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An Estimation of the Money Demand Function in Cambodia

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Abstract

In this paper, the money demand function in Cambodia is estimated. The function that incorporates the exchange rate is adopted as the estimation equation, taking into account the phenomenon of currency substitution. The autoregressive distributed lag approach to cointegration is used as the methodology, and data from the quarterly sample period between 2002Q1 and 2007Q4 are used for the estimation. The results indicate the existence of a long-run relationship among the variables considered in the money demand function. The cumulative sum as well as the cumulative sum of squares tests on the recursive residuals support the stability of the estimated function. Moreover, the long-run estimation results show that income and inflation are significant determinants of money demand in Cambodia; however, although the estimated coefficient of the exchange rate is negative, it is not statistically significant. This statistical insignificance may be due to the coexistence of the currency substitution effect and the wealth effect on domestic money demand in Cambodia when the exchange rate fluctuates. This study provides important information on the structure of money demand function in Cambodia and can serve as a foundation for further research.

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1 Introduction

Information on the structure of the money demand function is very important to policymakers designing effective monetary policy in both developed and developing countries. Recognizing this importance, this paper attempts to estimate the money demand function in Cambodia using quarterly data between 2002Q1 and 2007Q4.[1] For the methodology, the autoregressive distributed lag approach (ARDL) to cointegration is applied.[2] Moreover, the stability of the estimated model is examined, using the tests of the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) of recursive residuals.

Like other countries experiencing political and socio-economic transitions, during the period of transformation from a planned economy toward the market one in the late 1980s and early 90s, Cambodia experienced both macroeconomic and political instability; however, over the last decade, Cambodia has experienced good economic growth, and the development of its financial sector has been on a good trend as demonstrated by the operation of its first-ever securities exchange in 2012.[3] The study on money demand function in Cambodia is motivated by several factors. First, although there have been remarkable changes in both the financial sector and the economy as a whole, research on the Cambodian economy is very scarce, especially in terms of research on its money demand function. Thus, there is a need to fill this gap in the literature. Second, it is widely known that the currency substitution phenomenon may cause instability of the money demand function. This impacts the effectiveness of monetary policy. As indicated in some studies, including Kem (2001), Zamaróczy and Sa (2002), Kang (2005), and Samreth (2010, 2011), currency substitution is a widespread phenomenon in the Cambodian economy.[4] Under such circumstances, the estimation of the money demand function and the examination of its stability may provide good implications for policymakers.

From our estimation results, we confirm the significant long-run relationship between the monetary aggregate M1 and its explanatory variables, income, and inflation between 2002Q1 and 2007Q4.[5] The long-run relationship between M1 and the exchange rate, however, measured as the amount of Cambodian Riel per US dollar, is not statistically significant.[6] Furthermore, the results of the stability tests support the stability of our estimated money demand function. This study provides important information on the structure of the money demand function in Cambodia and can serve as a basis for further investigation.

The structure of this paper is organized as follows. Section 2 discusses the estimation equation and methodology. In Section 3, the data and estimation results are presented along with an explanation and discussion of the empirical analysis. Section 4 concludes.

[1] As discussed later, the sample period is selected based on the availability of the data.

[2] The justification for the use of this estimation methodology is discussed in Section 2.

[3] By 2014, however, there were still only two firms listed on the Cambodian Securities Exchange-Grand Twins International (Cambodia) Plc and Phnom Penh Water Supply Authority.

[4] Currency substitution is a phenomenon in which foreign currency is used widely in the economy along with domestic currency as a medium of exchange, a store of value, and a unit of account (Calvo and Végh, 1992; Samreth, 2010; Samreth, 2011).

[5] M1 consists of Cambodian Riel in circulation and Riel-denominated demand deposits in the banking system. The specification of the estimation equation is discussed in Section 3.

[6] Exchange rate is included in the estimation equation to capture the effect of currency substitution.

