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FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH: COINTEGRATION AND CAUSALITY ANALYSIS FOR THE CASE OF TURKEY

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ABSTRACT

The aim of this study is to examine the relationship between financial development leads to economic growth in Turkey. To accomplish this purpose, we apply the bounds testing approach to cointegration and Granger causality analysis to quarterly data covering the time period from 1987:1 to 2007:1. Cointegration analysis shows that the variables are cointegrated in the log-run. Parameter estimates show that both the short and long-run economic growth in Turkey is essentially insensitive to financial development. Causality analysis suggests that there is no Granger causality from financial development to economic growth. On the other hand, we find a strong unidirectional Granger causality from economic growth to financial development.

Keywords: Financial development, Economic Growth, causality, cointegration, Turkey.

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1. INTRODUCTION

The theoretical argument for linking financial development to growth is that a well-developed financial system performs several critical functions to enhance the efficiency of intermediation by reducing information, transaction, and monitoring costs. A modern financial system promotes investment by identifying and funding good business opportunities; mobilizes savings; monitors the performance of managers; enables the trading, hedging, and diversification of risk; and facilitates the exchange of goods and services. These functions result in a more efficient allocation of resources, a more rapid accumulation of physical and human capital, and faster technological progress, which in turn feed economic growth (Creane et al., 2004).

The relationship between financial development and economic growth is investigated in many studies. Ang (2008) provides a survey of recent developments in the literature of financial development and economic growth. The study highlights that most empirical studies focus on either testing the role of financial development in stimulating economic growth or examining the direction of causality between these two variables. Some studies were analyzed relationship of financial development and economic growth in Turkey (for example, Kar and Pentecost, 2000; Erim and Turk, 2005; Aslan and Kucukaksoy, 2006; Ardıc and Damar 2006; Acaravci et al., 2007; Halıcıoglu, 2007). Besides these studies Boulila and Trabelsi (2003) analyzed the causality between financial development and economic growth in the Middle Eastern and North African Countries (MENA) region including Turkey. The empirical findings show a one-way causal relationship running from the financial development to the economic growth in Turkey (Aslan and Kucukaksoy, 2006; Acaravci et al., 2007; Halıcıoglu, 2007). However, Kar and Pentecost's (2000) empirical results show that two-causal relationship is exist between the financial development and the economic growth in Turkey. For example, when financial development is measured by the money to income ratio the direction of causality runs from financial development to economic growth, but when the bank deposits, private credit and domestic credit ratios are alternatively used to proxy financial development, growth is found to lead financial development.

The aim of this study is to examine the relationship between financial development leads to economic growth in Turkey. To accomplish this purpose, we apply the bounds testing approach to cointegration developed by Peseran et al. (2001) and causality analysis developed by Dolado and Luthkepoh (1996) to quarterly data covering the time period from 1987:1 to

2007:1. Our study makes an empirical contribution to existing literature for Turkey applying recent developments in cointegration and causality analysis.

Rest of the paper is organized as follows. Section 2 explains the model the data. Section 3 introduces the econometric methodology. Section 4 discusses empirical findings, and . Finally, Section 5 concludes.

2. THE MODEL[2] AND THE DATA

The theoretical literature predicts that real income, financial depth and real interest rate are positively correlated. Mckinnon (1973) assumes that the positive relationship between the level of output and financial depth resulted from the complementarity between money and capital. The argument behind this view is that investment is lumpy and self-financed and hence cannot be materialized unless adequate savings are accumulated in the form of bank deposits. Shaw (1973), on the other hand, postulates that financial intermediaries promote investment which, in turn, raises the level of output. A positive real interest rate increases financial depth through the increased volume of financial saving mobilization and promotes growth through increasing the volume of productivity of capital. High real interest rates exert a positive effect on the average productivity of physical capital by discouraging investors from investing in low return projects (World Bank, 1989; Fry, 1997).

