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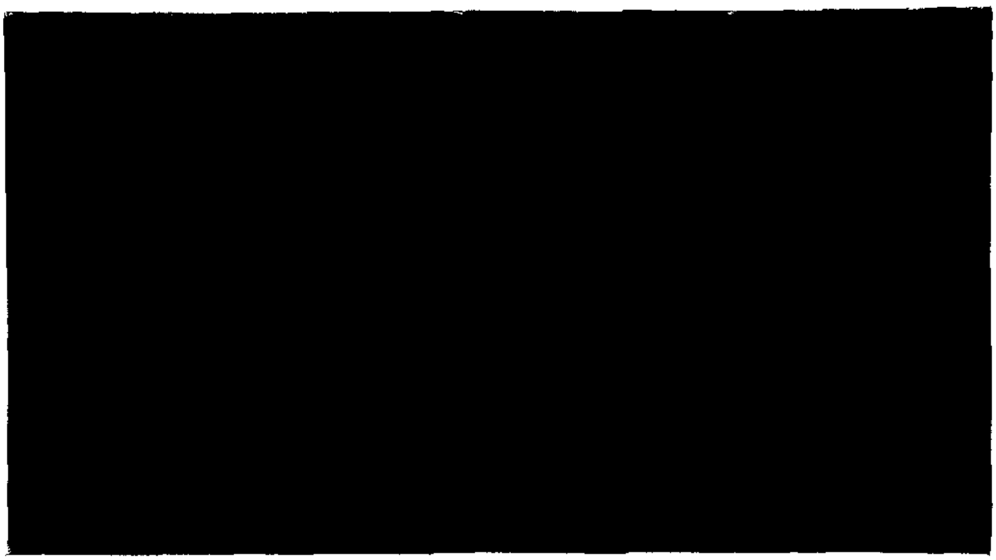

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MONEY DEMAND IN GUYANA

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Abstract

This paper analyzes broad money demand (M2) in Guyana from January 1990 to September 1999; a period marked by deep transformations aimed at shifting Guyana from a centralized to a market economy. The paper develops a stable error-correction model based on a long-run cointegrating vector of money demand. The latter establishes that real money demand is determined in the long run by real income, interest rates, and the exchange rate. The results also show the existence of strong exchange rate-induced inflation anticipations that are typical to Guyana.

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Contents Page

Appendices

I. Introduction

Breaking with a failing state-controlled economy, which marked the two decades after independence in 1966, Guyana embarked on a far-reaching reform process beginning in 1988. This process continued through the 1990s, albeit at an abating pace. Wide-ranging structural reforms, such as the elimination of price controls, the adoption of a free-floating exchange rate, and the privatization of state-owned enterprises set in motion the process of gradually moving the country toward a market economy. At the same time, Guyana implemented a macroeconomic stabilization program supported by the IMF to correct the serious imbalances that had plagued the economy. In that context, monetary policy was conducted in an environment where transmission mechanisms were being deregulated.

Guyana first signed a program supported by the Enhanced Structural Adjustment Facility (ESAF) in 1990 and has implemented Fund-supported programs for most of the time since. Under these programs, monetary policy is conceived as an integral part of the "financial programming" framework, in which monetary and credit aggregates variables play an important role in determining inflation, the balance of payments and the real activity. This approach has served Guyana well. After an initial surge in the wake of the successive devaluations of the Guyana dollar culminating in its free-floating in 1991, inflation was successfully brought down to single-digit levels by 1993 and has since remained in that range. In that regard, monetary policy has been successful in maintaining a measure of price stability, suggesting the existence of a stable money demand relation, which this study will endeavor to establish empirically.

To conduct monetary policy, the Bank of Guyana (BOG) moved from a liquidity forecasting framework to full reliance on indirect instruments, notably open-market operations. In that context, the role of interest rates in the transmission mechanism was enhanced. The exchange rate also has been playing an important role in the conduct of monetary policy. The BOG reckons that past surges in inflation have had a strong impact on popular perception. With the flexible exchange rate regime, exchange rate fluctuations tend to have fairly rapid effects on inflation. Therefore, the BOG takes into account these fluctuations to gauge future inflation, and thereby adjust the stance of monetary policy.

The transition period in Guyana is now more than 10 years old; a period long enough to allow a thorough analysis of money demand that has not been attempted before. This paper endeavors to determine a stable money demand relation. It proceeds as follows: a brief historical background and recent developments in the Guyanese economy are presented in Section II. Section III provides the theoretical framework for empirical investigation and presents the available data. Section IV analyses the integration and cointegration properties of the data in view of the theoretical background laid out in the previous section and discusses the empirical weak exogeneity status of the main variables. The existence of this property provides the foundation for the development of an empirically constant, single error-correction model (ECM) for money demand in Section V. Section V also examines the stability of the estimated money demand function in the face of the significant changes in the financial sector that took place in the 1990s. Section VI draws lessons and concludes.

II. Background and Recent Developments in the Financial Sector

Guyana is a small open economy that experienced considerable transformations in the last decade. The country relies on a few commodities for foreign exchange.[2] Following independence from Great Britain in 1966, Guyana adopted a socialist model of development and the role of the government expanded substantially[3]. The government imposed various controls, including on prices, interest rates, credit limits, and wages, and virtually all companies were nationalized. The exchange rate of the Guyana dollar was fixed at G$1.7 per US dollar. As a result, the size of the public sector increased manyfolds and the economy experienced severe distortions exacerbated by inadequate policy responses to adverse exogenous shocks—including sharp deterioration in the terms of trade and weak external demand for some of the country's main exports. As external financing dwindled, the authorities resorted to domestic financing of the fiscal deficit, fueling high inflation and unemployment and exacerbating macroeconomic imbalances.

In that context, real GDP growth declined by an average 1.6 percent during the period 1975-1988, with the level of recorded output in 1988 being only 65 percent of the level in 1975. Annual CPI inflation averaged 65 percent over 1980-1990. By 1988, official international reserves had been depleted and external payment arrears (mainly on debt service) had accumulated to over US$500 million (315 percent of GDP). Timid attempts at adjustment in 1984 and 1987, including through nominal devaluations of the Guyana dollar, had little effect, as macroeconomic imbalances were too severe. Faced with the continued deterioration of the economic situation, in 1988 Guyana embarked on a dramatic reform effort, through the Economic Recovery Program (ERP), with the objective of moving from a regulated to a market economy.

Under the ERP, Guyana implemented a macroeconomic adjustment program and undertook far-reaching structural reforms designed to shift economic policies towards a market-oriented economy. Price controls were abolished in 1991 except for a few restricted prices, notably on sugar, that were later abandoned. The authorites initiated a privatization program and a process of streamlining the central government, both intended to reduce the relative size of the public sector. In particular, the government gradually sold its shares in commercial banks and a number of new banks were allowed in the market.

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[2] These include food staples (sugar, rice, and shrimps) and mining products (bauxite, gold, and diamonds). Guyana also exports forestry products (logs and semi-transformed wood products). The world prices for these commodities are prone to wide fluctuations. Another source of foreign exchange are remittances by the large Guyanese community leaving in Europe and North America, but there are no reliable estimates of these.

[3] The constitution called for a socialist paradigm based on "cooperative efforts" and "economic law of socialism"

The financial sector was the focus of wide ranging reforms (see Appendix 2, Box 1). Interest rates were gradually liberalized, notably through the introduction of competitive bidding for treasury bills. The frequency of auctions increased progressively until February 1996 when weekly auctions were adopted. Equally gradual was the adjustment of the official exchange rate to cambio rates until the adoption of the free-float in February 1991 (see Appendix 2, Box 2). Between 1987 and 1991, the Guyana dollar was devalued successively from G$19.5 to G$101.75 per one US dollar. The Bank of Guyana initiated a policy of foreign exchange transactions consistent with its target for gross international reserves. The elimination of the foreign exchange surrender requirement in 1996, allowed a further liberalization of the foreign exchange market. At the same time, steps were taken to curtail excess liquidity in the banking system by transforming liquid assets into medium-term liabilities and raising the liquid assets and reserves requirement thresholds. In 1990, to strenghtened the institutional framework for the conduct of monetary policy, a monetary policy unit was created in the Bank of Guyana.

Financial sector reforms deepened in the second half of the 1990s with further privatization and the implementation of the Financial Institutions Act (FIA) in 1995. The government sold its shares in the two largest commercial banks allowing them to be totally privately owned. The FIA mandated a reclassification of loans in accordance with international standards. This revealed the existence of large amounts of nonperforming loans in the banking system. Banks were required to provision these loans progressively with a view to achieving full coverage by June 2001.

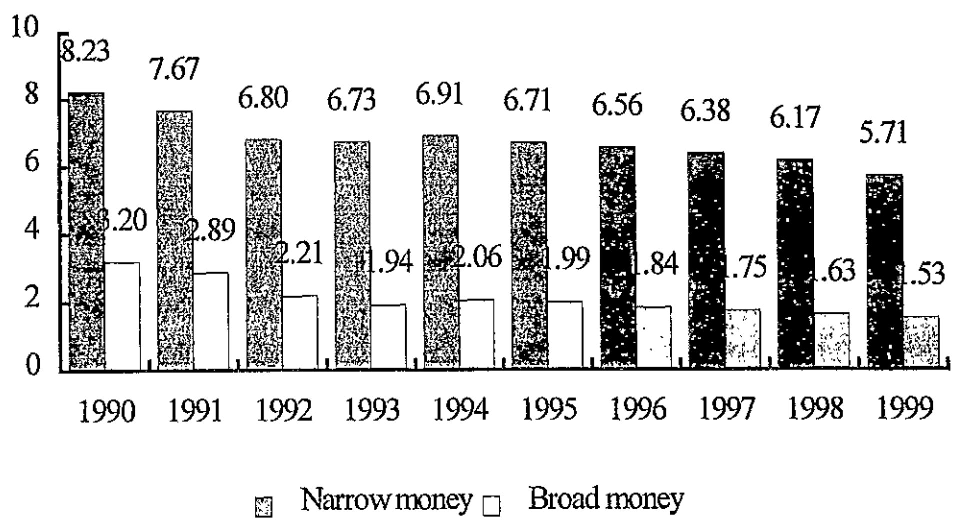
The high prevalence of nonperforming loans in the banking system caused retail interest rates to remain high. In addition, high liquidity requirements (25 percent of liquid assets and 15 percent reserve requirement[4]) resulted in a strong and captive demand for short-term treasury bills, hence distorting the market's determination of interest rates[5]. In addition, the market for government securities is still restricted to institutional players, which limits competition. At the same time, weaknesses in banks' portfolios coupled with provisioning requirements led to a segmentation of the credit market favoring large customers. The latter wield significant market power allowing them to obtain interest rates lower than transaction volumes would suggest. This is compounded by the competition from foreign capital markets that local commercial banks face in the upper segment of the market. Banks have tended to recoup their losses by charging the rest of the private sector punishingly high interest rates.

[4] The reserve requirement was lowered in January 2000 from an average of 15 percent to 12 percent in keeping with the drive for further liberalization.