2 Estimation Equation and Methodology

2.1 Estimation Equation

The widely used standard money demand function can be expressed as follows.

$$\frac{M}{P} = L\left(y, c\right), \tag{1}$$

where M is the money balance; P is the price level; y is the real income; and c is the opportunity cost variable. The interest rate on the alternative asset is usually used as the opportunity cost variable. But, in developing countries whose financial sector is not well developed, inflation is commonly used as the proxy of the opportunity cost variable.[7]

As mentioned above, Kem (2001), Zamaróczy and Sa (2002), Kang (2005), and Samreth (2010, 2011) provide evidence supporting the currency substitution phenomenon in Cambodia. Specifically, they indicate that the fluctuation of the exchange rate leads to the change in the ratio of domestic and foreign money balances. Taking this into account, the exchange rate should be incorporated into the money demand function. It is worth noting that the inclusion of exchange rate variable in the standard function of money demand was first suggested by Mundell (1963). In our study, nominal exchange rate is chosen for the estimation rather than real exchange rate. Kem (2001), Kang (2005), and Samreth (2010, 2011) also adopt the nominal exchange rate for their studies on the phenomenon of currency substitution in Cambodia. This choice is in line with recent studies on this kind of money demand function, such as Bahmani-Oskooee (1996), Bahmani-Oskooee and Techaratanachai (2001), Bahmani-Oskooee and Rehman (2005), Bahmani-Oskooee and Tanku (2006), Akinlo (2006), and Budina et al. (2006). Moreover, for the public, the nominal exchange rate is more perceivable than the real exchange rate that captures the value of domestic goods against those of foreign goods.

By using inflation as the proxy of opportunity cost variable and incorporating the exchange rate to capture currency substitution phenomenon, Equation (1) can be modified as follows.

$$\frac{M}{P} = L\left(y, \pi, E\right), \tag{2}$$

where π and E are the inflation and exchange rate, respectively. The exchange rate, here, is defined as the amount of domestic currency per unit of foreign currency. Some studies, such as Sriram (2009), include the returns yielded by holding money in the money demand function; however, that is not considered in this paper because the monetary aggregate M1 consisting of Cambodian Riel in circulation and Riel-denominated demand deposits is used as the proxy of money balance.[8] Generally, M1 bears no interest rate. Sriram (2009) also considers the interest rate on foreign assets as a variable in the money demand function in the case of Gambia; however, since the financial sector in Cambodia is underdeveloped,

[7] See, for example, Bahmani-Oskooee (1996), Bahmani-Oskooee and Tanku (2006), and Budina et al. (2006), among others.

[8] The justification for the use of M1 is explained in the next section.

it is unlikely that the public could access foreign assets as an alternative against money holding. Therefore, the interest rate on foreign assets is not considered in this paper.

Based on Equation (2), the estimation equation is specified as follows.

$$\ln \frac{M_t}{P_t} = \beta_0 + \beta_1 \ln y_t + \beta_2 \pi_t + \beta_3 \ln E_t + \varepsilon_t, \tag{3}$$

where ln denotes the natural logarithm; t is time index; and ε is an error term. The expected signs of the estimated coefficients are as follows. Since the increase in income leads to the increase in money demand, the income elasticity, β_1, is expected to be positive. An increase in inflation reduces the real value of a money balance. This makes people shift from holding a money balance to holding alternative assets. Hence, β_2 is expected to be negative.[9] For the coefficient of exchange rate elasticity, β_3, it can be either positive or negative (Arango and Nadiri, 1981). In a situation where people can hold foreign currency, the increase in exchange rate (depreciation of domestic currency) may be perceived as an increase in wealth, leading to a rise in the demand for domestic money balance (wealth effect). In this case, β_3 is positive; however, if the increase in exchange rate leads to the decrease in the demand of domestic money, then β_3 is negative. In this case, the phenomenon of currency substitution is observed. Therefore, the sign of β_3 is an empirical issue.

2.2 Estimation Methodology

For our estimation methodology, we adopt the ARDL approach to cointegration proposed by Pesaran and Pesaran (1997) and Pesaran et al. (2001), instead of the residual-based approach of Engle and Granger (1987) and the maximum likelihood-based approach of Johansen and Juselius (1990). One of the main advantages of the ARDL approach is that it does not require the variables in consideration be in the same integration order, I(1).[10] An error correction representation of the ARDL model of Equation (3) can be written as follows.

$$\begin{aligned}\Delta \ln \frac{M_t}{P_t} = \alpha_0 + \sum_{i=1}^{n_1} \alpha_{1i} \Delta \ln \frac{M_{t-i}}{P_{t-i}} + \sum_{i=0}^{n_2} \alpha_{2i} \Delta \ln y_{t-i} + \sum_{i=0}^{n_3} \alpha_{3i} \Delta \pi_{t-i} + \sum_{i=0}^{n_4} \alpha_{4i} \Delta \ln E_{t-i} \\ + \lambda_1 \ln \frac{M_{t-1}}{P_{t-1}} + \lambda_2 \ln y_{t-1} + \lambda_3 \pi_{t-1} + \lambda_4 \ln E_{t-1} + \mu_t, \end{aligned} \tag{4}$$

where μ is an error term and Δ denotes difference.

