A System Test of McKinnon's Complementarity Hypothesis With An Application to Turkey

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Abstract

This paper is the first to employ the multivariate cointegration and vector error correction models (VECM) to test McKinnon’s complementarity hypothesis between money and capital. We find that for the Turkish economy over the sample period 1980-1995 money and capital are complementary, suggesting that higher real interest rates will raise the demand for money and lead to higher levels of investment. It is also the case that government investment is complementarity to private sector investment so that there is no crowding out of private investment as a result of increased public investment. The policy implication is that further financial liberalisation in Turkey will enhance investment and lead to, at least temporarily, a higher rate of economic growth.

Keywords: Complementarity, cointegration, VECM, investment, demand for money, real interest rates, Turkey.

JEL Classification Nos: O11, O57

1. Introduction

Since the seminal work of McKinnon (1973) and Shaw (1973) there have been a number of tests of the complementarity hypothesis between physical capital and money. The complementarity hypothesis is a joint hypothesis whereby the demand for real money balances depends directly, *inter alia*, on the average, real return on capital and the investment ratio rises with the real deposit rate of interest. For there to be strict complementarity between investment and money balances both legs of this joint hypothesis must hold.

The empirical literature to date, however, has focused almost exclusively on the estimation of either a single investment equation (for example, DeMelo and Tybout, 1986; Edwards, 1988, Rittenburg, 1991; Morriset, 1993) or a single demand for money function (for example, Harris, 1979; Ajewole 1990; Thornton and Poudyal, 1990). This literature is therefore likely to be subject to simultaneous equation bias as either the demand for money relation or the investment relation is disregarded in the estimation process. On the other hand, although the estimates of Fry (1978), Laumas (1990), and Thornton (1990) avoid simultaneous equation bias by using the two-stage least squares method, they do not estimate the model as a system and do not therefore explicitly test both legs of the complementarity hypothesis. Most recently and Khan and Hasan (1998) have tested the complementarity hypothesis by estimating both savings and demand for money functions for Pakistan using single equation cointegration methods. Their results suggest evidence of complementary between money and capital, but these findings are not robust because single equation methods ignore the interdependence between the investment (savings) leg and the money leg of the joint hypothesis. Furthermore the assumption that the explanatory variables are exogenous is not tested and hence to the extent that they are also endogenous the estimated coefficients are not unbiased.

The principal contribution of this paper is therefore to use the multivariate cointegration and vector error correction methodology (VECM) to simultaneously identify the money demand and investment demand equations for Turkey, through tests of over-identifying restrictions and thereby provide a complete (joint) test of both legs of McKinnon’s complementarity hypothesis. A second contribution is to examine the case of Turkey in some detail, since the complementarity hypothesis has not been extensively tested for Turkey despite 20 years of structural, financial reforms stemming from the early 1980s.

The structure of the paper is as follows. In Section 2 the complementarity hypothesis is specified and related to the macroeconomic structure of the Turkish economy. Section 3 examines the econometric methodology and the data set employed; Section 4 reports the extensive empirical results and Section 5 concludes.

2 The Complementarity Hypothesis

The complementarity hypothesis of McKinnon (1973) states that money and real capital assets are complements in developing economies because in the absence of deep financial markets and extensive financial intermediation, money balances have to be accumulated before relatively costly and indivisible investment projects can be undertaken. This hypothesis implies that the demand for real money balances (*M/P*) depends positively upon real income, *Y*, the own real rate of interest on bank deposits, *R*, and the real average return on capital, *r*. Critically, the positive association between the average real return on capital and the demand for money balances represents the complementarity between capital and money. This, however, is only one leg of the complementarity hypothesis. According to McKinnon, the investment ratio, *I/Y,* must also be positively related, *inter alia*, to the real rate of return on money balances. This is because a rise in the real return on bank deposits, *R*, if it raises the demand for money and real money balances are complementary to investment, it must also lead to a rise in the investment ratio. The complementarity hypothesis therefore gives a demand for money function and a demand for investment function as:

$$M/P \; ? \; L(Y, r, R) \qquad L_Y \; ? \; 0,\ L_r \; ? \; 0,\ L_R \; ? \; 0 \qquad (1)$$

$$I/Y \; ? \; F(r,R) \qquad F_r \; ? \; 0,\ F_R \; ? \; 0 \qquad (2)$$

Equation (1) is the real money demand function, equation (2) is the investment function and the partial derivatives of (1) and (2) are all expected to be positive. The complementarity hypothesis specifically requires that both $L_r ? 0$ and $F_R ? 0$.

Note that this hypothesis is in contrast to the neo-classical approach which postulates that money and capital are substitutes, in which case $L_r ? 0$ and $F_R ? 0$. Hence a rise in *r* raises the demands for capital goods but reduces the demand for money, as economic agents switch demand to the relatively higher yielding real capital assets. Similarly, a rise in the real yield on money balances, *R*, raises the demand for money, but reduces the demand for real capital assets, whose relative real return has fallen.