[5] There is a strong demand for 3-month treasury bills as, among the government securities, they are the only ones that qualify as liquid assets towards meeting the liquid assets requirement. Interest rates on this instrument would probably be higher otherwise.

The past decade has witnessed a great deal of reforms that have had an impact on the financial system. As Figure 1 shows, the income velocity of money has been declining steadily throughout the decade under study (with the exception of 1994), implying a deepening of the financial system. Further liberalization of the economy has been taking place, notably through the privatization of state-owned enterprises and the adoption of regulations to strenghten property rights and reduce administrative bottlenecks. Additional financial sector reforms are expected, notably the automation of the security and money markets, laying the ground for a possible stock market. Against that backdrop, the next section reviews the money demand theory.

Figure 1: Guyana-- Income (Nominal GDP) Velocities of Money



III. Theory and Data Issues

A. Theoretical background

Money is both a means of payment and an asset (see Tobin, 1956, and Friedman, 1956)[6]. The transaction motive for holding money elicits the relationship with real activity and prices, while the portfolio motive highlights competition with alternative assets. Depending on the focus, the emphasis in theoretical studies has been put upon one or another determinant of

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[6] For a broad review of the literature on money demand see Sriram (1999a).

money demand. However, there is a general concensus on a long-run specification that sets the demand for real money balances as a function of a measure of real transactions and a set of variables capturing the opportunity cost of holding money.

$$M^d/P = f(Y/P, R) \tag{1}$$

where M^d represents the nominal monetary aggregate modeled, Y the scale variable capturing real economic activity, P the price level, and R a vector of rates of returns on competing assets. This specification imposes price homogeneity, which could actually be tested empirically. The function *f(.)* is assumed increasing in Y and those elements of R representing a return on components of M, and decreasing in those elements of R representing a return on competing assets.

This general theoretical framework provides little by way of guidance as to how deviations from the long-run equilibrium are reversed. In addition, short-term adjustments hinge very much on the structure of the economy. Bearing in mind that Guyana is basically a transition economy, empirical modeling becomes crucial in establishing the behavior of short-term adjustments to the long-run equilibrium. This aspect of the study will be dealt with in Section V that examines the error-correction model of money demand. The following sub-section reviews data issues.

B. Variable selection and data issues

Before the ERP, the Guyanese economy had experienced more than 20 years of a strong centralization where market forces were stifled, making that period unsuitable for the study of money demand. Therefore this study considers the period starting in January 1990, just over a year after the Economic Reform Plan was launched, through September 1999. Monthly data were used in order to obtain enough variability (there are 117 observations). All series are seasonally-unadjusted to avoid problems linked to pre-filtering and seasonal dummies are included in the set of regressors (see Ericsson, Hendry, and Tran (1994), and Ericsson and Sharma, (1996)).

The monetary aggregate choosen is broad money (M2), defined as the sum of currency in circulation and deposits (both sight and term). Broad money is appropriate as it captures the process of liberalization and innovation in the financial system that took place in Guyana in the last decade. In the absence of monthly (or quarterly) series of real activity, two indices of real economic activity were created using production volumes of economic sectors representing almost half the GDP (see Appendix 1). These include bauxite, gold, rice, sugar, and timber, for which monthly data were available throughout the entire sample period. The consumer price index (CPI) is used as the price variable (no other price variable is available on a monthly basis).

The vector of rates of return includes a set of interest rates on assets of the same maturity. The choosen own rate of return on money is the three-month net deposit rate (*idn*).[7] The net interest rate on three-month treasury bills (*itn*) was chosen as the return on alternative domestic financial assets.[8] As indicated in Section II, banks demand three-month treasury bills not only for portfolio allocation purposes, but also to meet the mandatory liquid assets requirements. This somewhat distorts the determination of interest rates and may affect the transmission mechanism.

Price inflation (Δp) reflects the opportunity cost of holding money rather than goods and is expected to be negatively related to money demand. Expected inflation is proxied by actual inflation annualized as follows: $(\ln CPI_m - \ln CPI_{m-1}) * 12$, where *m* denotes the month (see Honohan, 1994). As mentioned before, the Bank of Guyana believes that the public anticipates higher price inflation whenever the exchange rate depreciates, implying that both variables may be cointegrated, which is supported by Figure 3. Thus, the VAR analysis of money demand might produce more than one cointegrating vector (CIV).

As Guyana is an open economy, the Guyana dollar faces the competition of foreign financial assets, including financial instruments and currencies, notably the U.S. dollar. The discount rate on three-month US treasury bills (*itUS*) is choosen as the representative return on foreign instruments and is expected to be negatively related to money demand. The depreciation of the Guyana dollar (Δe) is intended to capture currency substitution[9]. As with inflation, changes in the nominal exchange rate are annualized using the following expression: $(\ln NER_m - \ln NER_{m-1}) * 12$.[10] Positive changes mean a depreciation of the Guyana dollar vis

[7] On average, quasi money accounts for 75 percent of M2 and deposit of maturity up to three months account for more than 80 percent of quasi money. The deposit rate is adjusted beginning in January 1991 to reflect the 15 percent withholding tax (*WT*) that was imposed then on interest earnings. The net deposit rate (*idn*) equal *id* from January 1990 to December 1990, and *id**(1-*WT*) from January 1991 to September 1999.

[8] This interest rate also was adjusted beginning in March 1st, 1995 when the withholding tax was extended to cover interest earnings on government securities. Therefore, the adjusted interest rate on three-month treasury bills (*itn*) equals *it* from January 1990 to February 1995, and *it**(1-*WT*) from March 1995 to September 1999.

[9] A direct measure of currency substitution is not available as there is no data compiled on the amount of foreign exchange available in the economy outside the banking system. A relatively large number of Guyanese nationals leave abroad (allegedly more than the 650 thousands leaving in Guyana) suggesting that remittances may be relatively substantial.

[10] A similar variable was constructed using the nominal effective exchange rate (NEER) compiled by the IFS. In this case, increases represent an appreciation of the Guyana dollar vis a vis the US dollar, implying a positive relation with the demand for the Guyana dollar.

(continued...)

a vis the US dollar and vice versa, implying a negative relation with the demand for Guyana dollars.

Since the money demand relation could be affected by the sheer number of reforms implemented during the 1990s, an attempt is made to capture relevant changes through dummies (bearing in mind the associated loss in degrees of freedom).[11] Two step dummies (*dev1* and *dev2*) were created to capture the devaluation of the Guyana dollar in june 1990 and February 1991 (when the currency was allowed to freely float). Another step dummy (*dumIR*, taking zero before January 1992 and 1 after) was created to capture the end of the administrative determination of interest rates. A fourth dummy (*dumTB*, taking zero before February 1996 and one after) was established to capture the frequency of Treasury bills auctions. Monthly auctions were introduced in June 1991 and their frequency was increased gradually to weekly auctions in February 1996 (the frequency that has prevailed since then). As data are seasonally unadjusted, seasonal dummies are also added.

The general model formulation suggested by the theory is:[12]

$$\begin{aligned} rm2 &= \beta_0 + \beta_1 y + \beta_2 idn + \beta_3 itn + \beta_4 itUS + \beta_5 \Delta p + \beta_6 \Delta e \\ &+ \beta_7 dev1 + \beta_8 dev2 + \beta_9 dumIR + \beta_{10} dumTB + \sum_{i=0}^{10} SD_{t-i} + \varepsilon \end{aligned} \qquad (2)$$

Where $rm2 = m2 - p$ is real money (Table 1 defines the other variables). Removing the discount rate on U.S. three-month Treasury bills and exchange rate depreciation from this general formulation reduces the model to a closed-economy model, which is generally suitable for large economies such as the U.S. economy. As the cointegration analysis will show later, the closed-economy model does not fit the Guyanese economy. Based on the econometric modeling and specificity of the Guyanese economy, this general formulation will be adjusted to establish the most suitable model.

However, the nominal exchange rate was preferred for the estimations because it better captures anticipations.

[11] The dynamic nature of financal liberalization may call for a dynamic dummy process (Baba, Hendry, an Starr, 1992). However, the need to neutralize large outliers justifies the use of discrete dummies.

[12] All variable except interest rates are in logarithms (lower case letters). This log-linear form allows to interpret coefficients of variables in logarithms as elasticities (percentage change leading to a one percent change in the modeled variable), and coefficients of interest rates as semi-elasticities (change in level leading to a one percent change in the modeled variable).

Table 1. Expected Signs of the Coefficients in the General Model

Variables	**Signs** (justification and magnitude where it applies)
y = ln (real economic activity)	+ (coefficient=1, assumed homogeneity of income)
idn = interest rate on 3-month time deposits at commercial banks.	+ (Interest rate on a component of money)
itn = interest rate 3-month treasury bills	- (Interest rate on a domestic instrument outside money)
itUS = 3-month US T-bills discount rate)	- (Interest rate on competing foreign assets)
Δp = annualized inflation rate	- (Opportunity cost of holding money rather than goods)
p = ln (consumer price index)	Price homogeneity is assumed
Δe = annualized depreciation of the G$ in nominal terms, NER	- (Opportunity cost of holding Guyana dollars rather than foreign currencies. For instance the US dollar)
Std = *itn* – *idn*	The larger the spread the lower the demand for money
SdGtUS = *idn* – *itUS*	The larger the spread, the stronger the demand for money