Based on these theoretical views and following Khan et al. (2005), the relationship between economic growth and financial development is formulated as follows:

$$\ln y_t = \alpha + \alpha_1 \ln S_t + \alpha_2 r_t + \alpha_3 \ln FD_t + \varepsilon_t \qquad (1)$$

where y is the real output, r is the real interest rate, S is the share of investment and ε is an error term. As can be seen from the model specification, all variables are expressed in natural logarithm with exception on the real interest rate. With regard the sign of the explanatory variables in Eqaution (1), according to theoretical postulates we expect to find a positive coefficient of each variable. The study is based on quarterly data and covering the time period from 1987:1 to 2007:1. The data for the variables are obtained from International Financial Statistics (IFS) of International Monetary Fund.

Choosing a satisfactory empirical measure of financial development is crucial for empirical analysis to examine the relationship between financial development and economic growth. To deal with this problem, we use the six most commonly proxies for financial development based on existing empirical literature. These proxies for financial development

[2] This section closely follows Khan et al. (2005).

are as follows: i) M2Y: the ratio of money (IFS line 35) to income, ii) BDY: the ratio of banking deposit liabilities (IFS line 24+25) to income (IFS line 99B), iii) DCY: the ratio of domestic credit (IFS line 32) to income, iv) PCY: the ratio of private sector credit (IFS line 32d) to income, v) PCDC: the share of private sector credit in domestic credit (line 32d/line 32), and finally vi) LLY: the ratio of liquid liabilities (line 34+35) to income.

The real income is measured as the ratio of nominal GDP to Consumer Price Index (CPI: 2000=100). S is the share of investment proxied by the gross fixed capital formation (IFS line 93E) to nominal GDP. r is the real deposit rate is calculated by taking the difference between the nominal deposit rate (IFS line 60) and inflation rate. The inflation rate is computed as the log-first difference of CPI.

3. ECONOMETRIC METHODOLOGY

Since our interest is to detect the long-run relationship between real GDP, financial depth, real deposit rate, and gross fixed capital formation, the appropriate method is to employ error-correction modeling and cointegration techniques. To this end, Autoregressive Distributed Lag (ARDL) approach to cointegration (i.e., the bounds testing approach to cointegration) pioneered by Pesaran et al. (2001) is followed. This approach has some econometric advantages over other known cointegration methodologies. Firstly, the need for pre-testing the order of integration is not required. In fact, whereas all other methods require that the variables in a time series regression equation are integrated of order one, i.e., the variables are I(1), bounds testing approach to testing for cointegration of levels relationship could be implemented irrespective of whether the underlying variables are purely I(0), purely I(1), or mutually integrated. Secondly, the long-run and short-run parameters of the model are estimated simultaneously. Third, all variables are assumed to be endogenous.

The bounds testing approach involves estimating the error-correction representation. From equation (1), the error-correction model (ECM) can be written as follows:

$$\Delta \ln y_t = \alpha + \sum_{i=1}^{p} \omega_k \Delta \ln y_{t-i} + \sum_{i=0}^{p} \beta_k \Delta \ln S_{t-i} + \sum_{i=0}^{p} \gamma_k \Delta r_{t-i} + \sum_{i=0}^{p} \lambda_k \Delta \ln FD_{t-i} + \delta_1 \ln y_{t-1} + \delta_2 \ln S_{t-1} + \delta_3 r_{j,t-1} + \delta_4 \ln FD_{t-1} + u_t \qquad (2)$$

where Δ is difference operator, p is the lag length, and u_t is assumed serially uncorrelated. The ARDL procedure involves two stages. In the first stage, the null hypothesis of non-cointegration relationship in the long-run defined as $H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ is tested against $H_0 : \delta_1 \neq 0, \delta_2 \neq 0, \delta_3 \neq 0, \delta_4 \neq 0$. Testing cointegration relationship is based on the F-

statistic that the asymptotic distribution of this F-statistic is non standard irrespective of whether the variables are I(0) or I(1). Pesaran et al. (2001) have therefore tabulated two sets of critical variables. One set assumes that all variables are I(0) and other set assumes that all variables are I(1). This provides a bound covering all possible classifications of the variables. If the calculated F-statistics lies above the upper level of the bound, the H_0 is rejected, indicating cointegration relationship in the long-run. If the calculated F-statistic lies below the lower level of the bound, the H_0 can not be rejected, supporting lack cointegration. If the calculated F-statistic falls between the bounds, then the test becomes inconclusive. In the case of inconclusive results, the error-correction term in the ARDL model are used to determine the existence of cointegration. Hence, if a negative and significant error-correction term is obtained, the variables are said to be cointegrated.