From an empirical perspective the main problem with the complementarity hypothesis is the inability to compute a sensible measure of the real return on capital in developing economies. McKinnon (1973) suggested that the real return on capital could be replaced by the investment to income ratio, *I/Y*, which is expected to vary directly with the average real return on capital. Furthermore in McKinnons' initial model it is assumed that agents are unable to borrow to undertake investment and so have to save up before they can buy expensive, indivisible capital equipment. However, to the extent that financial liberalisation gradually occurs and credit becomes available to businesses, investment may rise without a prior increase in money savings. In this scenario the availability of credit to domestic residents will lead to a rise in the investment ratio independently of money demand. This credit channel may be of some importance in the case of Turkey, since over the sample period the authorities have attempted to lift interest rate lending ceilings and to encourage the liberalisation of the financial sector (see for example Uygur, 1993). The model now becomes:

$$M/P ? L(Y, I/Y, R) \qquad L_Y ? 0, L_{I/Y} ? 0, L_R ? 0 \qquad (3)$$

$$I/Y ? G(DCY, R) \qquad G_{DCY} ? 0, G_R ? 0 \qquad (4)$$

where *DCY* is the ratio of domestic credit to income. The complementarity hypothesis now implies $L_{I/Y} ? 0$ and $G_R ? 0$. This model is referred to as System 1.

A further limitation of the model represented by equations (3) and (4) is that no distinction is made between public and private sector investment. This distinction is likely to be important in Turkey where the public sector has a special position. State Economic Enterprises (SEE) account for a sizeable portion of industrial value added. SEE products are mainly industrial raw materials or intermediate inputs used by other parts of the economy and the public sector is the single biggest agricultural purchaser and employer in the economy. As far as the breakdown of fixed capital formation is concerned, in the post-1980 period nearly 60 per cent of total investment has been undertaken by the public sector (Ekinci, 1990) and concentrated in infrastructure, energy, transport, and communication sectors in the post-1980 period. Thus following Laumas (1990) and Khan and Hasan (1998) total investment, *I* is split into its private sector and public sector components, denoted as *PI* and *GI* respectively, and where the demand for real money balances depends only upon private sector investment. This modification gives System 2 that is written as:

$$M / P \ ? \ L(Y, PIY, R) \qquad L_Y \ ? \ 0, L_{PIY} \ ? \ 0, L_R \ ? \ 0 \qquad (5)$$

$$PIY \ ? \ H(GIY, R) \qquad H_{GIY} \ ?? \ 0, H_R \ ? \ 0 \qquad (6)$$

where the domestic credit to income ratio has been dropped from (6), *PIY* is the ratio of private investment to income and *GIY* is the ratio of government investment to income.

Note that the effect of public sector investment on private sector investment is strictly ambiguous. In the conventional neo-classical model, public investment competes with the private sector for scarce physical and financial resources and thereby exerts a negative influence on private investment. However, there are a number of reasons why private investment could also be positively related to government investment. For example, increased public investment raises the demand for the output of the private sector, thereby raising output expectations and investment requirements of the private sector. Most developing countries, including Turkey – as noted above - have a large component of government investment concentrated on infrastructure projects. The creation of special infrastructure facilities by the government for transport, communications and electric power will tend to reduce the cost of production for private sector firms and thus increase the profitability for private investors.

3. The Empirical Methodology

The estimation strategy is to estimate the demand for money and investment equations simultaneously as a system. This is implemented by employing the multivariate cointegration approach of Johansen (1988). In this case a VAR(p) can be re-parameterised as:

$$\Delta X_t = \mu_0 + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots + \Gamma_{p-1} \Delta X_{t-p} + \Pi X_{t-p} + \varepsilon_t \qquad (7)$$

where $X_t = [mp, i, y, dcy, R]'$ in system 1 and $X_t = [mp, piy, y, giy, R]$ in system 2 where lower case letters denote logarithms of the respective variables in Section 2. ***X*** is a 5 x 1 vector of variables that are integrated of order one, denoted I(1); Π is a 5 x 5 matrix of coefficients and ε_t is a vector of normally and independently distributed error terms. The presence of *r* cointegrating vectors between the elements of *X*, implies that Π is of rank r (0<r<5) and that Π can be decomposed as: $\Pi = \alpha\beta'$, where α and β are both 5xr vectors and (5) can be re-written as:

$$\Delta X_t = \mu_0 + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots + \Gamma_{p-1} \Delta X_{t-p+1} + \alpha(\beta' X_{t-p}) + \varepsilon_t \qquad (8)$$

The rows of β' are interpreted as the distinct cointegrating vectors such that $\beta' X_t$ form linear stationary processes and the α's are the error correction coefficients.