Figure 2: Money, real income, price, and nominal exchange rate

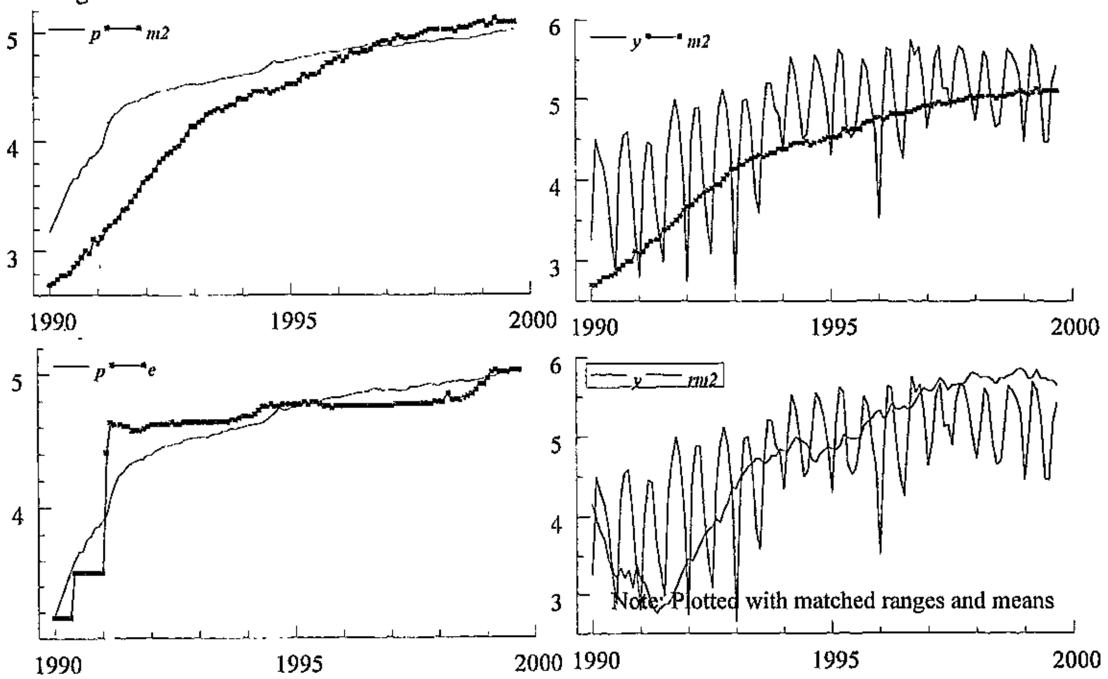
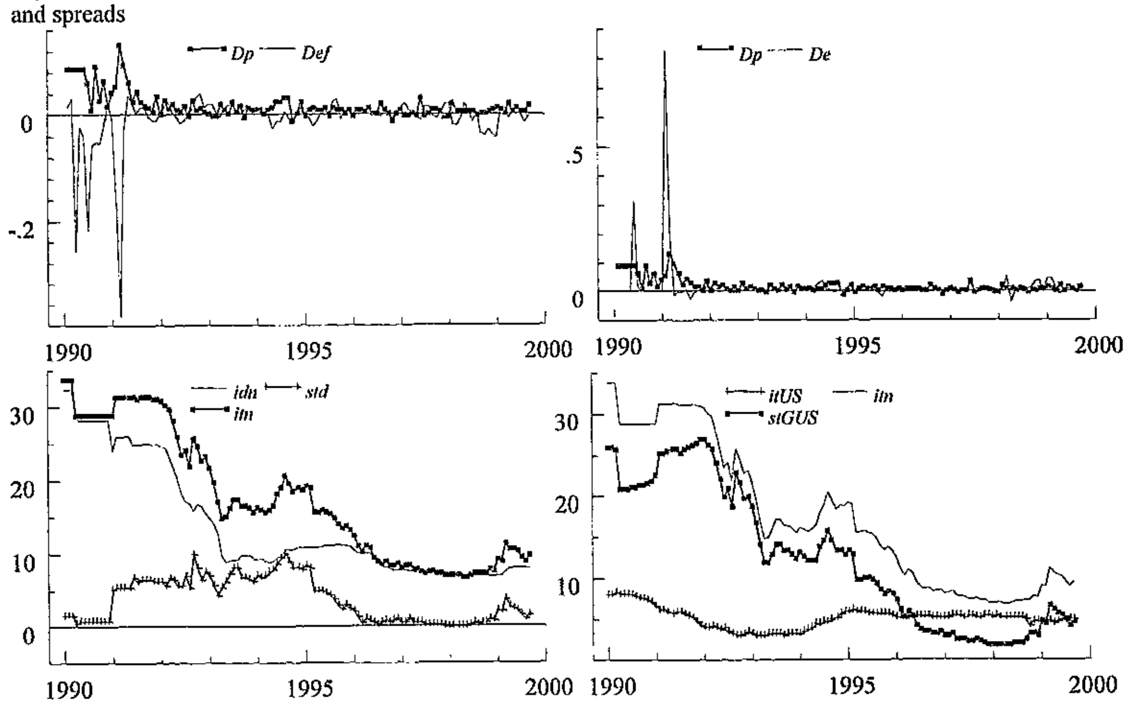


Figure 3: Inflation, nominal effective and nominal exchange rate variations, interest rates and spreads



IV. Integration and Cointegration

This section reviews first unit root tests for the selected variables using augmented Dickey-Fuller tests. Then, cointegration of the variables entering the money demand equation is tested using Johansen's (1988, 1991) maximum likelihood procedure, with a view to establishing a long run relationship.[13]

A. Integration

Table 2 presents the augmented Dickey-Fuller (ADF, 1981) statistics for testing the existence of a unit root. Units roots are reported for differenced variables of order *i* ($i = 1, 2, 3$), allowing to test whether a given series is I(1), I(2) or I(3).[14]

It appears that most variables are integrated of order two or three. CPI and the nominal exchange rate are integrated of order 1, implying that inflation and exchange rate depreciation are stationary (I(0), as Figure 3 suggests). Therefore, they may not play any role in the long-run. All the other variables appear to be I(3) except real income and the spread between domestic interest rate, which are I(2). The high order of integration required to make series stationary may reflect the high frequency of data. Monthly data are much more volatile (even though they contain more information) than quaterly and annual data, yielding a greater number of outliers. In addition, the large number of reforms during the period under consideration make the existence of structural breaks more likely. Events like the devaluations of the exchange rate and the liberalization of interest rates may cause such breaks.[15] Multivariate tests of stationarity are analyzed in the next sub-section.

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[13] Although there are 117 observations, one should note that a ten-year period is somewhat short for estimating a long run relationship (Section III.B. explains why this period could not be extended). The analysis proceeds with that caveat in mind.

[14] The order of integration (*i*) indicates the number of times a variable should be differenced to make it stationary.

[15] The regressions for testing the existence of units roots do not include the dummies created to capture these events.

Table 2. Unit Root Tests Using ADF T-Statistics 1/

Variables	Null order		
	I(1)	I(2)	I(3)
m2	-1.82	-2.76	-5.60**
rm2	-3.30	-2.47	-5.10**
p	-4.22**	-5.29**	-5.71**
y	-3.22	-3.71*	-5.42**
e	-7.87**	-5.54**	-7.17**
ef	-3.92*	-5.90**	-5.25**
idn	-2.35	-2.83	-6.04**
itn	-3.12	-3.08	-5.36**
itUS	-2.18	-3.15	-4.65**
std	-2.54	-3.97*	-5.26**
sdGtUS	-2.35	-3.06	-6.60**
stGUS	-3.02	-3.37	-5.66**

1/ The critical values for the test statistic are -3.454 at the 5 percent significance level and -4.05 at the 1 percent level. Smaller values imply rejection of the null hypothesis of non-stationarity. **, * indicate rejection at the 1 percent and 5 percent significance level respectively. A constant term, monthly dummies, and a trend are included in all the regressions.

B. Cointegration

This section analyses cointegration among the variables discussed in Section IV using the method developed by Johansen (1988) and Johansen and Juselius (1990). F-tests of sequential elimination of lags established that it was appropriate to include three lags in the Vector autoregression (VAR) system. [16] Generally, both the trace and maximum eigenvalue

[16] The Johansen's procedure is sensitive to the number of lags included in the VAR. The high frequency of the data (monthly) amplifies the importance of this issue. Given the number of degrees of freedom required, the number of observations (117) allows to include a maximum of only four lags. An F-test of the 4^{th} lag, generally is not significant and the elimination of the third lag is ruled out. Sriram (1999b) used the same frequency data in his study of money demand in Malaysia and also found that the inclusion of three lags was sufficient.

(λ_{max} and λ_{trace}) tests reject the null hypothesis of no cointegrating vector (CIV). Instead, many cointegrating vectors were found on alternative formulations consistent with money demand theory. It appears that both the closed and open-economy versions of the model defined in equation (2) do not yield cointegration vectors that are consistent with money demand theory (Appendix 4). In addition, the number of cointegrating vectors suggested by the tests (three to four) makes it difficult to interpret. The stationarity of inflation and exchange rate depreciation discussed above may be one of the reasons explaining that result.

Of the alternative formulations computed, the one excluding inflation yields one long-run cointegrating vector that can be interpreted as a money demand relationship. Table 3 reports the standard estimates and statistics of the Johansen procedure. The maximum eigenvalue and trace eigenvalue statistics point to one cointegrating vector. λ_{max} test suggests that there might be a second CIV, but when adjusted for degrees of freedom it becomes insignificant. However, further tests show that real money and real income are weakly exogenous, suggesting that there is one CIV for each. Nonetheless, as the maximum eigenvalue and trace tests do not unequivocally confirm the existence of a second CIV, we focus on the CIV that is consistent with the money demand theory (Figure 4 suggests that this CIV is stationary).

All the variables have the expected sign, but the income elasticity is lower than the expected 1 (as suggested by the quantitative theory of money demand). In a system context, it is possible to conduct identification tests by restricting coefficients to sought values, so long as these restrictions are not rejected. Following that approach, the real income elasticity was restricted to unity and that restriction was barely rejected (at 5 percent).[17] The elasticity closest to unity that was accepted is 0.8 (results are reportd in Table 3).[18] Therefore, the CIV retained is the following.

[17] The non-significance of that restriction is not strong enough to rule out a unit income elasticity. Assuming it actually holds, the CIV would be the following (standard deviations in parenthesis):

rm2	*y*	*idn*	*itn*	*itUS*	*e*	*trend*	$\chi^2(1)$
1.0	1.0	0.08	-0.05	-0.18	-0.17	0.005	4.5*
(0.0)	(0.0)	(0.03)	(0.03)	(0.04)	(0.19)	(0.003)	

[18] The long run income elasticity of money demand tends to be slightly higher than one in developing countries reflecting the small number of alternative assets (notably the shallowness of financial markets). There may be two (not necessarily mutually exclusive) reasons for the lower-than-unit elasticity of income. First, the income variable that was constructed reflects production in sectors that account for a little less than 50 percent of GDP. Thus, it might not be sufficiently representative. The second problem might be a misspecification of the model (by variable omission or inclusion).

$$rm2^* = 0.8y + 0.060idn - 0.046itn - 0.145itUS - 0.169e + 0.0047$$

The demand for real money balance is positively affected by real income with an elasticity close to unity, the interest rate on deposits, and a trend. The interest rates on Guyanese and U.S. Treasury bills, as well as the nominal exchange rate affect real money demand negatively.

Semi-elasticities of domestic interest rates suggest that these variables have a strong impact on the demand for real money. For instance (and ceteris paribus), assuming the current interest rate on three-month deposits is 10 percent, a rise of six tenth of a percentage point would increase money holding by one percent. It would take almost half a percentage point increase in three-month Treasury bill rate for real money demanded to decrease by one percentage point in exchange for Treasury bills. However, it would take almost 1½ percentage point increase in the U.S. Treasury bill discount rate for agents to relinquish 1 percent of their holding of real Guyanese dollars in favor of that asset. The difference between domestic and foreing assets may reflect transaction costs as foreign instruments are not available at Guyanese financial institutions. The coefficients of domestic interest rates are of almost equal magnitude. A Chi-square test accepts the hypothesis that they are exactly the same with opposite signs.[19]

The elasticity of the nominal exchange rate is small, but has the expected negative sign.[20] Although the exchange rate has been remarkably stable throughout the decade (Figure 3), the impact on public perception of devaluations that occurred in the early 1990s has not totally subsided. Therefore, money demand is affected in the short-run by movements in the exchange rate (as confirmed by the error-correction model presented in Section V).