The estimation is conducted as follows. First, it is necessary to test the existence of the long-run relationship among the variables in the estimation equation. For this, the null hypothesis of no cointegration or no long-run relationship, $H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$,

[9] Notably, some studies explain the possibility that an increase in inflation may lead to an increase in money holding, because higher inflation increases the amount of money required for transactions. Therefore, people need to hold more money (see Sriram, 2009, among others).

[10] Pesaran and Pesaran (1997) and Pesaran et al. (2001) explain the advantages of ARDL approach in more detail.

is tested against its alternative, $H_1 : \lambda_1 \neq 0, \lambda_2 \neq 0, \lambda_3 \neq 0, \lambda_4 \neq 0$, using an F-test. The critical value (CV) of the F-statistic for this test is available in Pesaran and Pesaran (1997). The computed F-statistics are compared with their CVs: the null hypothesis is rejected if the F-statistic is higher than the upper bound of the CV; it cannot be rejected if the F-statistic is lower than the upper bound of CV; the test is inclusive if the F-statistic lies between the lower and upper bounds. After the existence of cointegration among variables is confirmed and discussed based on the results of the F-test, the lag orders of the variables are selected using Schwarz Bayesian Criteria (SBC).[11] Next, the short- and long-run models are estimated based on the selected ARDL model. Following Pesaran et al. (2001), Andrés and Halicioglu (2011), and Okada and Samreth (2013), the error correction representation of the selected ARDL model is constructed by using the error correction term to replace the lag of level variables in equation (4). The equation can be expressed as follows.

$$\Delta \ln \frac{M_t}{P_t} = \gamma_0 + \sum_{i=1}^{p_1} \gamma_{1i} \Delta \ln \frac{M_{t-i}}{P_{t-i}} + \sum_{i=0}^{p_2} \gamma_{2i} \Delta \ln y_{t-i} + \sum_{i=0}^{p_3} \gamma_{3i} \Delta \pi_{t-i} + \sum_{i=0}^{p_4} \gamma_{4i} \Delta \ln E_{t-i} + \lambda EC_{t-1} + \xi_t, \quad (5)$$

where EC is the error correction term and ξ is an error term.

The stability tests, CUSUM of recursive residuals and CUSUMSQ of recursive residuals, are also conducted.

3 Data and Estimation Results

3.1 Data

Quarterly data spanning from 2002Q1 to 2007Q4 are used for our estimation. The data are obtained from International Financial Statistics (IFS), published by the International Monetary Fund (IMF). This sample period is chosen due to the availability of the data of all variables in the estimation equation. The monetary aggregate $M1$, consisting of Cambodian Riel in circulation and Riel-denominated demand deposits in the banking system, is used as the proxy of money balance (M).[12] GDP and consumer price index (CPI) are used as proxies of the income level (y) and price level (P), respectively. $M1$ and GDP are converted into real values using CPI. Inflation (π) is also constructed from this CPI. The exchange rate (E) is the amount of Cambodian Riel per US dollar and it is the period average exchange rate published in IFS. The summary of the descriptive statistics for each variable is illustrated in Table 1.

[11] Various studies suggest the lag order selection based on SBC (Narayan, 2004; Samreth, 2011; Okada and Samreth, 2013).

[12] Due to the fact that time and saving deposits in Cambodia are mostly in foreign currencies, $M2$, which is the sum of $M1$ and time and saving deposits, is not considered in our study.