The problem with the system (8) is that the β's are unrestricted and thus cannot identify typical long-run economic relationships. Each vector requires at least *r* restrictions, one of which is the normalisation restriction. These normalisation restrictions must be motivated by economic theory so that the identified cointegrating vectors can be interpreted as long-run economic relationships. In this context we are expecting to obtain two cointegrating vectors – one denoting the demand for real money balances and the other the investment function – so the β vector will be of dimension 5x2 and have the general form:

$$?^{1} ? \begin{pmatrix} 1 & ?^{1}_{12} \\ ?^{1}_{21} & 1 \\ ?^{1}_{31} & ?^{1}_{32} \\ ?^{1}_{41} & ?^{1}_{42} \\ ?^{1}_{51} & ?^{1}_{52} \end{pmatrix}, \qquad ?^{2} ? \begin{pmatrix} 1 & ?^{2}_{12} \\ ?^{2}_{21} & 1 \\ ?^{2}_{31} & ?^{2}_{32} \\ ?^{2}_{41} & ?^{2}_{42} \\ ?^{2}_{51} & ?^{2}_{52} \end{pmatrix}$$

It may of course be possible to further restrict the $?$ matrix if the some of the variables do not influence the normalised variable. For example, in System 1 if the first vector is the demand for real money balances and this is independent of the level of domestic credit, then the relevant $?^{1}$, $?^{1}_{41}$ will be zero. All such identifying restriction can be tested and need not be zero or unit restrictions.

Finally the error correction coefficients, $?_{11}$ and $?_{22}$, relating to the two cointegrating vectors must be negative and significant if they are to be interpreted as representing the speed of adjustment back to long-run equilibrium following short run deviations from equilibrium.

The data set used to estimate Systems 1 and 2 is quarterly, seasonally unadjusted data for Turkey covering the period 1980Q1 to 1995Q4. The quarterly time series for nominal GDP, private investment and public investment are published by the State Institute of Statistics (SIS). The consumer price index, also published by the SIS, is used as the deflator since the GDP deflator is not available quarterly. The quarterly series for domestic credit, the money supply (M2 measure) and the interest rate on deposits are taken from the IMF's International Financial Statistics[1].

4. Empirical Results

Following Hendry and Doornik (1994) and Doornik and Hendry (1994), the simultaneous equation model can be estimated in a cointegration framework. The first step prior to modelling the relationships between economic variables, is to examine the

[1] In order to obtain the same length for all time series the IMF interest rate on deposits series is extended back two years, to 1980Q1, according to changes in the regulation of the interest rate which are published in the Quarterly Bulletin of the Turkish Central Bank. The full data set is available from Muhsin Kar request.

univariate, time series properties. The results of the ADF test indicate that all the variables are stationary in first differences; that is they are integrated of order one, denoted as, I(1). These results are shown in Table 1.

The second step is to estimate the unrestricted system given by equation (6) and to identify two cointegrating vectors, one for the demand for money and another for the investment ratio. The final step is to model the short-run dynamics using the vector error correction model (VECM). The systems comprise the potential variables in the demand for money and the investment functions, noted above where all variables are in logarithmic form except *R*.

After determining the lag length, the unrestricted reduced form of the system, which constitutes a five-equation VAR model, is estimated by ordinary least squares (OLS) for the whole sample period. In addition to the economic variables in the system, a linear trend is also included to capture the long-run dynamics and which may also pick up the effects of other determinants of the demand for money and investment that are missing in the model. Because the data is seasonally unadjusted a constant and three seasonal dummies are also entered into the long-run unrestricted model.

The empirical investigation starts from an augmented VAR with four lags on all variables. The resulting unrestricted VAR estimates for both System 1 and System 2 are presented in Tables 2 and 3 respectively. The diagnostic test results of the unrestricted VAR for both systems seem satisfactory and are presented in Table 4. As can be seen from Table 4, the equation residuals do not suffer from serial correlation, heteroskedasticity or non-normality.

According to the maximum eigenvalue and trace statistics, reported in Table 5, there are two long-run stable relationships in each system. These can be identified as the demand for money and investment equations. The corresponding cointegrating vectors are represented in the rows of Table 6. According to the unrestricted cointegrating vectors for System 1, the first vector reading across the rows in Table 6 seems to be identified as a demand for money with a positive effect from investment ratio, real income and a negative effect from interest rate. The second vector may be interpreted as an investment equation, with positive effects from income, the domestic credit ratio and the real interest rate. As far as System 2 is concerned, similar arguments can be made. Here the demand for money is positively related to private investment ratio, real income and negatively associated with real interest rate. The second vector shows the private investment ratio as positively related to real income, government investment ratio and the real interest rate.

Next, the speeds of adjustment coefficients corresponding to the above cointegrating vectors are shown in the columns of Table 7. The adjustment coefficients indicate the average speed of adjustment back towards the estimated equilibrium position. To be able to identify unique long-run relationships it is necessary to be able to impose identifying restrictions on the cointegrating relations. The restrictions on the speed of the adjustment coefficients describe whether the variables in the system are weakly exogenous. If some variables are weakly exogenous, it means that there is no loss of information from not modelling the determinants of these variables and they can enter right hand side of the VECM in the short-run. It is argued that conditioning the system might be very useful for interpreting the empirical results (Hendry and Doornick, 1994). The weak exogeneity test results are given in Table 8.