Adjustment coefficients (α) measure the speed of the short-run response to a desequilibrium in endogenous variables of the system. We focus on the real money demand relation as only one CIV was identified. The restricted VAR shows that money has a feedback coefficient of -0.034, which implies a rather fast adjustment (3.4 percent in the first month). The negative coefficient implies that lagged excess money induces smaller holdings of current money. The feedback response on income rate is even stronger, whereas the adjustment from the nominal exchange rate is small but very significant. In contrast, feedback responses of all three interest rates are not significant, which implies that they might not play any role in the short-run. The existence of weak exogeneity, which is discussed next, directly tests for the relevance of a given variable in a short-run model.

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[19] The Chi-square test strongly supports that restriction ($\chi^2(1) = 1.59$ [0.2073]).

[20] Although the coefficient of the NER in the restricted model is not at all significant, a test of the significance of the variable in the system rules out its exclusion at the 5 percent confidence level (an analysis of the VAR excluding the NER is provided in Appendix 3).

Table 3. Cointegration Analysis of Guyana's Money Demand and Weak Exogeneity Tests

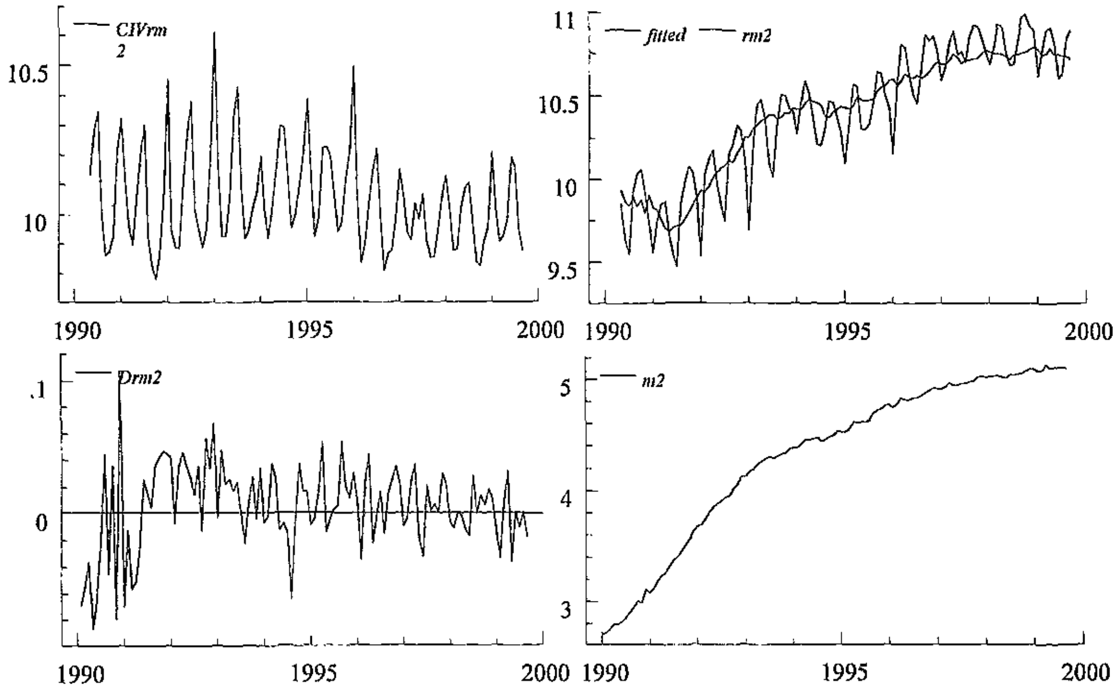
Eigenvalues	0.444	0.304	0.129	0.119	0.054	0.035	
Hypotheses	r = 0	r≤1	r≤2	r≤3	r≤4	r≤5	
λ_{max}	66.34**	40.95*	15.64	14.33	6.25	3.99	
$\lambda^{a}_{\max}$	55.77**	34.42	13.15	12.04	5.25	3.35	
95% critical value	44.0	37.50	31.50	25.50	19.00	12.30	
λ_{trace}	147.5*	81.15	40.20	24.56	10.23	3.99	
λ^{a}_{trace}	124*	68.22	33.80	20.65	8.60	3.35	
95% critical value	114.90	87.30	63.00	42.40	25.30	12.30	
	Unrestricted standardized eigenvectors β'						
	rm2	*y*	*idn*	*itn*	*itUS*	*e*	*trend*
	1.000	-0.276	-0.017	0.029	0.052	0.147	-0.0042
	7.533	1.000	-0.036	0.235	0.032	0.336	-0.022
	-35.538	-0.528	-1.996	1.000	4.945	8.846	0.004
	-202.330	-7.876	-10.627	1.288	1.000	-51.952	0.990
	-2.665	-0.176	0.132	-0.271	0.276	1.000	-0.004
	-64.043	-25.567	1.000	-0.363	-0.283	-17.330	1.889
	Unrestricted standardized adjustment coefficients α						
rm2	-0.130	-0.016	0.001	0.000	-0.002	0.000	
y	2.523	-0.156	0.003	0.004	-0.014	0.000	
idn	-0.186	0.521	0.024	0.008	0.094	-0.001	
itn	3.016	0.026	-0.035	0.018	0.283	-0.001	
itUS	-0.103	0.005	0.001	0.002	-0.062	0.000	
e	-0.045	0.004	-0.000	0.000	-0.004	-0.000	
$\chi^2(1)$ =3.6078 [p =0.0575]	Restricted standardized eigenvectors β'						
	rm2	*y*	*idn*	*itn*	*itUS*	*e*	*trend*
	1.000	-0.800	-0.060	0.046	0.145	0.169	-0.0047
	Standard deviations of the restricted standardized eigenvector β						
	0.000	0.000	0.023	0.020	0.030	0.1567	0.0025
	Restricted standardized adjustment coefficients α						
	-0.034	1.079	-0.361	-1.033	-0.037	-0.019	
	Standard deviations restricted standardized adjustment coefficients α						
	0.016	0.171	0.403	0.673	0.119	0.009	
	Weak exogeneity tests						
$\chi^2(1)$	7.90**	18.41**	0.03	3.47	0.14	3.6	
	Statistic for testing the significance of each variable						
$\chi^2(1)$	24.88**	13.36**	0.03	13.05**	4.54*	6.60*	17.70**
	Multivariate statistic for testing stationary						
$\chi^2(5)$	29.31**	28.71**	50.24**	40.94**	72.10**	66.28**	

Notes to Table 3

1/ The vector autoregression includes three lags on each variable (*rm2, y, idn, itn, itUS, e*), a constant term, a restricted trend, seasonal dummies ($M_{t-1}, \ldots, M_{t-11}$), the two devaluation dummies *dev1* and *dev2*, a dummy to capture the liberalization of interest rates (*dumIR*), and a dummy to capture the frequency of Treasury bills auctions (*dumTB*). The estimation period is 1990 (5)-1999 (9).

2/ The statistics λ_{max} and λ_{trace} are Johansen's maximum eigenvalue and trace eigenvalues statistics for testing for cointegration, adjusted for degrees of freedom. The null hypothesis is in relation to the cointegration rank *r*. Rejection of $r = 0$ is evidence in favor of at least one cointegrating vector.

Figure 4: Cointegrating vector, actual and fitted values, and change in real broad money; nominal broad money



C. Weak exogeneity and other relevant tests

The weak exogeneity property allows to model a single equation that captures the short-run dynamics of money demand without loss of information. Table 3 reports the results of $\chi^2(1)$ tests for weak exogeneity. Real money and real income are weakly exogenous, suggesting that each of these two variables has a long-run relationship, in other words a CIV. However, since the estimates point to one CIV consistent with money demand theory, the paper proceeds to an error-correction model of money demand (Section V). Table 3 also displays the results for testing the significance of each individual variable in the VAR and multivariate stationary (rejected in all cases). On the relevance of each variable, only the interest rate on three-month deposits appears not to be significant.

V. A SHORT-RUN ERROR-CORRECTION MODEL (ECM) OF MONEY DEMAND

Based on the cointegration analysis and weak exogeneity tests reported in Table 3, we now turn to modeling money demand in a single equation context.[21] This conditional short-run model allows to examine adjutments that take place to restore the long-run equilibrium of the money demand relation in response to short-term disturbances. In addition, a conditional model can be stable even though the reduced form VAR is not. As discussed in the background section, Guyana experienced substantive transformations that may have created structural breaks. Therefore, a well-specified model may be easier to obtain in a single equation context than with a system. This section develops a parsimonious error-correction model of real money demand in Guyana. The model contains an error-correction term, which ensures that the long-run relationship established by the cointegration analysis holds in the steady state.

The short-run model is a second-order autoregressive distibuted lag (ADL) in *rm2, y, idn, itn, itUS, and e,* given that 3 lags were retained for the vector autoregression.[22] The dummies added in the VAR were also included here to capture the events that may have affected money demand. Seasonal dummies also were added as the series are seasonally unadjusted. ADL have error correction representations, which capture long-run relations. In the case of money demand, the error-correction term (defined below) represents the desequilibrium from the long-run solution, with money adjusting in subsequent periods if $\gamma_7 < 0$. The unrestricted reduced form (URF) model estimated is the following:

[21] The existence of a cointegrating vector implies an error-correction representation. For a simple presentation see Ericsson (1994).

[22] Right-hand side variables are expressed in terms of first differences, except for the error-correction term that remains in level. Therefore, two lags in this equation are equivalent to the three lags included in the vector autoregression.

$$\Delta rm2 = \sum_{j=1}^{6}\sum_{i=1}^{2}\gamma_{1i}\Delta V_{j,t-i} + \gamma_7 ECTrm2_{t-1} + \sum_{i=0}^{10}\gamma_{8i}SD_{t-i} + \sum_{i=1}^{4}\gamma_{9i}Dum_i + \varepsilon_t$$

where *V* is a vector of six variables lagged twice (*Δrm2, Δy, Δidn, Δitn, ΔitUS, Δe*); an error-correction term $ECTrm2_{t-1} = (rm2 - rm2^*)_{t-1}$; monthly dummies ($SD_{t-i}$); dummies ($Dum_i$, also entered in the cointegration analysis) capturing financial sector reforms, specifically devaluations of the Guyanese dollar, liberalization of interest rates, and frequency of Treasury bills auctions.

A. The unrestricted and parsimonious reduced form error-correction models

The unrestricted reduced form (URF) error-correction model (ECM) defined above is the starting point. Following the general-to-specific strategy for model reduction based on the full-information likelihood technique (monitored by the "model progress" feature in PcFiml), the URF ECM is reduced to a parsimonious, yet robust model of short-run real money demand. The reduction procedure allows to reduce the right hand-side set of variables to a sub-set comprising first and second lag changes in money demand, second lag change in the interest rate on three-month deposits, lagged exchange rate depreciation, the error-correction term, and a constant. Dummies created to capture the reforms were retained in the model. The results of the unrestricted and the parsimonious model are reported in Table 4.

