delta\ln MB - 0.185Dumb - 0.003FINT + 0.001Dumfint$

(0.946) (-0.807) (-0.905) (0.489)

$+ 0.101\Delta\ln Qn_{-1}$

(0.386)

R^2 = 0.151DW = 1.673LMSC[χ^2(1)] = 0.740

QSTAT[χ^2(10)] = 6.10NORM[χ^2(2)] = 0.584

ARCH[χ^2(1)] = 4.097RESET[F(1,18)] = 1.327

JAMAICA

5. $\ln Qn = 3.572 + 0.077\ln Qt - 0.101\ln Pt + 0.121\ln MB$

(3.536) (1.168) (-1.327) (1.589)

$+ 0.0002FINT + 0.425\ln Qn_{-1}$

(0.090) (3.138)

R^2=0.861DW=2.148LMSC[χ^2(1)] = 0.5808

QSTAT[χ^2(10)]= 6.77NORM[χ^2(2)]=0.814

ARCH[χ^2(1)]=0.361RESET[F(1,18)]=4.805

6. $\ln Qn = 4.429 + 0.127\ln Qt - 0.421Dumqt - 0.020\ln Pt - 0.554Dumpt$

(1.608) (1.169) (-1.892) (-0.211) (-2.191)

$+ 0.045\ln MB + 0.446Dummb - 0.209FINT + 0.008Dumfint$

(0.488) (1.601)(-0.642) (0.969)

$+ 0.350\ln Qn_{-1}$

(1.805)

R^2 = 0.882 DW = 2.097LMSC[χ^2(1)] = 2.122

QSTAT[χ^2(10)] = 5.81NORM[χ^2(2)] = 1.447

ARCH[χ^2(1)] = 0.777RESET[F(1,18)] = 14.144

7. $\Delta Qn = 0.061 + 0.282\Delta\ln Qt - 0.244\Delta\ln Pt + 0.059\Delta\ln MB$

(1.826) (2.210) (-2.687) (1.647)

$- 0.0016FINT - 0.051\Delta\ln Qn_{-1}$

(-0.636) (-0.323)

R^2 = 0.482DW = 2.686LMSC[χ^2(1)] = 8.733

QSTAT[χ^2(10)] = 17.81 NORM[χ^2(2)] = 0.099

ARCH[χ^2(1)] = 2.588RESET[F(1,18)] = 1.085

8. $\Delta Qn = 0.065 + 0.229\Delta\ln Qt - 0.331Dumqt - 0.158\Delta\ln Pt - 0.578Dumpt$

(1.740) (1.884) (-1.030) (-1.613) (-2.472)

$+ 0.038\Delta\ln MB - 0.295Dummb - 0.003FINT + 0.015Dumfint$

(1.721) (-1.284)(-1.145) (3.424)

$+ 0.007\Delta\ln Qn_{-1}$

(0.031)

R^2 = 0.621DW = 1.728LMSC[χ^2(1)] = 3.869

QSTAT[χ^2(10)] = 21.81NORM[χ^2(2)] = 1.017

ARCH[χ^2(1)] = 4.713RESET[F(1,18)] = 3.668

TRINIDAD AND TOBAGO

9. $\ln Qn = -3.697 + 0.611\ln Qt + 0.173\ln Pt - 0.128\ln MB$

(-3.518) (5.412) (2.699) (-2.165)

$- 0.0048FINT + 0.927\ln Qn_{-1}$

(-1.218) (9.645)

R^2 = 0.975DW = 1.529LMSC[χ^2(1)] = 1.249

QSTAT[χ^2(10)] = 21.15NORM[χ^2(2)] = 0.542

ARCH[χ^2(1)] = 3.177RESET[F(1,18)] = 1.536

10. $\ln Qn = -2.855 + 0.836\ln Qt - 0.141Dumqt + 0.248\ln Pt - 0.317Dumpt$

(-4.794) (6.039) (-1.433) (4.223) (-2.179)

$- 0.119\ln MB + 0.146Dummb - 0.005FINT + 0.338Dumfint$

(-2.060) (1.233) (-1.297) (0.377)

$+ 0.830\ln Qn_{-1}$

(8.249)

R^2 = 0.984 DW = 2.346LMSC[χ^2(1)] = 4.647

QSTAT[χ^2(10)] = 17.68NORM[χ^2(2)] = 0.563

ARCH[χ^2(1)] = 0.222RESET[F(1,18)] = 0.000002

11. $\Delta Qn = 0.025 + 0.455\Delta\ln Qt + 0.094\Delta\ln Pt - 0.052\Delta\ln MB$

(0.561) (1.525) (1.307)(-0.803)