As far as System 1 is concerned, *y*, *dcy* and *R* are all weakly exogenous in the first and second cointegrating vectors. This implies that the first cointegrating vector is only significant in the short-run demand for money and the second cointegrating vector appears only in the short-run investment ratio equation. There is therefore no loss of information from not modelling *y*, *dcy* and *R* in the VECM. Similarly, in System 2 the weak exogeneity of *y* and *giy* in the first and second cointegrating vectors can be easily seen. It seems that *R* is not weakly exogenous in these cointegrating vectors at 5 per cent significance level (critical value of chi-squared is 5.99). However, as there are not any relevant variables in this system as possible determinants of the real deposit rate, it is assumed that *R* is indeed exogenous. This can be justified by reference to Metin (1994) who estimated a conventional demand for money for the Turkish economy and found *R* to be weakly exogenous. Therefore *R* is assumed to be weakly exogenous in the following analysis.

The following restrictions are imposed on the cointegration relations for System 1. In the first cointegrating vector, which represents the demand for money, the domestic credit ratio and trend have no effects on the money demand. In the second cointegrating vector, which is the investment equation, real money balances and trend have no role in determining the investment ratio. Applying these two restrictions yields a chi-squared statistic of 2.44, indicating that the restrictions are not rejected at the 5 per cent level (critical value of $?(2)?5.99$).

As far as the cointegration relations for System 2 are concerned, the following restrictions are imposed: first, the real supply of money is independent of the government investment ratio and the time trend; second, the private investment ratio is not affected by the time trend. These restrictions yield the chi-squared test statistic of 0.14 and so again the restrictions cannot be rejected at the 5 per cent level. If the effect of real money balances on the investment ratio is also assumed to be zero and added to the above zero restrictions the set of the restrictions is rejected. It is therefore necessary to allow real money balances to affect the private investment ratio directly, thus giving a direct measure of complementarity as in Thornton (1990), Thornton and Poudyal (1990) and Khan and Hasan (1998).

Jointly applying the restrictions on the adjustment coefficients and cointegration relations for each system, the following long-run relations are obtained. For System 1 we obtain:

$$MD1 ? mp ? 0.70i ? 0.45y ? 0.006R$$

$$MD2 ? i ? 1.15y ? 0.66dcy ? 0.002R$$

where *MD1* and *MD2* are the restricted cointegrating vectors for System 1. As can be seen from the first cointegrating vector, the demand for money is determined by the investment ratio, real income and real rate of interest and all coefficients have the expected signs. The second cointegrating vector implies that investment is positively related to real income, domestic credit and real rate of interest where again all coefficients have the expected signs. As far as System 1 is concerned, there is clear support for the complementarity hypothesis for the Turkish economy over the sample period with the signs of both i in the demand for money and R in the investment function being positive.

The long-run relations for System 2 are:

$$DM1 \; ? \; mp \; ? \; 0.25piy \; ? \; 0.32y \; ? \; 0.005R$$

$$DM2 \; ? \; piy \; ? \; 1.62mp \; ? \; 0.043y \; ? \; 0.43giy \; ? \; 0.002R$$

where *DM1* and *DM2* are the restricted cointegrating vectors for System 2. As with System 1 the first cointegrating vector is the long-run demand for money equation and the second one is the long-run private investment equation. The demand for money is positively related to the private investment ratio, real income and the real rate of interest. The second cointegrating vector is the private investment equation in which real money balances, real income, public investment ratio and real rate of interest have a positive impact on private investment. Government investment is found to be complementary to private investment rather than a substitute. As far as the period under investigation is concerned, it is not a surprising result since, especially after the 1980s, most of the public investment has gone to infrastructure, energy and telecommunications. It seems that these expenditures have positively influenced private investment. As far as McKinnon's complementarity hypothesis is concerned, there is again clear support from System 2 with the signs of both *piy* in the demand for money and *R* in the investment function being positive.

The next step is to model the short-run VAR in error correction form (VECM) for each system, which includes the corresponding cointegration relationship explicitly. Since weakly exogenous variables do not need to be modelled in the short-run both systems will have the form of a two-equation VECM, consisting of both a demand for money and investment equation. The conditional model is initially estimated by OLS as recommended by Doornik and Hendry (1994). The same conditioned VECM is then estimated by Full Information Maximum Likelihood (FIML), which is identical to the OLS in this stage, and is reported in Table 9. The diagnostic test results are presented in Table 10. These show that the residuals are free from serial correlation, heteroscedasticity and non-normality.

As can be seen from Table 9, the conditioned variables enter the short-run VAR in error correction form (VECM) without lags. Here all the variables are first differences of the levels and qualify as I(0) variables. There are insignificant variables in each equation. These should be removed from the VECM and these restrictions should be supported by the LR (likelihood ratio) test. As far as the cointegrating vectors (error correction terms) are concerned, they are significant in the corresponding equations. For example, the long-run demand for money vector ($MD1_{-1}$) for system 1 is only significant in the short-run demand for money. Similar arguments can be made for the rest of the cointegrating vectors. The significance of the error correction terms (cointegrating vectors) indicates that the long-run relationships are identified accurately.