In both models, the error-correction term has a negative and significant coefficient, validating the long-run relation identified by the cointegration analysis. The negative sign implies that money demand adjusts in the subsequent month in response to a disequilibrium. In other words, if there were excess money balances during the current month, agents will rein in money demand in the next month and vice versa. While the changes in real income do not affect the short-term variations of real money demand, the latter is strongly affected by the nominal exchange rate depreciation in the previous month. This shows how sensitive is the public to exchange rate movements. However, the effect of the NER depreciation wears off very quickly—the second-lag depreciation is not significant at all, which is consistent with the insignificance of the NER coefficient in the long-run CIV. Short-run real money demand is also affected by its second lag, as well as the second lag of the change in three-month interest rate deposits. The diagnostic test statistics, reported at the end of Table 4, do not reveal any problem with either model.

A short run model of nominal money demand also was estimated to see whether inflation had an impact. The results (not reported here) show that lagged as well as two-lag inflation have insignificant coefficients. In fact, it appears that price anticipations are almost entirely captured by the depreciation of the exchange rate, making the latter a key variable to achieve price stability. This result also may imply that agents do not acquire goods in exchange for money in anticipation for a rise in inflation, but rather relinquish Guyanese dollars for U.S. dollars (or whatever alternative financial assets they like better) when the exchange rate depreciates.

Table 4 Estimates of the Short-Run Error-Correction Model of Real Money Demand

Variables	Unrestricted reduced for error-correction model	Restricted (parsimonious) error-correction model
$\Delta rm2_{t-1}$	-0.203 (-2.02)**	-0.140 (-1.49)
$9\Delta rm2_{t-2}$	0.229 (2.26)**	0.264 (2.74)**
Δy_{t-1}	0.008 (0.85)	
Δy_{t-2}	-0.002 (-0.26)	
Δitn_{t-1}	0.004 (-1.40)	
Δitn_{t-2}	-0.003 (-0.99.)	
Δidn_{t-1}	0.009 (1.64)	
Δidn_{t-2}	-0.012 (-2.47)**	-0.014 (-3.27)***
$\Delta itUS_{t-1}$	-0.022 (-1.43)	
$\Delta itUS_{t-2}$	-0.009 (-0.62)	
Δe_{t-1}	-0.151 (-3.67)***	-0.140 (-4.03)***
Δe_{t-2}	-0.001 (-0.03)	
$ECTrm2_{t-1}$	-0.037 (-2.13)**	-0.029 (-2.26)**
Dev1	-0.114 (-3.25)***	-0.101 (-3.16)***
Dev2	-0.0004 (-0.013)	-0.027 (-0.95)
DumIR	0.009 (1.16)	0.005 (0.63)
DumTB	-0.010 (-1.97)**	-0.007 (-1.47)
Constant	0.320 (2.35)**	0.204 (2.67)**
Information on quality of the model	T = 114 [1990 (4) – 1999 (9)]; R^2 = 0.5728; σ = 0.0237; DW = 1.86 , AR 1- 7 F(7, 78) = 1.5476 [0.1638] *ARCH* F(7, 71) =10.028 Normality $\chi^2(2)$=156 *RESET* F(1, 84) = 0.64601	T = 114 [1990 (4) – 1999 (9)]; R^2 = 0.5363; σ = 0.0236; DW = 1.86; *ARCH*: $\chi^2(7)$ = 10.812 F (7,58) = 1.19; Normality $\chi^2(2)$ = 260 Heteroscedasticity: $\chi^2(22)$= 23.157 F (22, 49) = 0.738

Notes to Table 4

Significance thresholds: *** 1 percent; ** 5 percent; * 10 percent. T-statistic in parenthesis.

Figure 5: Parsimonious ECM: recursive estimates of the coefficients (for testing for parameter constancy)

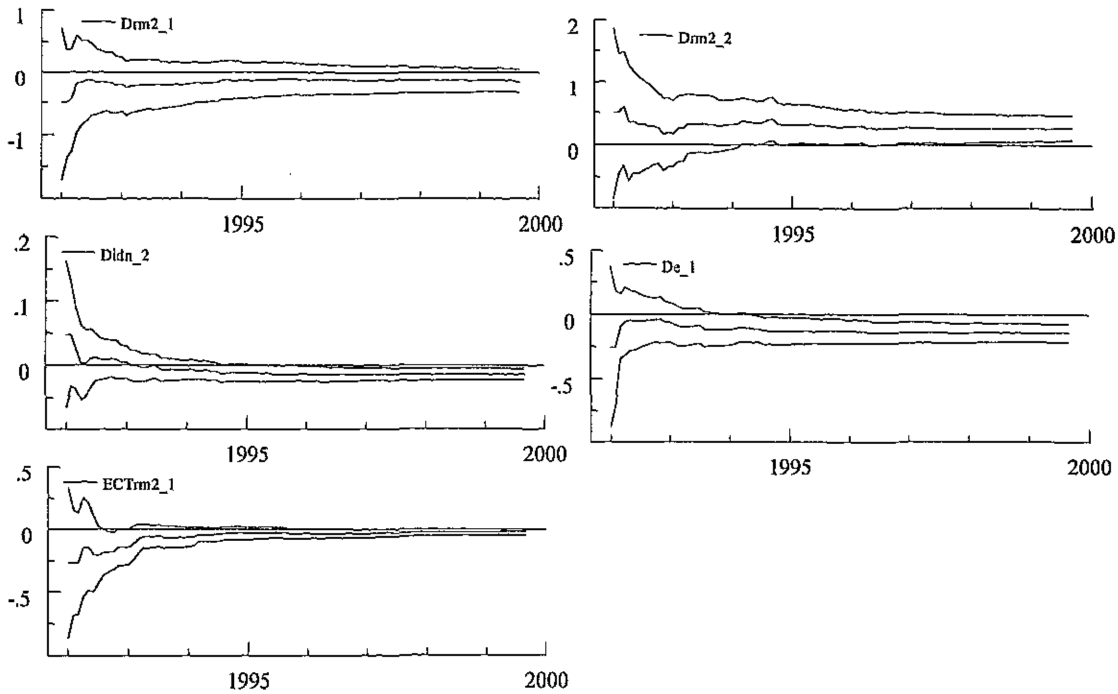


Figure 6: Graphic analysis of the parsimonious ECM of real money demand

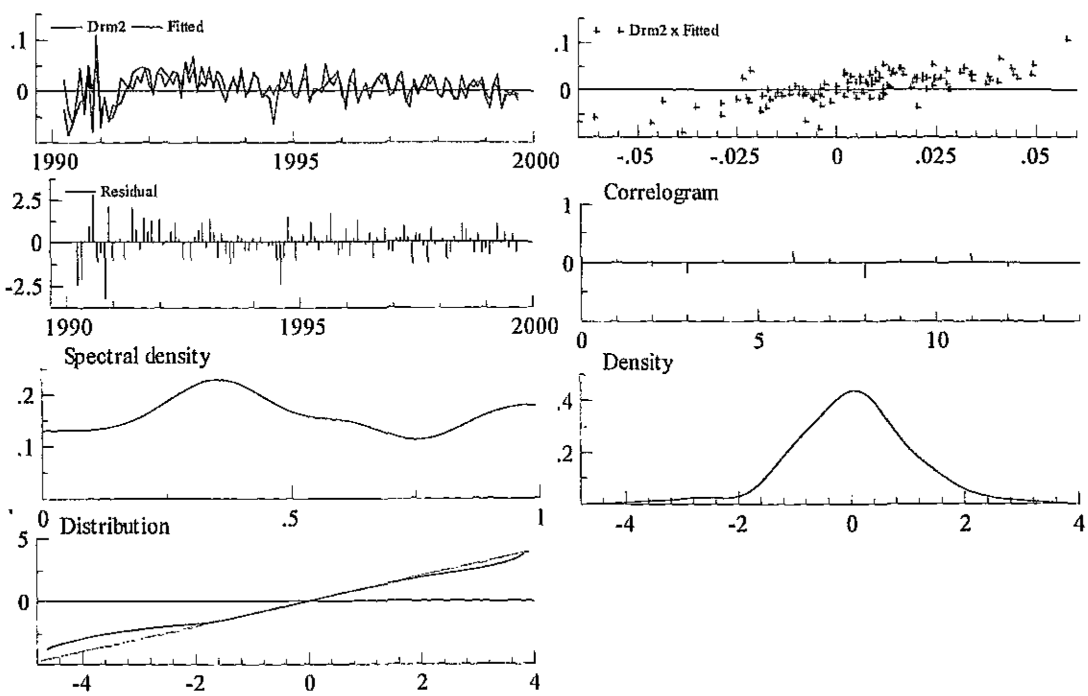
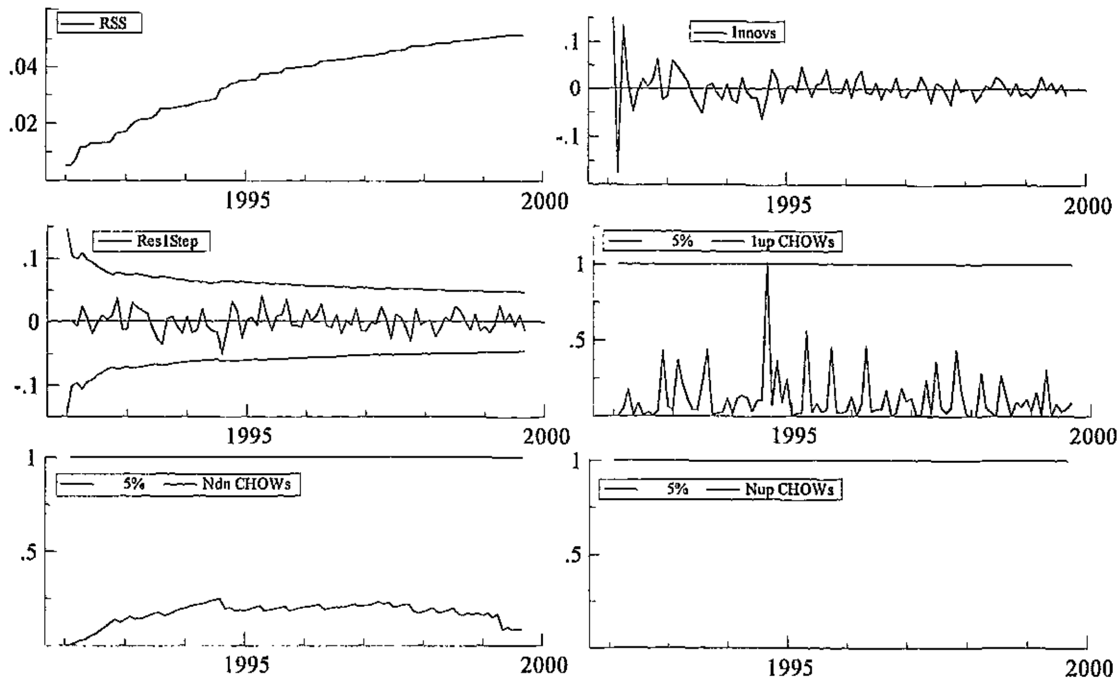


Figure 7: Recursive diagnostic graphs of the parsimonious ECM of real money demand



B. Statistical properties of the model

Given the sheer amount of data produced by the full diagnostic analysis, the graphical representation of statistical properties of the model is useful way to examine the model's quality. Figures 5, 6, and 7 are diagnostic tests for the parsimonious ECM, whereas graphs 8 and 9 represents an analysis of the unrestricted model. Overall, these graphs show that both short-run models are well-specified, with the the parsimonious model having a higher quality than the unrestricted one.