Once a long-run cointegration relationship is established, then the second stage of the ARDL procedure is to estimate the error-correction model from equation (2). The error-correction model can be written as follows:

$$\Delta \ln y_{it} = \alpha + \sum_{i=1}^{p} \omega_k \Delta \ln y_{t-i} + \sum_{i=0}^{p} \beta_k \Delta \ln S_{t-i} + \sum_{i=0}^{p} \gamma_k r_{t-i} + \sum_{i=0}^{p} \lambda_k \Delta \ln FD_{t-i} + \varpi EC_{t-1} + \mu_t \qquad (3)$$

where ϖ is the speed of adjustment parameter, EC_{t-1} is the error correction terms that EC is the residuals obtained from equation (1). The negative and statistically significant error correction terms supports cointegration among the variables and long-run equilibrium of the model of interest.

The existence of a cointegration relationship among the variables indicates that Granger causality should exist in at least one direction. To test causality relationships among the variables, we use modified Wald (MWALD) test developed by Dolado and Luthkepol (1996). The main advantage of this causality test is that the preliminary unit root analysis is not necessary, similar to the bounds testing approach, since the estimated model is robust to the type of integration and cointegration properties exhibited by data. Dolado and Lutkepohl (1996) propose a simple and intuitive method that overcomes the difficulties associated with standard Granger causality test that variables may or may not be integrated–cointegrated. Their approach is based on the notion that asymptotic properties of the Wald test on the coefficients of integrated–cointegrated VAR systems are the non-standard because of the singularity of the asymptotic distribution of the least squares estimators. They solve the problem of singularity by fitting a VAR model by augmenting and additional lag to the true order of unrestricted VAR and show that this procedure eliminates the nonsingular distribution of VAR coefficients. The method involves two steps. First, the

number of lagged terms (k) in the VAR is determined by some consistent model selection criterion such as Schwarz Bayesian Criterion (SBC). Second, a VAR with k +1 lags is estimated, and the standard Wald test is applied to the first k VAR coefficient matrix (Booth and Ciner, 2005).

4. EMPIRICAL RESULTS

The first step in the bounds testing approach is to carry out the F-test. Bahmani-Oskooee and Brooks(1999), and following them, Bahmani-Oskooee et. al (2006), and Bahmani-Oskooee and Harvey (2006) have demonstrated that the results will be sensitive to the choice of the lag order. We therefore carry out the F-test up to five lags for quarterly data. Another crucial point is to determine whether or not the test for cointegration should include a time trend (Pesaran et al. 2001). Following Narayan and Narayan (2008), we use both the Akaike Information Criteria (AIC) and the Schwarz Bayesian Criterion (SBC) and find that there are significant differences between model with deterministic trends and model without deterministic trends. We therefore prefer the model with deterministic trends.

The F-statistics for cointegration analysis are reflected in Table 1. The results show that there is at least one lag order at which the calculated F-statistic exceeds the upper bound critical value, supporting cointegration relationship among the variables in the long-run. Following Bahmani-Oskooee and Brooks (1999) and Bahmani-Oskooee et al. (2006), we consider these results preliminary due to much stronger results in favor of cointegration from more efficient results of the second stage.

<Insert Table 1>

In the second stage, the ECM is estimated by the ARDL approach to cointegration. For this purpose, the ARDL method first estimates $(m+1)^{k+1}$ number of regression to obtain optimal lag length for each variable, where m is the maximum lag to be chosen and k is the number of variables in the equation (Pesaran and Pesaran, 1997:393). Following Jonhston and DiNardo (1997:250), we impose the maximum 5 lags on the level of variables (i.e., 4 lags on each first differenced variable) for quarterly data, and then employ AIC in selecting the optimum number of lags.