Furthermore, by removing the insignificant variables through the marginalisation process, the short-run models become more easily interpretable. The parsimonious dynamic equations for the demand for money and investment for System 1 and the demand for money and private investment equation for System 2 are presented in Table 11. The diagnostic test results for this estimation are also reported in Table 12. The removal of insignificant variables is supported by the LR test as reported above for each system. The diagnostic test results are acceptable, although there is some non-normality of residuals in the demand for money in system 2 at the 5 per cent significance level. There are still some insignificant variables in the VECM, but as removing them leads to inferior results according to the diagnostic test results they are retained in the parsimonious VECM. Most of the variables that are retained in the model are significant at either the 1 or 5 percent significance levels, although the coefficients on lagged changes in real money balances in both systems are only statistically significant at the 10 per cent level.

The performance of the short-run equations is acceptable. First of all, the relevant cointegrating vectors are statistically significant in the corresponding equations. The magnitudes of the error-correction terms (cointegrating vectors) indicate that the adjustment to the equilibrium level in the investment equations is faster than that in the demand for money equations. This is quite surprising, since one might expect that the adjustment would be faster in the money demand. Another significant finding is that weakly exogenous variables seem to be significant in every specification.

Overall both systems yield sensible long-run and short-run demand for money and investment equations. The coefficients on the investment ratio in the demand for money and of real rate of interest in the investment function are both positive in System 1. Similarly, the coefficients on the private investment ratio in the demand for money and of real rate of interest and real money balances in the private investment function are both positive in system 2. These empirical findings strongly support the complementarity between capital and money in the long run.

In the short-run System 1 shows the coefficients on the investment ratio to be mixed (one being positive and the other being negative) and statistically significant. The coefficient of the real interest rate is, however, positive and significant. In the short-run System 2, gives empirical support to the complementarity hypothesis, with the coefficients on the private investment ratio in the demand for money and of real rate of interest in the private investment equation both positive and significant. The coefficients on real money balances in the private investment ratio equation, however, are negative albeit two of them are significant at the 10 percent level. This is, however, not crucial for the complementary hypothesis.

The other determinants of the demand for money and investment functions need to be interpreted briefly. Real income has a positive influence on the demand for money and investment rate in both the long- and short-run of System 1. It is not significant, however, in the short-run of System 2. The long-run income elasticity of the demand for money in System 2 seems to be low compared with the conventional demand for money equations. Metin (1994), for example, finds that the long-run income elasticity is greater than one, as it is in System 1, while it is much lower at 0.32 in System 2. In the short run it is about 0.48 and highly significant in System 1, but only 0.06 and insignificant in System 2. Domestic credit is positively related to the investment rate in the long- and short-run in System 1. Again public investment is positively associated with private investment in the long- and short-run in System 2. This implies that there is short-run complementarity between private and government investment.

5. Conclusions

This paper has provided a rigorous test of McKinnon's complementarity hypothesis for Turkey over the period 1980-1995. Applying the Johansen cointegration framework, long-run stable relationships have been identified for the demand for money and investment relations. The coefficients of the long-run equations strongly support the idea of complementarity between money and capital. Given these empirical findings we conclude that the financial liberalisation policies pursued in Turkey have been associated with some the financial deepening. During the period under investigation, it seems that financial liberalisation has lead to the accumulation of money balances (financial assets) which would improve the availability of loanable funds for investment. However, it would seem that further liberalisation is necessary, in particular with respect to long term lending to private businesses for investment, to alleviate the need for a prior accumulation of cash balances as implied by the complementarity hypothesis.

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Table 1 Unit root tests

Dependent Variable, x	ADF	No of lags, j	Dependent Variable, $?x$	ADF	No of lags, j
mp	-2.59	3	$?mp$	-9.88*	0
i	-1.82	4	$?i$	-3.63*	5
y	-1.21	6	$?y$	-4.24*	5
piy	-1.02	4	$?piy$	-3.42*	5
dcy	-0.86	4	$?dcy$	-2.94*	5
R	-2.71	4	$?R$	-9.24*	2
giy	1.89	4	$?giy$	-3.46*	4

Critical value of the ADF statistic at 5 per cent is –2.91. The statistic in column 2 is the t-value of ? from the model: $?x_t ? a ? ?x_{t?1} ? \sum_{j?2}^{p} ?_j ?x_{t?1i?j} ? ?_t$; the ADF statistic in column 5 is the t-value from the model: $?^2x_t ? a ? ??x_{t?1} ? \sum_{j?2}^{p} ?_j ?^2x_{t?1i?j} ? ?_t$. Identical results were obtained when a deterministic trend was included in the models.