Parameter constancy is a key feature a money demand model has to exhibit. Coefficients of variables estimated recursevily (by least squares) plus and minus twice their recursively estimated standard errors are presented in the funnel-shaped graphs. Figures 5 and 8 contain such graphs for the parsimonious and the unrestricted models respectively. Although, the unrestricted model exhibits stable coefficients, the restricted model's coefficients are more stable, with the standard error interval narrowing quickly. From mid-1994 onward, the coefficients of all the right-hand side variables in the parsimonious model (Figure 5) are virtually constant—a strong indication of the stability of the model.

Figures 7 and 9 present the graphs of the following indicators or tests: residual sum of squares (RSS), standardized innovations (Innovs), one step residuals (Res1Step) and the corresponding equation standard errors, one step Chow tests (1up CHOWs), break point Chow tests (Ndn CHOWs), and forecast Chow tests (Nup CHOWs). As illustrated by the graphs in Figure 7, innovations appear very stable, one-step residuals vary little within the "funnel" depicted by their plus-or-minus twice standard errors. All three Chow tests graphs show that at any point in time none of the tests is significant (at their one-off 5 percent levels). The forecast Chow tests actually yield a zero statistic throughout the entire period studied. The same graphs for the unrestricted model (Figure 9) are also well oriented, although the parsimonious model is clearly better.

The stability of the short-run error-correction model is remarkable, considering the large number of important reforms undertaken during the 1990s. This also indicates that the model is well-specified and, in particular, events that were capable of creating outliers or structural breaks have been captured appropriately.

Figure 8: Graphs of the recursive coefficients of the short run unrestricted reduced form ECM of real money demand

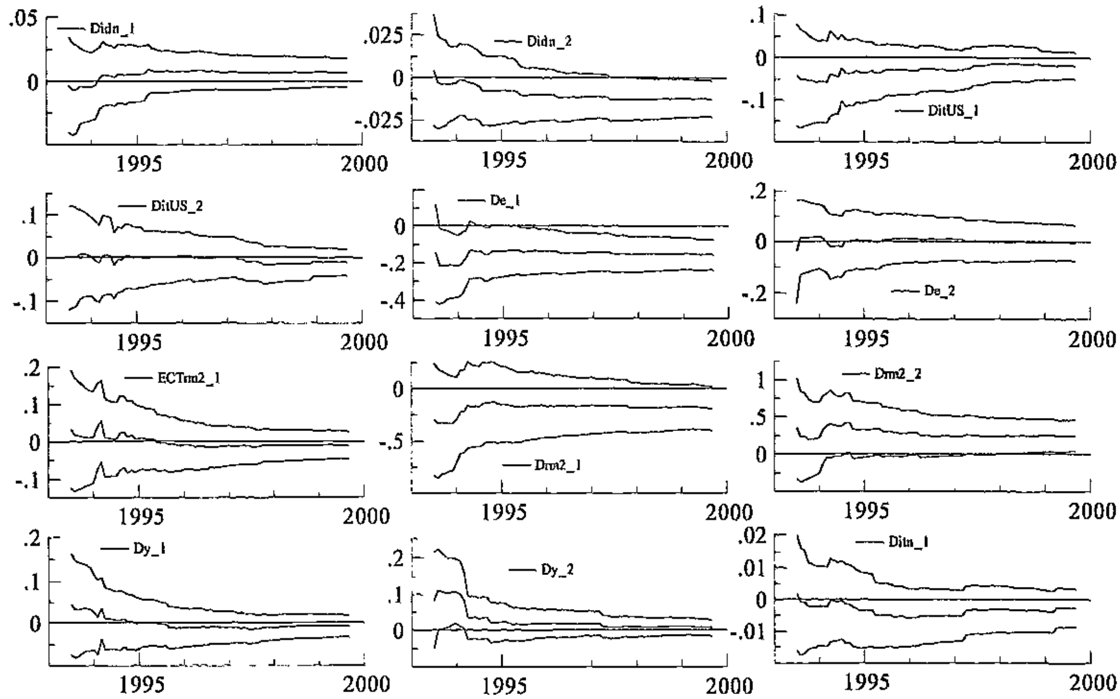
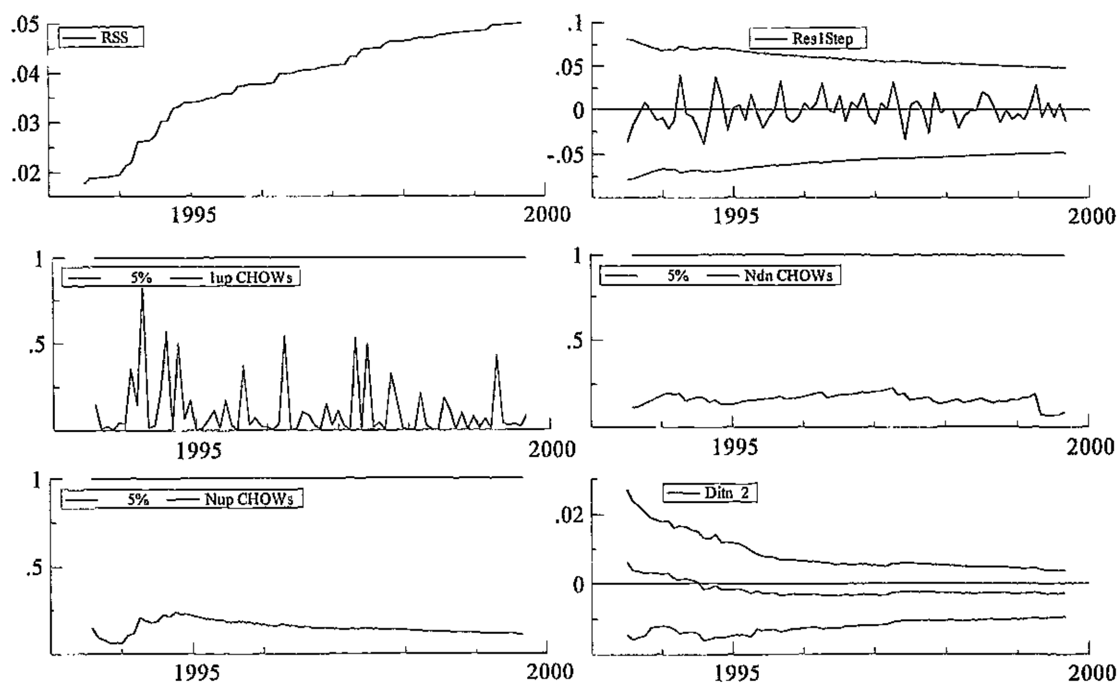


Figure 9: Recursive diagnostic graphs of the short run unrestricted reduced form ECM of real money demand



VI. CONCLUDING REMARKS

Cointegration analysis of money demand shows that there is a long-run money demand relationship in Guyana that is in conformity with the theory. Prices have a unit elasticity as expected and the income elasticity is close to one. The interest on deposits is positively related to money whereas interest rates on alternative assets negatively affect money demand. Nominal exchange rate depreciation and inflation have an insignificant role and no role at all in the long run, as both processes are stationary.

Despite a host of reforms implemented during the 1990s, the conditional short-run model of money demand in Guyana is remarkably stable, confirming that the market determination is the underlying force behind money demand.[23] Although the NER does not have a significant role in the long-run, exchange rate depreciation appears to have a strong impact in the short run, confirming that agents are still very sensitive to exchange rate movements. It appears that price anticipations are almost entirely captured exchange rate fluctuations, making it an important factor to achieve price stability. This calls for prudent monetary and fiscal policies that do not put undue pressure on the exchange rate. In the other hand, given the smallness and openess of the economy and the structure of its exports, the exchange rate should remain a prime shock absorber.

The money demand relationship established in this paper should be revisited from time to time as the quality of the data improves, the series lengthen, and considering the evolving nature of the Guyanese economy.

[23] There are a number of studies of money demand for countries that have experienced numerous reforms that have established stable money demand relations [Ericsson and Sharma (1996) on Greek data; G. Jonsson (1999) on South Africa's data; Sriram (1999b) on Malaysian data, and Leigh (1997) on Kyrgyz data to name a few].

Appendix 1: Data Sources and Definitions of Variables

m2: currency in circulation plus sight, saving, and time deposits. Source: Bank of Guyana (BOG), *Statistical Bulletin.*

rm2: *m2* deflated by CPI.

p: consumer price index. Source: Bureau of Statistics (BOS), Ministry of Finance, Guyana.

y: Index of real economic activity calculated as a composite index of production for the five main sectors (bauxite, gold, rice, sugar, timber) representing about half the GDP using the production data supplied by BOS. A Laspeyres-type index and a Paasche-type index were created. As they are almost perfectly correlated, using one or the other does not change results. The Laspeyres-type index was used in this study. Source: the author.

e: End of period (month) nominal exchange rate of the Guyana dollar vis a vis the US dollar. Source: *Internation Financial Statistics* (IFS), IMF.

idn: Interest rate (average for the month) on three-month deposits at commercial banks, net of the 15 percent withholding established in January 1991. Source: *Internation Financial Statistics* (IFS), IMF.

itn: Average tender rate (for the month) for three-month Treasury Bills net of the 15 percent withholding tax that became effective on March 1st 1995. Source: *Internation Financial Statistics* (IFS), IMF.

itUS: Three-month US Treasury bill discount rate. Source: *Internation Financial Statistics* (IFS), IMF.