Table 2 represents only the short-run coefficient estimates of the model. The EC_{t-1} has a negative and significant coefficient in all cases. This supports not only cointegration compatible with F-statistics, but also the fact that the described growth equation is adjusting

towards equilibrium in the long-run. It is clear from Table 2 that in the short-run M2Y, BDY, DCY, PCY, and LLY as proxies for the financial development are generally statistically significant and negative effects on economics growth. On the other hand, PCDC has positive and statistically significant impact on economic growth in Turkey. Accordingly, as the share of private sector credit in domestic credit increases, economic growth has been positively affected in the short-run. The impacts of the real interest rate on economic growth seem very marginal and also statistically insignificant in the cases of M2Y, BDY, DCY, and LLY. However, when PCY and PCDC is used as a indicators of financial development, interest rate is getting statistically significant and negative very small coefficients. According to Khan et al. (2005), this requires a need for further liberalization of interest rate. The results also show that the impacts of the share of investment on Turkey's economic growth are mixed and generally statistically insignificant.

<Insert Table 2>

The long-run coefficients of the variables can not be inferred from the error-correction terms. Thus, in order to asses the long-run effects of the variables on economic growth, we represented the long-run coefficient estimates and some diagnostic tests in Table 3. The estimated parameters of the indicators of financial development with the exception of PCY are statistically significant. However, the results show that only the PCDC has positive effect on economic growth in Turkey. Accordingly, a 1 percent increase in PCDC stimulates the growth rate by 0.17 percent in the long-run that this effect can be thought as not big as expected. The share of investment has positive and statistically significant coefficients in the cases of M2Y, BDY, PCY, and LLY. Although, the coefficients of the real interest rate are negative and statistically insignificant. Overall results show that the share of investment is important factor contributing to economic growth in Turkey in the long-run due to employed growth equation. As far as diagnostic tests are considered in Table 2, the results show that the selected ARDL models pass the diagnostic checking in all cases. Accordingly, serial correlation, functional misspecification, normality, heteroscedasticity, and autoregressive conditional heteroscedasticity do not pose any problem in the estimation of the growth equation.

<Insert Table 3>

It is important note that cointegration among the variables does not ensure the stability of the parameters. Hence, following Bahmani-Okooee and Harvey (2006), we test for the stability of the long-run coefficients. To this end, CUSUM and CUSUMSQ tests are applied

to the residuals of equation (2). No that applying these tests to the residuals of the error-correction model amounts to testing for the stability of the short-run as well as the long-run coefficient estimates. A common practice in reporting the results of CUSUM and CUSUMSQ is a graphical presentation. Fig.1 shows that the long-run and the short-run coefficient estimates in the model in the case of M2Y are stable due to fact that the plots of both CUSUM and CUSUMSQ statistics fall between critical values. Due to large number of graphs, the stability test result for all other models is summarized in Table 4. Accordingly, CUSUM and CUSUMSQ statistics show that all models have the stable parameter over times.

<Insert Fig. 1>

<Insert Table 4>

To apply Dolado and Luhthepohl (1996) causality test, first step of the process is to select the numbers of optimal lags for the variables in the VAR system. To this end, we utilize model selection criterions. Table 5 represents VAR lag order selection criteria and serial correlation test statistics. The SBC is used to determine appropriate lag order; because Lutkepohl (1985) shows that this criterion preferred in small samples. LM test for serial correlation shows that autocorrelation does not pose any problem in the estimation of the models to detect the direction of causality between financial depth and economic growth.

<Insert Table 5>

In the second step of the causality analysis, we estimated VAR models with k+1 lags, and apply standard Wald test to the first k VAR coefficient matrix. Table 6 includes the results of causality analysis. The results show that there is no causality from financial development to economic growth for all indicators of financial development, with exception of PCDC. However, it is clear from Table 6 that there is a strong unidirectional Granger causality from economic growth to financial development.