Table 2. Unrestricted VAR estimates of the System 1

	mp	*i*	*y*	*dcy*
mp_{-1}	0.78 (3.11)	-0.36 (-1.01)	0.21 (0.90)	-0.19 (-0.62)
mp_{-2}	-0.06 (-0.18)	0.23 (0.50)	-0.23 (-0.73)	0.08 (0.20)
mp_{-3}	-0.27 (-0.84)	-0.28 (-0.62)	0.03 (0.10)	0.03 (0.07)
mp_{-4}	0.16 (0.65)	0.53 (1.51)	-0.11 (-0.46)	0.33 (1.11)
i_{-1}	0.04 (0.26)	0.40 (1.76)	-0.03 (-0.20)	0.13 (0.65)
i_{-2}	-0.24 (-1.36)	0.25 (1.03)	0.008 (0.04)	-0.09 (-0.46)
i_{-3}	0.006 (0.03)	-0.19 (-0.74)	0.08 (0.47)	0.06 (0.28)
i_{-4}	0.20 (1.48)	0.33 (1.66)	-0.21 (-1.58)	0.19 (1.16)
y_{-1}	0.15 (0.63)	0.67 (1.93)	0.66 (2.79)	0.40 (1.32)
y_{-2}	-0.53 (-1.17)	0.55 (0.86)	-0.78 (-1.78)	0.28 (0.51)
y_{-3}	0.89 (1.85)	0.14 (0.21)	0.35 (0.75)	0.54 (0.91)
y_{-4}	-0.09 (-0.24)	-0.40 (-0.75)	0.36 (0.99)	-0.85 (-1.85)
dcy_{-1}	0.14 (0.63)	-0.09 (-0.27)	0.24 (1.10)	0.57 (2.06)
dcy_{-2}	-0.12 (-0.43)	0.19 (0.46)	-0.4 (-1.34)	0.34 (0.95)
dcy_{-3}	0.20 (0.65)	0.14 (0.32)	0.1 (0.32)	0.15 (0.39)
dcy_{-4}	-0.11 (-0.46)	-0.25 (-0.74)	0.21 (0.93)	-0.48 (-1.65)
R_{-1}	-0.0008 (-1.08)	0.0009 (-0.74)	-0.001(-2.01)	0.0008 (0.83)
R_{-2}	0.0007 (0.71)	0.0004 (0.25)	-0.0005 (-0.54)	0.001 (1.08)
R_{-3}	0.001 (1.60)	0.0009 (0.80)	0.0007 (0.92)	0.0004 (0.38)
R_{-4}	0.0001 (0.19)	0.0002 (.26)	0.0003 (0.59)	-0.0003 (-0.59)
Trend	-7.5e-006 (-0.001)	-0.01 (-1.15)	0.008 (1.12)	-0.015(-1.58)
Constant	-0.25 (-0.05)	-9.81 (-1.60)	5.36 (1.27)	-7.25 (-1.36)
Seasonal	0.00005 (0.00)	-0.07 (-0.40)	-0.003 (-0.02)	-0.09 (-0.52)
Seasonal-1	-0.25 (-1.64)	0.16 (0.76)	0.04 (0.25)	-0.27 (-1.47)
Seasonal-2	-0.07 (-0.68)	0.12 (0.80)	0.24 (2.19)	-0.33 (-2.39)

Note: t-values are reported in the parentheses.

Table 3 Unrestricted VAR estimates of System 2

	mp	*piy*	*y*	*giy*
mp_{-1}	0.92 (4.59)	0.27 (0.77)	0.08 (0.41)	-0.36 (-0.63)
mp_{-2}	-0.35 (-1.27)	-0.05 (-0.10)	-0.23 (-0.84)	-0.01 (-0.02)
mp_{-3}	-0.07 (-0.28)	-0.31 (-0.67)	0.14 (0.52)	-0.80 (-1.06)
mp_{-4}	0.12 (0.70)	0.65 (2.07)	-0.05 (-0.32)	0.94 (1.85)
piy_{-1}	0.08 (0.96)	0.41 (2.70)	0.13 (1.54)	-0.03 (-0.12)
piy_{-2}	-0.10 (-1.05)	-0.02 (-0.12)	-0.03 (-0.35)	0.19 (0.68)
piy_{-3}	0.24 (2.69)	0.24 (1.57)	-0.08 (-0.99)	0.07 (0.30)
piy_{-4}	-0.12 (-1.65)	0.01 (0.14)	0.03 (0.42)	-0.06 (-0.30)
y_{-1}	0.04 (0.26)	-0.26 (-0.82)	0.65 (3.54)	0.70 (1.36)
y_{-2}	-0.23 (-0.99)	0.93 (2.23)	-0.35 (-1.46)	1.06 (1.56)
y_{-3}	0.76 (3.08)	0.66 (1.53)	-0.08 (-0.34)	0.87 (1.23)
y_{-4}	-0.09 (-0.42)	-1.16 (-2.81)	0.51 (2.16)	-0.12 (-0.19)
giy_{-1}	-0.05 (-0.88)	-0.02 (-0.22)	0.06 (1.12)	0.25 (1.55)
giy_{-2}	-0.02 (-0.40)	0.11 (1.03)	0.008 (0.14)	0.08 (0.50)
giy_{-3}	-0.03 (-0.51)	-0.01 (-0.12)	-0.06 (-1.14)	0.07 (0.42)
giy_{-4}	0.1 (2.01)	0.007 (0.06)	0.09 (1.39)	0.41 (2.07)
R_{-1}	-0.0007 (-1.11)	0.0004 (0.40)	-0.0009 (-1.48)	0.003 (1.66)
R_{-2}	0.001 (1.41)	-0.0005 (-0.41)	-0.0002 (-0.26)	0.002 (1.11)
R_{-3}	0.001 (2.11)	0.0005 (0.41)	0.001 (1.78)	0.002 (1.29)
R_{-4}	0.0002 (0.48)	-0.00004 (-0.05)	0.0005 (1.04)	-0.0002 (-0.21)
Trend	-0.004 (-.65)	-0.002 (-0.19)	0.003 (0.49)	-0.03 (-2.14)
Constant	-1.29 (-0.36)	-6.29 (-0.99)	2.69 (0.74)	-21.26 (-2.06)
Seasonal	0.11 (0.98)	-0.35 (-1.80)	0.19 (1.76)	-0.70 (-2.19)
Seasonal-1	-0.17 (-1.41)	-0.38 (-1.78)	0.24 (1.93)	-0.19 (-0.53)
Seasonal-2	0.10 (0.99)	0.21 (1.17)	0.35 (3.37)	0.05 (0.16)