3.2 Estimation Results

As mentioned above, the ARDL approach to cointegration does not require that the variables in the estimation equation be integrated in the same order; however, the CVs in the F-test reported by Pesaran and Pesaran (1997) are computed depending on whether the variables in consideration are I(0) or I(1). Since the F-test is not applicable if there is any variable integrating with order 2, I(2), or higher, we typically need to investigate the integration order of the variables (Samreth, 2011; Okada and Samreth, 2013). Table 2 provides the results of the unit root test for each variable based on the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. It is clear from the table that no variable is I(2). Therefore, it is not problematic to apply the F-test suggested by Pesaran and Pesaran (1997) for examining the long-run or cointegration relationship among variables.

The F-statistics with various lag lengths (from one to three) for testing the existence of the cointegration or long-run relationship among variables are reported in Table 3.[13] From the table, the computed F-statistics with lag order one lies between the lower and upper bounds of the critical values, leading to the inclusive result on whether there exists a long-run or cointegration relationship among the variables. When encountering this case, as suggested by Kremers et al. (1992), Bahmani-Oskooee and Nasir (2004), Iwata et al. (2012), and Okada and Samreth (2013), we should examine the significance of the error correction (EC) term in the next estimation step to determine the existence of this relationship.

Next, equation (5) is estimated based on the ARDL approach to cointegration, in which the maximum lag order is set to two. This setting helps us save the degree of freedom, as our available sample period for analysis is small. Based on SBC, ARDL(1,0,0,0) is obtained.[14] The estimation results of the short-run model are shown in Table 4. The diagnostic tests of serial correlation, functional form, normality, and heteroscedasticity are also provided. Based on the table, the estimated coefficient of the error correction term (EC_{t-1}) is significantly negative and its absolute value is smaller than one. This provides evidence supporting the cointegration relationship among variables in the model. The absolute value of the estimated coefficient of EC_{t-1} is 0.4503, indicating fairly high speed of adjustment to equilibrium following short-run shocks. Specifically, when shocks to money balance have occurred in the previous period, about 45% of the disequilibrium caused by the shocks converges back to the long-run equilibrium. This fairly high speed of adjustment may reflect the phenomenon of currency substitution in Cambodia to the extent to which people can adjust domestic money balance by holding or releasing foreign currency. Moreover, the results of the diagnostic tests in Table 4 indicate that the estimated function passes all the tests of serial correlation, functional form, normality, and heteroscedasticity. The results help justify the specification of our money demand function.

Table 5 illustrates the long-run estimation results. From the table, the estimated coefficients of log income ($\ln y$) and inflation (π) are significantly positive and negative, respectively, as expected. It is also worth noting that the income elasticity of money demand is 1.4638. The income elasticity exceeds unity is natural, given the underdeveloped financial sector in Cambodia. In such circumstance, the demand for money may increase

[13] It is common to choose lag orders of up to four when dealing with quarterly data; however, the estimation cannot be conducted with a lag order of four due to our limited sample size.

[14] By setting the maximum lag length to one or three, we also obtain ARDL(1,0,0,0) model.

at a speed higher than that of the increase in income because alternative financial assets are lacking for savings (Perkins et al., 2006). Table 5 also indicates that, although the estimated coefficient of exchange rate is negative, it is not statistically significant. This statistical insignificance may be due to the coexistence of a wealth and currency substitution phenomenon effects on money demand in Cambodia with the fluctuation of exchange rate. Specifically, as mentioned above, in a situation where people can hold foreign currency, the depreciation of domestic currency may be captured as an increase in wealth, leading to a rise in the demand for domestic money balance. However, the depreciation can also lead to the decrease in the demand of domestic money through the phenomenon of currency substitution. These two effects can neutralize the effect of exchange rate fluctuation on domestic money demand, leading to the statistical insignificance of the estimated coefficient of exchange rate. This can be the case for Cambodia where people can widely purchase or sell domestic currency against foreign currency and the use of foreign currency for transaction purpose and wealth accumulation is widespread.

To confirm the stability of the estimated model, we also conduct the CUSUM and CUSUMSQ of recursive residuals tests. Figures 1 and 2 illustrate the plots of CUSUM and CUSUMSQ of recursive residuals, respectively. Although Figure 2 shows a transitory deviation of the plot of CUSUMSQ of recursive residuals, both plots of CUSUM and CUSUMSQ of recursive residuals are roughly within the five percent criteria bands. These results indicate that the estimated model is stable over the sample period.