<Insert Table 6>

5. CONCLUSION

In this study we analyzed the relationship between financial development leads to economic growth in Turkey applying the bounds testing approach to cointegration and Granger causality analysis to quarterly data covering the time period from 1987:1 to 2007:1. To choose a satisfactory empirical measure of financial development, we use the six most commonly proxies for financial development based on existing empirical literature.

We can summarize our findings as (i) cointegration analysis shows that the variables are cointegrated in the log-run, ii) in the short- and long-ru proxies for the financial

development are generally statistically significant and negative effects on economics growth with the exception one proxy, iii) there is no Granger causality from financial development to economic growth for all indicators of financial development, with exception of one proxy, finally iv) there is a strong unidirectional Granger causality from economic growth to financial development.

Table 1: The F-statistics for Cointegration among the Variables

FD Indicator	Lag	Without Deterministic Trends			With Deterministic Trends		
		AIC	SBC	F-stat	AIC	SBC	F-stat
M2Y	1	-2.74	-2.38	2.80	-3.13	-2.74	12.48
	2	-2.77	-2.28	0.93	-3.16	-2.65	9.18
	3	-3.32	-2.71	0.89	-3.41	-2.77	2.67
	4	-3.35	-2.61	0.66	-3.50	-2.74	3.15
	5	-3.35	-2.48	1.08	-3.47	-2.58	2.66
BDY	1	-2.68	-2.32	1.54	-3.12	-2.73	11.50
	2	-2.80	-2.31	0.64	-3.19	-2.67	8.38
	3	-3.28	-2.68	0.99	-3.41	-2.77	3.38
	4	-3.38	-2.64	0.57	-3.54	-2.77	3.25
	5	-3.37	-2.51	0.83	-3.50	-2.61	2.63
DCY	1	-2.59	-2.23	0.32	-3.02	-2.63	9.08
	2	-2.73	-2.25	0.29	-3.03	-2.52	6.00
	3	-3.23	-2.62	1.35	-3.31	-2.67	2.97
	4	-3.24	-2.51	0.43	-3.39	-2.62	2.75
	5	-3.22	-2.36	0.82	-3.39	-2.49	3.00
PCY	1	-2.46	-2.10	1.21	-2.88	-2.49	10.82
	2	-2.80	-2.32	1.55	-2.95	-2.44	4.69
	3	-3.23	-2.62	3.85	-3.30	-2.66	4.58
	4	-3.23	-2.49	1.49	-3.32	-2.56	2.92
	5	-3.19	-2.32	2.35	-3.36	-2.46	4.41
PCDC	1	-0.63	-0.27	19.32	-2.22	-1.83	161.14
	2	-1.69	-1.21	1.25	-2.17	-1.66	11.88
	3	-2.93	-2.32	1.29	-2.92	-2.28	0.53
	4	-3.027	-2.29	1.40	-3.11	-2.35	2.29
	5	-2.97	-2.10	1.81	-3.11	-2.22	3.34
LLY	1	-2.80	-2.44	1.32	-3.21	-2.82	10.21
	2	-2.90	-2.41	0.53	-3.26	-2.74	7.55
	3	-3.33	-2.72	1.02	-3.45	-2.81	3.35
	4	-3.44	-2.71	0.74	-3.60	-2.84	3.47
	5	-3.47	-2.60	0.90	-3.61	-2.71	2.83

The F-statistics critical values for the mode without deterministic trend are (2.72-3.77) for %10 critical value, (3.23-4.35) for %5 critical value, and (4.29-5.61) for %1 critical value. The critical values are obtained from Table CI(iii) Case III . The F-statistics critical values for the mode with deterministic trend are (3.47-4.45) for %10 critical value, (4.01-5.07) for %5 critical value, and (5.17-6.36) for %1 critical value. The critical values are obtained from Table CI(v) Case V.