Note: t-values are reported in the parentheses.

Table 4 Diagnostics Test Results

System 1			
	$F_{ar}(4,29)$	$F_{arch}(4,25)$	Chi-squared(2)
mp	1.17 (0.34)	0.58 (0.67)	0.37 (0.82)
i	2.46 (0.07)	0.71 (0.58)	0.21 (0.89)
y	1.57 (0.20)	0.81 (0.52)	1.39 (0.49)
dcy	2.20 (0.09)	0.17 (0.94)	3.27 (0.19)
R	1.25 (0.31)	0.33 (0.84)	0.11 (0.94)
System 2			
	$F_{ar}(4,29)$	$F_{arch}(4,25)$	Chi-squared(2)
mp	0.67 (0.61)	0.66 (0.62)	2.07 (0.35)
piy	0.12 (0.97)	0.56 (0.69)	1.53 (0.46)
y	1.02 (0.41)	0.58 (0.67)	4.38 (0.11)
giy	1.23 (0.31)	1.06 (0.39)	4.86 (0.08)
R	1.37 (0.26)	0.53 (0.71)	2.19 (0.33)
Note: p-values are in the parantheses.			

Table 5 Johansen Cointegration Tests

Ho: rank=r	Max Eigen.	95%	Trace	95%
System 1				
r= =0	42.13	37.5	104.5	87.3
r< =1	28.52	31.5	68.4	63.0
r< =2	14.91	25.5	34.33	42.4
r< =3	8.09	19.0	18.42	25.3
r< =4	5.32	12.2	5.32	12.2
System 2				
r= =0	55.56	37.5	107.1	87.3
r< =1	32.34	31.5	65.12*	63.0
r< =2	18.44	25.5	36.65	42.4
r< =3	9.25	19.0	14.21	25.3
r< =4	2.95	12.2	2.95	12.2

Table 6 Unrestricted Cointegrating Vectors

System 1					
mp	*i*	*y*	*dcy*	*R*	*Trend*
1.000	-0.408	-0.015	-0.099	0.0016	-0.011
1.46	1.000	-1.042	-1.598	-0.002	-0.031
System 2					
mp	*piy*	*y*	*giy*	*R*	*Trend*
1.000	-0.254	-0.476	-0.083	0.0002	-0.002
-0.576	1.000	-2.767	-0.765	-0.004	0.021

Table 7 The Speed of Adjustment Coefficients

System 1			System 2		
mp	-0.255	-0.048	*mp*	-0.32	-0.021
i	0.191	0.009	*piy*	0.50	-0.149
y	0.020	-0.067	*y*	-0.05	-0.009
dcy	-0.023	0.217	*giy*	-0.33	-0.198
R	-85.83	19.0	*R*	-119.4	-16.83

Table 8 Weakly Exogeneity Tests

System 1	*y*	*dcy*	*R*
Chi-Squared (2)	0.59 (0.74)	3.99 (0.13)	5.28 (0.07)
System 2	*y*	*giy*	*R*
Chi-Squared (2)	0.41 (0.81)	3.54 (0.16)	6.12 (0.048)*