4 Conclusion

Due to the importance of information on the structure of the money demand function for monetary policy, it has been investigated extensively in both developed and developing countries. To make a significant contribution to the literature, this paper estimates the money demand function in Cambodia using the autoregressive distributed lag approach to cointegration and stability tests of cumulative sum and cumulative sum of squares of recursive residuals.

The estimation results indicate that there exists a cointegration or long-run relationship among the variables considered in the money demand function in Cambodia. Moreover, the stability tests support the stability of the estimated model. From the long-run estimation results, the estimated coefficients of real income and inflation are statistically significant and are positive and negative, respectively. The estimated coefficient of the exchange rate is negative but not statistically significant. This may be due to the mixed currents of both currency substitution and wealth effects in long-run for the case of Cambodia. A more detailed investigation on this should be a subject for future study. It is also important to note that, due to data limitations, the sample size in this study is quite small. As a result, the finding results should be interpreted with caution; however, this study does provide essential information on the structure of the money demand function in Cambodia and can serve as the basis for further investigation.

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Table 1: Descriptive statistics

Variables	Observations	Mean	Maximum	Minimum	Std. Dev.
$\ln \frac{M1}{P}$	24	7.0726	7.4270	6.6447	0.2252
$\ln y$	24	8.7011	8.9879	8.4079	0.1799
π	24	0.0140	0.0546	-0.0180	0.0185
$\ln E$	24	8.3003	8.3319	8.2681	0.0185

Source: Author's calculation based on data from International Financial Statistics published by the International Monetary Fund.

Table 2: Unit root test

	ADF-test				PP-test			
	Level		**First Difference**		**Level**		**First Difference**	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend
$\ln \frac{M1}{P}$	-1.5149	-4.1445**	-6.6155***	-6.7957***	-1.6348	-4.7525***	-7.5635***	-8.4950***
$\ln y$	-0.8220	-6.3363***	-8.7299***	-8.5348***	0.2820	-6.0046***	-9.3287***	-8.3360***
π	-3.8897***	-5.1248***	-5.7683***	-5.7746***	-3.3508**	-6.5091***	-10.1197***	-10.4844***
$\ln E$	-2.0262	1.0894	-1.6895	-6.6454***	-2.3625	0.8189	-3.6859**	-5.0520***

Note: 1. Null hypothesis: non-stationary
2. The asterisks *** and ** indicate the rejection of null hypothesis at 1% and 5% of levels of significance, respectively.

Source: Author's estimation based on data from International Financial Statistics published by the International Monetary Fund.

Table 3: F-statistics of bound test

Lag order	**1**	**2**	**3**
F-statistics for Equation (4)	3.2412^{a}	0.417	1.1721
Critical value	5% significance level		
Lower bound	3.219		
Upper bound	4.378		

Note: "*a*" indicates the value between the lower and upper bounds of the critical values.
Source: Author's estimation based on data from International Financial Statistics published by the International Monetary Fund.

Table 4: Error correction representation for the selected autoregressive distributed lag model (dependent variable: $\Delta \ln \frac{M1}{P}$)

Variable	ARDL(1,0,0,0)	
	Coefficient	Standard error
$\Delta \ln y_t$	0.6592***	0.1399
$\Delta \pi_t$	-1.0378***	0.3531
$\Delta \ln E_t$	-0.9254	0.5780
Constant	5.1645	4.4797
EC_{t-1}	-0.4503***	0.1171
SE of regression:	0.0271	
$\overline{R}^2$	0.6386	
DW statistic:	1.7061	
Diagnostic tests		
Serial correlation test:	$\chi^2_{SC} = 5.4936$ [0.240]	
Functional form test:	$\chi^2_{FF} = 0.6055$ [0.436]	
Normality test:	$\chi^2_{N} = 0.4535$ [0.797]	
Heteroscedasticity test:	$\chi^2_{H} = 0.8510$ [0.356]	

$$EC = \ln \frac{M1}{P} - 1.4638 \ln y + 2.3046\pi + 2.0550 \ln E - 11.4684$$

Note: 1. The asterisk *** indicates the 1% level of significance.
2. The number in the brackets is the p-value.