$- 0.0019FINT + 0.717\Delta\ln Qn_{-1}$

(-0.478) (3.834)

R^2 = 0.437DW = 2.268LMSC[χ^2(1)] = 1.529

QSTAT[χ^2(10)] = 10.54 NORM[χ^2(2)] = 9.124

ARCH[χ^2(1)] = 0.446RESET[F(1,18)] = 0.167

12. $\Delta Qn = 0.063 + 0.597\Delta\ln Qt + 0.250Dumqt + 0.193\Delta\ln Pt - 0.138Dumpt$

(0.913) (1.746) (0.177) (1.919) (-0.479)

$- 0.029\Delta\ln MB - 0.036Dummb - 0.005FINT - 0.002Dumfint$

(-0.378) (-0.156)(-0.910) (-0.296)

$+ 0.684\Delta\ln Qn_{-1}$

(3.299)

R^2 = 0.383DW = 2.340LMSC[χ^2(1)] = 0.015

QSTAT[χ^2(10)] = 11.10NORM[χ^2(2)] = 0.601

ARCH[χ^2(1)] = 0.221RESET[F(1,18)] = 0.013

Notes

APPENDIX B

SUMMARY STATISTICS FOR EXPOST SIMULATIONS

	CC	RMSE	STD	RC	U	UB	URB	URV
Equation 1	0.978	0.033	0.212	1.038	0.005	0.003	0.075	0.923
Equation 2	0.978	0.032	0.205	1.038	0.005	0.6D-4	0.017	0.983
Equation 3	0.538	0.031	0.861	0.965	0.754	0.001	0.275	0.725
Equation 4	0.676	0.027	0.729	1.016	0.659	0.6D-4	0.206	0.794
Equation 5	0.948	0.031	0.319	1.083	0.003	0.003	0.146	0.852
Equation 6	0.966	0.025	0.258	1.033	0.003	0.5D-3	0.061	0.938
Equation 7	0.749	0.029	0.630	0.996	0.614	0.1D-6	0.140	0.859
Equation 8	0.881	0.021	0.457	0.999	0.438	0.1D-8	0.063	0.937
Equation 9	0.987	0.044	0.162	0.973	0.005	0.057	0.008	0.936
Equation 10	0.997	0.022	0.081	1.008	0.002	0.001	0.019	0.980
Equation 11	0.690	0.049	0.710	1.169	0.690	0.004	0.314	0.683
Equation 12	0.840	0.039	0.565	1.307	0.544	0.003	0.382	0.615

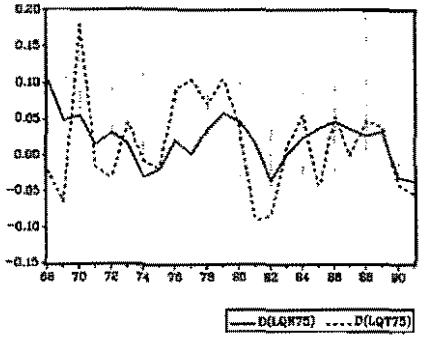
CC = Coefficient of Correlation
RMSE = Root Mean Squared Error
STD = RMSE/standard deviation
RC = Regression Coefficient of actual on simulated
U = Theil's inequality coefficient
UB = Proportion of mean square error due to bias
URB = Proportion of mean square error due to difference of regression coefficient from unity
URV = Proportion of mean square error due to residual variance

1. Serial Correlation: Lagrange multiplier test statistic, LMSC[$\chi^2(1)$]
2. Autocorrelation: Ljung-Box Q statistic, QSTAT[$\chi^2(10)$]
3. Normality: Jarque-Bera test for skewness and kurtosis of residuals, NORM[$\chi^2(2)$]
4. Heteroscedasticity: Arch test based on the regression of squared residuals on lagged, squared residuals, ARCH[$\chi^2(1)$]
5. Functional Form: Ramsey's reset test using squares of fitted values, RESET[F(1,18)]
6. 'ln' prefix denotes that the variables are in logarithms.

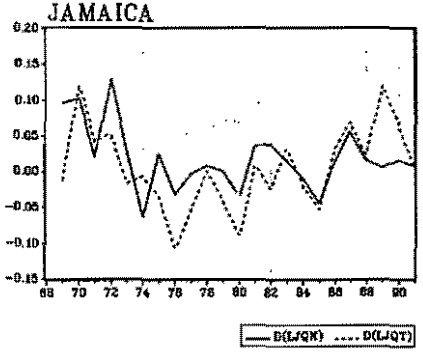
NONTRADED AND TRADED OUTPUT

FOR THE ESTIMATION PERIOD 1968–1991

BARBADOS



JAMAICA



TRINIDAD AND TOBAGO