Table 9 Conditioned VECM

	System 1		System 2	
Variables	? *mp*	? *i*	? *mp*	? *piy*
? mp_{-1}	0.178 (1.47)	0.021 (0.10)	0.20 (1.21)	-0.66 (-1.94)
? mp_{-2}	0.10 (0.94)	-0.14 (-.81)	0.022 (0.15)	-0.49 (-1.68)
? mp_{-3}	0.003 (0.03)	0.024 (0.15)	-0.03 (-0.25)	-0.08 (-0.33)
? mp_{-4}	0.123 (1.33)	-0.204 (-1.34)	0.138 (1.22)	-0.36 (-1.55)
? i_{-1}	0.04 (0.61)	-0.058 (-0.53)	-	-
? i_{-2}	-0.029 (-0.44)	-0.01 (-0.09)	-	-
? i_{-3}	-0.104 (-1.70)	-0.26 (-2.62)	-	-
? i_{-4}	-0.03 (-0.43)	0.388 (3.41)	-	-
? piy_{-1}	-	-	0.029 (0.51)	0.02 (0.16)
? piy_{-2}	-	-	-0.014 (-0.24)	-0.35 (-2.96)
? piy_{-3}	-	-	0.073 (1.33)	-0.25 (-2.24)
? *piy*-4	-	-	0.018 (0.30)	0.19 (1.46)
? *y*	0.48 (4.69)	0.25 (1.49)	0.036 (0.63)	-0.18 (-1.57)
? *dcy*	0.44 94.34)	0.26 (1.59)	-	-
? *giy*	-	-	-0.003 (-0.016)	0.08 (1.94)
? *R*	0.001 (5.18)	0.0008 (1.86)	0.001 (4.71)	0.0009 (1.57)
$MD1_{-1}$	-0.22 (4.07)	0.019 (0.21)	-	-
$MD2_{-1}$	-0.04 (-0.63)	-0.40 (-3.60)	-	-
$DM1_{-1}$	-	-	-0.23 (-3.61)	0.056 (0.41)
$DM2_{-1}$	-	-	-0.02 (-0.48)	-0.38 (-3.53)
I1994	0.07 (1.55)	-0.002 (-0.03)	0.008 (0.16)	0.14 (1.37)
Constant	0.31 (0.74)	-2.80 (-4.01)	0.96 (1.30)	-5.81 (3.74)

Table 10 Diagnostic Test results

	System 1		System 2	
	? *mp*	? *i*	? *mp*	? *piy*
F_{ar} (4,38)	0.59 (0.66)	0.45 (0.77)	0.71 (0.58)	0.38 (0.81)
F_{arch} (4,34)	0.06 (0.99)	0.19 (0.94)	0.18 (0.94)	0.55 (0.69)
Chi-squared (2)	0.67 (0.71)	2.14 (0.34)	2.58 (0.27)	3.82 (0.14)
F_{het} (27,16)	0.92 (0.58)	0.42 (0.97)	0.46 (0.95)	0.91 (0.59)
p-values are in the parentheses.				

Table 11 Parsimonious Conditioned VECM

	System 1		System 2	
Variables	? *mp*	? *i*	? *mp*	? *piy*
? mp_{-1}	0.20 (1.80)*		0.23 (1.69)*	-0.60 (-1.87)*
? mp_{-2}				-0.35 (-1.31)
? mp_{-4}	0.147 (1.79)*	-0.24 (-1.81)*	0.16 (1.61)	-0.38 (-1.69)*
? i_{-1}	0.041 (1.11)		-	-
? i_{-3}	-0.05 (-1.55)	-0.28 (-4.29)***	-	-
? i_{-4}		0.42 (4.63)***	-	-
? piy_{-2}	-	-		-0.38 (-3.79)***
? piy_{-3}	-	-	0.072 (2.41)**	-0.20 (-2.75)***
? *piy*-4	-	-	0.06 (1.47)	0.34 (3.19)***
? *y*	0.47 (4.97)***	0.29 (2.27)**	0.059 (1.31)	
? *dcy*	0.45 (5.08)***	0.26 (2.00)**	-	-
? *giy*	-	-		0.095 (2.60)**
? *R*	0.001 (7.15)***	0.0008 (3.57)***	0.0013 (5.84)***	0.0009 (1.79)*
$MD1_{-1}$	-0.208 (-4.68)***		-	-
$MD2_{-1}$		-0.41 (-5.09)***	-	-
$DM1_{-1}$	-	-	-0.23 (-4.13)***	
$DM2_{-1}$	-	-		-0.34 (-3.95)***
I1994p2	0.06 (1.53)			
Constant	0.56 (4.75)***	-2.88 (-5.0)***	1.31 (4.15)***	-5.00 (-3.93)***
* , **, and *** indicate the significance of the coefficients at 10, 5 and 1 percent level respectively.				
LR-test	4.04 (0.98)		8.31 (0.76)	

Table 12 Diagnostics test results of parsimonious VECM

	System 1		System 2	
	? *mp*	? *i*	? *mp*	? *piy*
$F_{ar}(4,38)$	1.34 (0.26)	0.90 (0.47)	1.24 (0.30)	1.47 (0.22)
$F_{arch}(4,34)$	0.04 (0.99)	0.16 (0.95)	0.17 (0.95)	0.24 (0.90)
Chi-squared (2)	1.27 (0.52)	1.72 (0.42)	6.95 (0.03)*	4.99 (0.08)
F_{het} (27,16)	0.78 (0.72)	0.48 (0.95)	0.43 (0.97)	0.65 (0.83)
p-values are in the parentheses.				