Structural Reforms in the Financial Sector, and Exchange and Trade Regimes During the 1990s

Box 1. Guyana: Selected Financial Reform Measures

April 1989	Bank rate increased from 14 percent to 35 percent, and the treasury bill rate increased from 11.3 percent to 33.7 percent.
July 1989	Liquid asset holdings of the commercial banks were frozen for a period of six months.
June 1990	The rediscount rate for treasury bills was set at 1 percentage point above the treasury bill rate.
July 1990	To strengthen the institutional framework for the conduct of monetary policy, a monetary policy unit was established in the central bank.
April 1991	Two thirds of the conversion of excess liquidity of commercial banks into medium-term liabilities was completed with the remaining amount scheduled to be completed by end-October 1991.
June 1991	Competitive bidding for treasury bills was introduced.
March 1992	Central bank implemented new mechanism for the determination of the bank rate, special deposit rates, and the rediscount rate linking them to the market-determined treasury bill yields.
June 1994	The frequency of 91-day treasury bill auctions increased from monthly to a biweekly.
December 1994	Special reserve deposits of banks were remunerated/eliminated.
March 1995	The Financial Institutions Act (FIA) was passed and became operational in May 1995.
May 1995	To ensure conformity with the FIA, amendments were made to the Cooperative Financial Institutions Act, the dealers in foreign currency (Licensing) Act, the Companies Act, and the Capital Issues (Control) Act.
February 5, 1996	Weekly auctions for 91-day treasury bills commenced.
January 1, 1997	As part of the currency reform program, the public was asked to stop using the $1, $5, and $10 notes.
January 2, 1997	In accordance with the FIA, the Bank of Guyana issued a provisional license to GNCB Trust Corporation to carry on depository financial business with authority to engage in trust business.
October 1997	Republic Bank of Trinidad and Tobago purchased the government-owned 51 percent share in NBIC.
July / September 1998	Bank of Guyana revised the 1966 circulars on reserve and liquid assets requirements of all licensed financial institutions in line with international standards.
September 1998	Bank of Guyana introduced the National Clearing House, which significantly reduced the time for processing interbank checks by commercial banks.
November 1998	Parliament passed the revised Bank of Guyana Act for the reorganization and recapitalization of the Bank (Bank's capital raised from G$6 million to G$1 billion).
January 1999	The Bank of Guyana reduced the reserve requirement ratios of licensed financial institutions from 16 to 14 percent on demand and time liabilities, respectively, to 12 percent on all liabilities.

Box 2. Guyana: Selected Structural Reforms in the Exchange System, 1987–96

February 1987	A secondary foreign exchange window at commercial banks was established with the intention of operating at a market-related rate.
April 1989	The Bank window rate and special rates for gold and diamonds were abolished and the official rate was devalued by about 70 percent, to G$33.00 per US$1.
March 1990	The cambio market was established as a first step toward unification of the exchange rate system. The new system introduced two markets—the official and the cambio markets.
June 1990	The Guyana dollar was further devalued from G$33 per US$1 to G$45 per US$1. This was effected to correct the wide and growing disparity between the parallel market rate (G$55 to G$60 per US$1) and the official exchange rate (G$33 per US$1).
February 1991	The Guyana dollar in the official market was again devalued from G$45 to G$101.75 per US$1, the level prevailing in the cambio market on that date. The official rate was determined weekly based on the average free-market rates for the preceding week.
August 1993	With a view of achieving closer integration of the official and cambio markets, the Bank of Guyana initiated a policy of foreign exchange transactions with the cambio market. Consistent with its target for gross international reserves, the bank was able to supply US$21.9 million to that market.
December 1995	The Exchange Control Act was abolished.
December 1996	The foreign exchange surrender requirements for exporters were abolished.

Box 3. Guyana: Selected Structural Reforms in the Trade System, 1988–99

June 1988	The import licensing requirements were abolished for goods intended for personal use that would not involve official foreign exchange.
August 1988	Import prohibitions on a number of manufactured products were eliminated. Prohibitions were limited to certain food products and permissible imports were subject to individual licensing by the ministry of trade except for personal effects, gifts, and primary agricultural products from CARICOM countries.
September 1988	Import licenses for no-foreign currency imports were granted automatically.
October 1988	Import licensing requirements for goods originating and consigned from CARICOM countries were removed.
February 1991	Legislation to bring Guyana in line with the Common External Tariff (CET) of the Caribbean Common Market (CCM) was approved. A Common External Tariff (CET) was applied to imports from outside CARICOM.
October 1992	CARICOM member states agreed to a phased reduction in the CET rate structure from the existing rates of 0–45 percent to 5–20 percent by January 1, 1997 (which was later extended). For basic competing primary inputs and capital goods, the average rate was to fall from 30 percent to 10 percent.
January 1994, September 1995	Guyana implemented the first and second steps in the phased CET reduction, lowering its maximum tariff rate from 45 to 30 percent.
November 1997	Guyana implemented the third step in the phased CET reduction, lowering its maximum tariff rate from 30 to 25 percent.
April 1999	Guyana is expected to implement the fourth and final phase of the reduction by lowering its maximum tariff rate from 25 percent to 20 percent.

VAR Excluding Nominal Exchange Rate

As the coefficient of the nominal exchange rate in the restricted VAR presented in table 3 is not significant, this appendix discusses the estimates of a VAR of the system identified excluding the NER. The results in Table 5 show that excluding the nominal exchange rate yields two cointegrating vectors. The first CIV can be interpreted as a long-run relationship for real money demand. Real income and the three interest rates have the expected signs (a Chi-square test accepts the restriction that the coefficients of the interest rates on three-month deposit and on three-month Treasury bills are equal with opposite signs). However, the real income elasticity is lower than one, as in the VAR including the NER. As previously, that elasticity is successfully restricted to unity. The second CIV is not obvious. It could represent a long-run relationship between domestic interest rates. Indeed, commercial banks are the main suscribers for three-month interest Treasury bills. Given that the latter are of the same maturity as three-month deposits, commercial banks would seek to match the cost of the resources raised with the return on their investments. Alternatively, the second cointegration vector could be a long-run real income relationship.

To sort this out, the coefficients on the endogenous variables (on the two CIVs identified) are restricted with alternative models in mind. For the first CIV, the restriction imposes a unit elasticity of real income. As for the second CIV, the restriction that dominates (with the largest margin of acceptance of the Chi-square test) is the one that allows to regard that CIV as a real income long-run relationship. One possible interpretation of that relationship is that as real income increases agents reduce their holdings of money (negative coefficients of the interest rate on deposits) and acquire more alternative financial assets (which have positive coefficients), both domestic and foreign. This is consistent with the fact that, as income increases individuals are likely to accept riskier and/or less liquid assets in exchange for higher return.[24] The larger coefficient on the U.S. Treasury bills discount rate as opposed to the interest rate on Guyanese Treasury bills, in the face of a positive spread between the domestic and U.S. returns, suggests that agents attach a higher risk premium to Guyanese securities and therefore prefer a lower but less risky return on U.S. securities.

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[24] Whether Treasury bills, both Guyanese and foreign (U.S.), are riskier than term deposits in a Guyanese bank is debatable. However, clearly government securities are less liquid because governments can always impose a rollover justified by monetary policy objectives or simple default.

Table 5: Cointegration Analysis of Money Demand (Model Excluding Nominal Exchange Rate)

Eigenvalues	0.439	0.303	0.135	0.093	0.044	
Hypotheses	r = 0	r≤1	r≤2	r≤3	r≤4	
λ_{max}	65.33**	40.72**	16.39	11.07	5.12	
$\lambda^a_{\max}$	56.66**	35.32	14.22	9.603	4.44	
95% critical value	37.50	31.50	25.5	19.0	12.30	
λ_{trace}	138.6**	73.31**	32.58	16.19	5.12	
λ^a_{trace}	120.2**	63.58*	28.26	14.04	4.44	
95% critical value	87.30	63.0	42.4	25.30	12.30	
	Unrestricted standardized eigenvectors β'					
	rm2	*y*	*idn*	*itn*	*itUS*	*trend*
	1.000	-0.307	-0.037	0.045	0.061	-0.003
	4.452	1.000	-0.020	0.152	-0.001	-0.013
	-45.747	-1.714	-2.893	1.000	3.816	0.122
	164.360	-0.279	1.000	36.501	53.824	1.203
	-12.316	-1.808	0.297	-0.622	1.000	0.111
	Unrestricted standardized adjustment coefficients α					
rm2	-0.146	-0.0218	0.002	0.0000	-0.000	
y	1.874	-0.288	0.011	-0.000	-0.004	
idn	0.173	0.617	0.043	-0.000	0.012	
itn	-1.950	0.065	-0.004	-0.003	0.022	
itUS	-0.033	0.022	0.003	0.0000	-0.025	
$\chi^2(1) = 0.0231$ $[p = 0.8792]$	Restricted standardized eigenvectors β'					
	rm2	*y*	*idn*	*itn*	*itUS*	*trend*
	1.000	-1.000	-0.079	0.059	0.141	-0.003
	0.0000	1.000	0.061	-0.021	-0.115	0.000
	Standard deviations of the restricted standardized eigenvectors					
	0.0000	0.0000	0.023	0.020	0.038	0.001
	0.0000	0.0000	0.024	0.021	0.041	0.000
	Restricted standardized adjustment coefficients α					
	-0.243	0.594	2.917	-1.667	0.062	
	-0.219	-0.265	3.476	-1.008	0.092	
	Standard deviations of the restricted standardized adjustment coefficients α					
	0.051	0.521	1.154	2.038	0.362	
	0.052	0.525	1.163	2.054	0.365	

Notes to Table 5

1/ The vector autoregression includes three lags on each variable (*rm2, y, idn, itn, itUS, e*), a constant term, a restricted trend, seasonal dummies ($M_{t-1}, \ldots, M_{t-11}$), the two devaluation dummies *dev1* and *dev2*, a dummy to capture the liberalization of interest rates (*dumIR*), and a dummy to capture the frequency of Treasury bills auctions (*dumTB*). The estimation period is 1990 (5)-1999 (9).

2/ The statistics λ_{max} and λ_{trace} are Johansen's maximum eigenvalue and trace eigenvalues statistics for testing for cointegration, adjusted for degrees of freedom. The null hypothesis is in relation to the cointegration rank *r*. Rejection of *r = 0* is evidence in favor of at least one cointegrating vector.

Cointegration Analysis of the Closed and Open-Economy Versions of Money Demand

Variables:
LrealM2BOG = *rm2*
LindRA1 = *y*
Ndeprate = *idn*
NetTBrate = *itn*
USTBrate = *itUS*
AnInf = Δp
AGEpNER = Δe