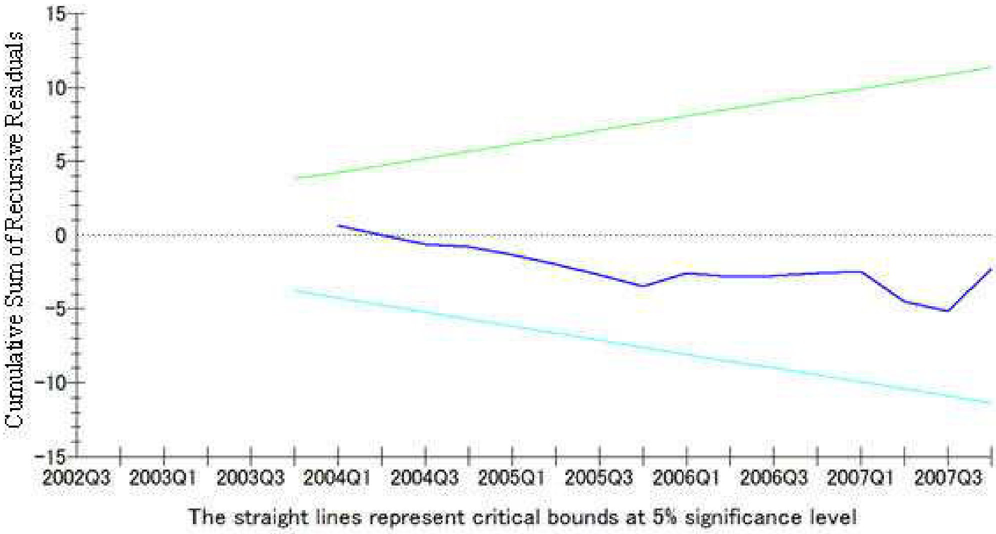
Source: Author's estimation based on data from International Financial Statistics published by the International Monetary Fund.

Table 5: Long-run estimation results (dependent variable: $\ln \frac{M1}{P}$)

Variable	ARDL(1,0,0,0)	
	Coefficient	Standard error
$\ln y_t$	1.4638***	0.1620
π_t	-2.3046*	1.1390
$\ln E_t$	-2.0550	1.4475
Constant	11.4684	10.9149

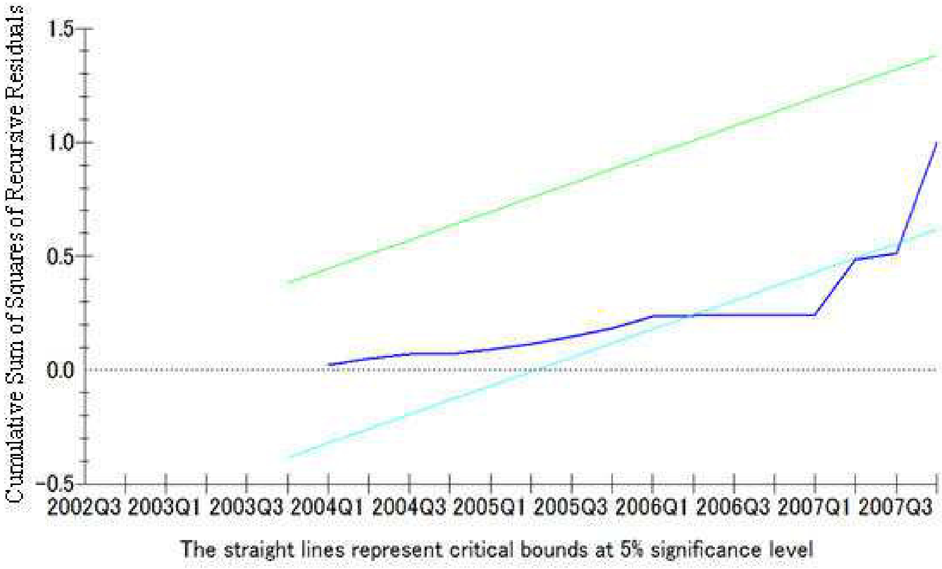
Note: The asterisks *** and * are 1% and 10% of levels of significance, respectively.
Source: Author's estimation based on data from International Financial Statistics published by the International Monetary Fund.

Figure 1: Plot of the cumulative sum of the recursive residuals



Source: Author's estimation based on data from International Financial Statistics published by the International Monetary Fund.

Figure 2: Plot of cumulative sum of squares of recursive residuals



Source: Author's estimation based on data from International Financial Statistics published by the International Monetary Fund.