Table 2: The Short-run Coefficient Estimates

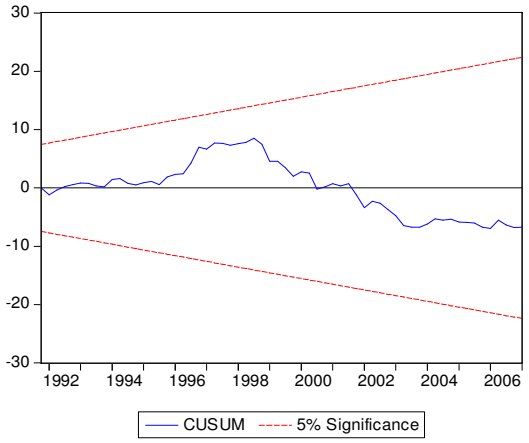
	FD Indicator					
Variable	M2Y	BDY	DCY	PCY	PCDC	LLY
$\Delta \ln Y_{t-1}$	-0.053 (0.29)	0.167 (1.00)	0.028 (0.18)	0.161 (0.79)	0.218 (0.93)	0.157 (0.98)
$\Delta \ln Y_{t-2}$	-0.008 (0.06)	0.019 (0.14)	-0.107 (0.78)	-0.131 (0.71)	-0.035 (0.18)	0.017 (0.13)
$\Delta \ln Y_{t-3}$	-0.132 (1.34)	-0.095 (0.97)	-0.166 (1.72)	-0.050 (0.33)	-0.167 (1.28)	-0.088 (0.09)
$\Delta \ln Y_{t-4}$	0.316 (3.73)	0.297 (3.66)	0.285 (3.30)	0.274 (2.55)	0.524 (5.07)	0.289 (3.63)
$\Delta \ln S$	0.064 (1.75)	0.033 (0.09)	0.037 (1.00)	0.074 (1.76)	-0.010 (0.21)	0.028 (0.82)
$\Delta \ln S_{t-1}$		-0.107 (2.25)		-0.086 (1.93)		-0.100 (2.17)
$\Delta \ln S_{t-2}$		-0.063 (1.78)				-0.061 (1.75)
$\Delta \ln R$	-0.3E-3 (0.73)	-0.1E-3 (0.65)	-0.3E-3 (1.19)	-0.002 (4.71)	-0.010 (2.01)	-0.2E-3 (1.11)
$\Delta \ln R_{t-1}$				0.001 (2.20)	-0.001 (2.06)	
$\Delta \ln R_{t-2}$				-0.001 (2.80)	-0.001 (2.02)	
$\Delta \ln FD$	-0.452 (7.95)	-0.496 (8.64)	-0.403 (6.58)	-0.343 (4.45)	0.142 (3.14)	-0.523 (8.94)
$\Delta \ln FD_{t-1}$	-0.161 (2.02)			0.198 (2.40)		
$\Delta \ln FD_{t-2}$				0.070 (0.85)		
$\Delta \ln FD_{t-3}$				0.150 (1.77)		
Constant	3.116 (3.18)	3.677 (3.49)	2.825 (2.97)	2.696 (22.5)	4.567 (3.37)	3.601 (3.53)
Trend	0.005 (3.19)	0.006 (3.75)	0.005 (3.77)	0.003 (2.98)	0.005 (3.08)	0.005 (3.81)
ECM_{t-1}	-0.549 (3.10)	-0.637 (3.43)	-0.517 (3.00)	-0.435 (2.28)	-0.834 (3.36)	-0.619 (3.46)

Numbers in parentheses are absolute values of the t-ratios.