1. Closed-economy model

```
SYS( 5) Cointegration analysis 1990 (6) to 1999 (9)

    eigenvalue      loglik for rank
                     981.669   0
      0.376656       1008.14   1
      0.273451       1026.03   2
      0.193224       1038.05   3
      0.139157       1046.44   4
     0.0523046       1049.45   5

Ho:rank=p  -Tlog(1-\mu)    using T-nm   95%  -T\Sum log(.)  using T-nm   95%
 p ==  0         52.94**       43.48**  37.5       135.6**        111.4**  87.3
 p <=  1         35.78*        29.39    31.5       82.63**        67.87*   63.0
 p <=  2         24.05         19.75    25.5       46.85*         38.48    42.4
 p <=  3         16.78         13.79    19.0        22.8          18.73    25.3
 p <=  4         6.017         4.942    12.3       6.017          4.942    12.3

standardized \beta' eigenvectors
   LrealM2BOG     LIndRA1    NetTBrate     Ndeprate        AnInf         Trend
       1.0000    0.026834     0.031970    -0.023956       1.1857    -0.0023384
      -1.7423      1.0000    -0.046166     0.034893      0.42232     0.0070929
       42.378     0.61023       1.0000      0.41094      -6.4939     -0.089012
      -2.9307     0.89680     -0.42700       1.0000       7.3273     -0.022191
      -1.7992    -0.37600     -0.45238      0.28275       1.0000    -0.0051441

standardized \alpha coefficients
 LrealM2BOG      -0.10362     0.015179  -0.0032780    0.0010428  -0.0040607
 LIndRA1         -0.60490     -0.63792   -0.022387    -0.011227   -0.015601
 NetTBrate       -0.51875      0.77629    -0.11249    -0.077818     0.19594
 Ndeprate         0.34826      0.50853   -0.013776    -0.053047    -0.10556
 AnInf           -0.24106    -0.048256    0.038818    -0.010094    0.020037

long-run matrix Po=\alpha*\beta', rank 5
             LrealM2BOG      LIndRA1   NetTBrate     Ndeprate        AnInf
 LrealM2BOG     -0.26473     0.012860  -0.0058997    0.0015595   -0.091585
 LIndRA1        -0.38118     -0.67202 -0.00042412    -0.032606    -0.93911
 NetTBrate       -6.7630      0.55026    -0.22033    -0.029130    0.069028
 Ndeprate       -0.77617      0.50158    0.044284    -0.079153     0.22290
 AnInf            1.4816    -0.047623    0.028585     0.015614    -0.61222
                   Trend
 LrealM2BOG   0.00063949
 LIndRA1     -0.00078813
 NetTBrate      0.017451
 Ndeprate      0.0057390
 AnInf        -0.0031130

Number of lags used in the analysis: 3
Variables entered unrestricted:
 Seasonal_10 dumdev0690 dumdev0291     dumIR dumTBauct Seasonal_2
```

```
  Seasonal_1 Seasonal_4  Seasonal  Constant Seasonal_3 Seasonal_9
  Seasonal_5 Seasonal_6 Seasonal_7 Seasonal_8
 Variables entered restricted:
      Trend
```

2. Open-economy model

```
SYS( 5) Cointegration analysis 1990 (5) to 1999 (9)

    eigenvalue      loglik for rank
                      1327.13   0
      0.865747        1440.58   1
       0.57457        1488.87   2
      0.420666        1519.71   3
      0.354461        1544.44   4
      0.133613        1552.54   5
     0.0944755        1558.15   6
     0.0509906        1561.11   7

Ho:rank=p  -Tlog(1-\mu)   using T-nm   95%  -T\Sum log(.)  using T-nm   95%
 p ==  0        226.9**      184.7**  49.4          468**        381** 146.8
 p <=  1        96.58**      78.63**  44.0        241.1**      196.3** 114.9
 p <=  2        61.68**      50.22**  37.5        144.5**      117.6**  87.3
 p <=  3        49.46**      40.27**  31.5        82.79**      67.41*   63.0
 p <=  4        16.21        13.19    25.5        33.34        27.14    42.4
 p <=  5        11.21         9.13    19.0        17.13        13.95    25.3
 p <=  6        5.914        4.815    12.3        5.914        4.815    12.3

standardized \beta' eigenvectors
   LrealM2BOG      LIndRA1    NetTBrate     Ndeprate     USTBrate        AnInf
       1.0000       3.1392    -0.048027      0.23836      -1.2341       3.0816
      -5.6858       1.0000     -0.15559    -0.086158     -0.18712       10.047
       19.269      -8.6647       1.0000      -1.2160       1.6281       15.179
      -89.896      -14.115      -3.0490       1.0000     -0.57174      -20.004
      -10.986     -0.29204      0.36803     -0.77047       1.0000     -0.66402
       12.787      0.44596      0.64845      0.20622      0.40426       1.0000
       121.64       13.361       4.3865     -0.93971      -9.1664      -17.613
      AGEpNER        Trend
      -18.353     0.045634
     -0.68189     0.017041
      -1.6124    -0.045285
    -0.084516      0.23866
    -0.014664     0.024169
     -0.32033    -0.017713
       1.0000     -0.86391

 standardized \alpha coefficients
  LrealM2BOG    0.00094870    0.0061083   -0.0040059    0.0012377    0.0054714
  LIndRA1     -6.5572e-005     -0.12318     0.061275     0.015849     0.036853
  NetTBrate      0.0039136      0.16576    -0.040907   -0.0064560    -0.073829
  Ndeprate       0.0011251     0.023698    0.0030830    -0.040460      0.14538
  USTBrate      0.00071285     0.067422    0.0082801   -0.0028797     0.011299
  AnInf         -0.0072762     -0.13595   0.00057016   -0.0096131    -0.020374
  AGEpNER         0.045057    -0.046093   -0.0057097  -0.00072721   -0.0048973
  LrealM2BOG    0.00069939-8.4324e-006
  LIndRA1        -0.015590    0.0011767
  NetTBrate       -0.16673   -0.0027707
  Ndeprate       -0.037119   -0.0027956
  USTBrate      -0.0037410    0.0032148
  AnInf         -0.0060275   0.00083760
  AGEpNER       -0.0041494   0.00038788

 long-run matrix Po=\alpha*\beta', rank 7
                LrealM2BOG      LIndRA1    NetTBrate     Ndeprate     USTBrate
  LrealM2BOG      -0.27443     0.024927   -0.0063454    0.0017454   -0.0037120
```

LIndRA1	-0.0048035	-0.88002	0.040736	-0.080781	0.13360
NetTBrate	-2.8043	0.53380	-0.19464	0.055043	-0.21459
Ndeprate	1.1512	0.47525	0.13988	-0.16302	0.17833
USTBrate	0.25487	0.076547	0.022371	-0.031086	-0.018050
AnInf	1.8895	-0.013589	0.043650	0.013340	0.010354
AGEpNER	0.31041	0.15985	-0.0012764	0.023480	-0.065990

	AnInf	AGEpNER	Trend
LrealM2BOG	-0.024054	-0.015535	0.00075131
LIndRA1	-0.68559	-0.0093097	-0.00094419
NetTBrate	1.1167	-0.066630	0.0068774
Ndeprate	1.0133	-0.031398	-0.0027543
USTBrate	0.79500	-0.067917	-0.0023187
AnInf	-1.1946	0.22920	-0.0060781
AGEpNER	-0.40409	-0.78447	0.00097571

Number of lags used in the analysis: 3
Variables entered unrestricted:
Seasonal_4 Seasonal Constant Seasonal_3 Seasonal_1 Seasonal_7
Seasonal_8 Seasonal_9 Seasonal_5 Seasonal_10 dumdev0690 dumdev0291
Seasonal_6 dumIR dumTBauct Seasonal_2
Variables entered restricted:
Trend

SYS(10) Cointegration analysis 1990 (5) to 1999 (9)

eigenvalue	loglik for rank	
	1888.72	0
0.865747	2002.17	1
0.57457	2050.46	2
0.420666	2081.30	3
0.354461	2106.03	4
0.133613	2114.13	5
0.0944755	2119.74	6
0.0509906	2122.70	7

Ho:rank=p	-Tlog(1-\mu)	using T-nm	95%	-T\Sum log(.)	using T-nm	95%
p == 0	226.9**	184.7**	49.4	468**	381**	146.8
p <= 1	96.58**	78.63**	44.0	241.1**	196.3**	114.9
p <= 2	61.68**	50.22**	37.5	144.5**	117.6**	87.3
p <= 3	49.46**	40.27**	31.5	82.79**	67.41*	63.0
p <= 4	16.21	13.19	25.5	33.34	27.14	42.4
p <= 5	11.21	9.13	19.0	17.13	13.95	25.3
p <= 6	5.914	4.815	12.3	5.914	4.815	12.3

standardized \beta' eigenvectors

LrealM2BOG	LIndRA1	NetTBrate	Ndeprate	USTBrate	DLCPI
1.0000	3.1392	-0.048027	0.23836	-1.2341	36.979
-5.6858	1.0000	-0.15559	-0.086158	-0.18712	120.56
19.269	-8.6647	1.0000	-1.2160	1.6281	182.14
-89.896	-14.115	-3.0490	1.0000	-0.57174	-240.05
-10.986	-0.29204	0.36803	-0.77047	1.0000	-7.9683
1.0656	0.037164	0.054038	0.017185	0.033688	1.0000
10.137	1.1134	0.36554	-0.078309	-0.76386	-17.613

DLEpNER	Trend
-220.24	0.045634
-8.1826	0.017041
-19.349	-0.045285
-1.0142	0.23866
-0.17597	0.024169
-0.32033	-0.0014761
1.0000	-0.071993

standardized \alpha coefficients

LrealM2BOG	0.00094870	0.0061083	-0.0040059	0.0012377	0.0054714
LIndRA1	-6.5572e-005	-0.12318	0.061275	0.015849	0.036853
NetTBrate	0.0039136	0.16576	-0.040907	-0.0064560	-0.073829
Ndeprate	0.0011251	0.023698	0.0030830	-0.040460	0.14538

```
 USTBrate      0.00071285     0.067422   0.0082801  -0.0028797    0.011299
 DLCPI        -0.00060635    -0.011329 4.7514e-005 -0.00080109  -0.0016978
 DLEpNER       0.0037548    -0.0038411 -0.00047580-6.0601e-005 -0.00040811
 LrealM2BOG    0.0083927 -0.00010119
 LIndRA1        -0.18708      0.014120
 NetTBrate       -2.0007     -0.033249
 Ndeprate       -0.44542     -0.033547
 USTBrate      -0.044893      0.038578
 DLCPI        -0.0060275    0.00083760
 DLEpNER      -0.0041494    0.00038788

long-run matrix Po=\alpha*\beta', rank 7
             LrealM2BOG      LIndRA1   NetTBrate     Ndeprate    USTBrate
 LrealM2BOG     -0.27443     0.024927  -0.0063454   0.0017454  -0.0037120
 LIndRA1      -0.0048035     -0.88002    0.040736   -0.080781     0.13360
 NetTBrate       -2.8043      0.53380    -0.19464    0.055043    -0.21459
 Ndeprate         1.1512      0.47525     0.13988    -0.16302     0.17833
 USTBrate        0.25487     0.076547    0.022371   -0.031086   -0.018050
 DLCPI           0.15746   -0.0011325   0.0036375   0.0011116  0.00086284
 DLEpNER        0.025868     0.013321 -0.00010636   0.0019567  -0.0054992
                   DLCPI      DLEpNER       Trend
 LrealM2BOG     -0.28865     -0.18642  0.00075131
 LIndRA1         -8.2270     -0.11172 -0.00094419
 NetTBrate        13.401     -0.79956   0.0068774
 Ndeprate         12.160     -0.37677  -0.0027543
 USTBrate         9.5400     -0.81501  -0.0023187
 DLCPI           -1.1946      0.22920 -0.00050651
 DLEpNER        -0.40409     -0.78447 8.1309e-005

Number of lags used in the analysis: 3
Variables entered unrestricted:
 Seasonal_5 Seasonal_10 dumdev0690 dumdev0291 Seasonal_6     dumIR
 dumTBauct Seasonal_2 Seasonal_4  Seasonal  Constant Seasonal_3
 Seasonal_9 Seasonal_1 Seasonal_7 Seasonal_8
Variables entered restricted:
     Trend
```

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