Table 3: The long-run Coefficient Estimates with Diagnostic Tests

	FD Indicator					
Variable	M2Y	BDY	DCY	PCY	PCDC	LLY
lnS	0.253 (3.45)	0.281 (4.48)	0.072 (1.15)	0.555 (2.46)	-0.012 (0.21)	0.279 (4.47)
R	0.5E-3 (1.10)	-0.2E-3 (0.60)	-0.6E-3 (0.98)	-0.001 (1.23)	0.4E-3 (1.14)	-0.4E-3 (0.98)
lnFD	-0.191 (2.47)	-0.23 (3.38)	-0.315 (3.31)	-0.292 (1.61)	0.170 (4.12)	-0.252 (3.35)
C	5.677 (38.2)	5.772 (52.2)	5.456 (47.8)	6.192 (20.5)	5.472 (63.4)	5.811 (54.0)
T	0.009 (7.13)	0.009 (8.96)	0.010 (6.73)	0.008 (4.45)	0.006 (13.3)	0.009 (9.12)
Adj.R^2	0.96	0.96	0.96	0.96	0.94	0.97
Diagnostic Tests						
$LM_{SC}(\chi^2_4)$	9.11 [0.058]	5.15 [0.272]	3.22 [0.520]	19.67 [0.001]	13.01 [0.011]	6.01 [0.198]
$FF(\chi^2_1)$	0.05 [0.812]	2.62 [0.105]	1.95 [0.162]	1.76 [0.184]	3.98 [0.046]	2.45 [0.117]
$JB(\chi^2_2)$	0.06 [0.969]	0.09 [0.955]	4.71 [0.095]	1.43 [0.489]	21.30 [0.000]	0.08 [0.960]
$LM_{het}(\chi^2_1)$	0.08 [0.770]	0.02 [0.869]	0.01 [0.907]	0.009 [0.921]	0.57 [0.447]	0.01 [0.898]
$ARCH(\chi^2_4)$	4.09 [0.393]	3.10 [0.540]	2.34 [0.672]	5.68 [0.223]	7.38 [0.116]	2.67 [0.614]

$LM_{SC}(\chi^2_4)$ is the Breusch–Godfrey Lagrange Multiplier test statistics for the null of no fourth-order serial correlation; FF (χ^2_1) is the Ramsey's test statistic for the null of no functional misspecification; JB (χ^2_2) is the Jarque–Bera statistic of the test for the null of normality; $LM_{het.}(\chi^2_1)$ is the White's test statistic to test for the null of homoskedasticity; and ARCH (χ^2_4) is the Engle's test statistic for the null of no autoregressive conditional heteroscedasticity. Numbers in parentheses and brackets are values of the t-ratios and *p*-values, respectively. Numbers in parentheses and brackets are absolute values of the t-ratios, and *p*-values, respectively.



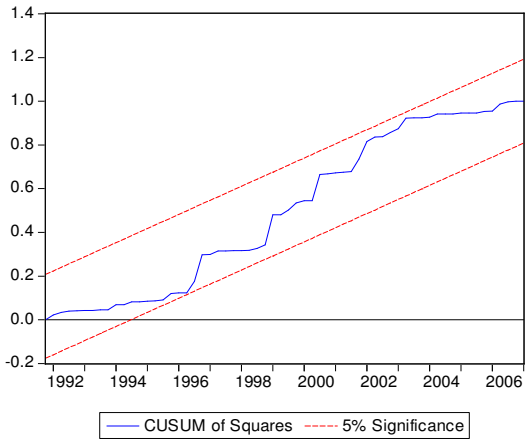


Fig.1. Plot of CUSUM and CUSUMSQ Test Results (M2Y)

Table 4: Stability tests results

FD Indicator	CUSUM	CUSUMSQ
BDY	Stable	Stable
DCY	Stable	Stable
PCY	Stable	Stable
PCDC	Stable	Stable
LLY	Stable	Stable

Table 5: VAR Lag Order Selection Criteria

FD Indicator	Lag	Information Criterion LR	FPE	AIC	**SBC**	HQ	LM-Stat	*p*-value
M2Y	0	NA	0.002947	5.524425	5.773513	5.623789		
	1	182.9936	0.000308	3.265775	4.013040	3.563868	20.00900	0.2198
	2	136.8748	5.63e-05	1.559540	2.804980	2.056361	19.25189	0.2558
	3	33.83498	4.99e-05	1.428056	3.171673	2.123606	13.95044	0.6024
	4	98.98356	1.34e-05	0.092925	2.334718	0.987204	19.18288	0.2593
	5	51.34033*	7.97e-06*	-0.461957*	2.278012*	0.631051*	14.00064	0.5987
BDY	0	NA	0.002870	5.497951	5.747039	5.597315		
	1	193.1828	0.000258	3.089460	3.836725	3.387553	22.02872	0.1423
	2	123.9140	5.78e-05	1.585736	2.831177	2.082558	14.48247	0.5628
	3	35.57299	4.98e-05	1.425285	3.168902	2.120835	28.54800	0.0272
	4	99.37186	1.33e-05	0.083220	2.325013	0.977499	11.20285	0.7968
	5	53.55256*	7.57e-06*	-0.514204	2.225765*	0.578803*	21.92587	0.1456
DCY	0	NA	0.003890	5.802099	6.047440	5.900149		
	1	215.9056	0.000272	3.138786	3.874808	3.432936	16.52377	0.4170
	2	131.9824	5.63e-05	1.560106	2.786807	2.050355	16.44889	0.4221
	3	24.46253	5.84e-05	1.586601	3.303984	2.272951	18.60460	0.2897
	4	97.66584	1.69e-05	0.323760	2.531823	1.206209	14.91284	0.5310
	5	49.61795*	1.06e-05*	-0.174038*	2.524706*	0.904511*	20.30340	0.2069
PCY	0	NA	0.007034	6.394492	6.639833	6.492542		
	1	256.6138	0.000275	3.149633	3.885654	3.443782	9.493652	0.8917
	2	124.3303	6.39e-05	1.686893	2.913595	2.177143	17.60344	0.3476
	3	29.13031	6.15e-05	1.638102	3.355485	2.324451	24.90534	0.0715
	4	121.8510	1.17e-05	-0.041725	2.166338*	0.840724	13.58645	0.6295
	5	35.43907*	9.54e-06*	-0.276951*	2.421793	0.801597*	17.66351	0.3440
PCDC	0	NA	0.008404	6.572431	6.817771	6.670481		
	1	260.6654	0.000310	3.269692	4.005713	3.563842	10.60897	0.8330
	2	126.3569	6.99e-05	1.776247	3.002949	2.266496	12.74909	0.6910
	3	27.02090	6.96e-05	1.761478	3.478861	2.447827	20.25139	0.2091
	4	97.18538	2.02e-05	0.506921	2.714984*	1.389370	13.92801	0.6041
	5	45.77688*	1.36e-05*	0.080254*	2.778997	1.158802*	17.77364	0.3373
LLY	0	NA	0.002594	5.396993	5.642333	5.495043		
	1	204.2754	0.000214	2.899825	3.635846	3.193975	25.14464	0.0673
	2	129.0070	4.64e-05	1.366226	2.592928	1.856475	15.23682	0.5074
	3	33.87595	4.13e-05	1.240892	2.958275	1.927242	28.20627	0.0299
	4	102.4587	1.10e-05	-0.104585	2.103478	0.777864	9.461289	0.8932
	5	61.46718*	5.53e-06*	-0.821813*	1.876931*	0.256735*	21.58094	0.1572

* indicates lag order selected by the criterion; LR is sequential modified LR test statistic; FPE is Final Prediction Error; AIC is Akaike Information Criterion; SBC is Schwarz Bayesian Criterion; HQ is Hannan-Quinn Information criterion; LM-Stat is the VAR residual serial correlation Lagrange Multiplier test.

Table 6: Dolado and Lutkepohl Test of Granger Causality

Hypothesis	Lag	MWALD	p-value	Causal
M2Y does not cause Y	5	0.823	0.5392	No
Y does not cause M2Y	5	3.486	0.0090	Yes
BDY does not cause Y	5	0.106	0.9904	No
Y does not cause BDY	5	3.605	0.0074	Yes
DCY does not cause Y	5	1.175	0.3345	No
Y does not cause DCY	5	4.797	0.0012	Yes
PCY does not cause Y	4	0.659	0.6226	No
Y does not cause PCY	4	14.633	0.0000	Yes
PCDC does not cause Y	4	3.155	0.0211	Yes
Y does not cause PCDC	4	0.638	0.6374	No
LLY does not cause Y	5	0.163	0.9749	No
Y does not cause LLY	5	4.420	0.0021	Yes

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