Estimating Money Demand Function in Cambodia: ARDL Approach

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Abstract

This paper empirically estimates the money demand function in Cambodia. We adopt the money demand model that includes exchange rate. For the analysis, Autoregressive Distributed Lag (ARDL) approach to cointegration is employed. Our results indicate that there is cointegration among variables in money demand function. CUSUM and CUSUMSQ tests roughly support the stability of estimated model. However, in the long-run, even the sign of estimated coefficient of exchange rate support the currency substitution phenomenon in Cambodia, it fails t-test. This may be due to the mix of both currency substitution and wealth effects in the long-run.

Keywords: Money Demand, M1, Cambodia, Currency Substitution

JEL classifications: C32; E41

1 Introduction

One of the most popular research interests in Macroeconomics is the empirical research on the money demand function because the information on

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its structure is very useful for policy makers in designing effective monetary policy. Due to this importance, many studies on money demand function in both developed and developing countries have been conducted in the past.[1]

Despite the fact that there is a great deal of studies on money demand function in both developed and developing countries, to our knowledge, no published research has been reported yet on this subject for Cambodia. This paper aims to fill this gap in the literature by providing another empirical study on the case of a developing country in Southeast Asia, namely Cambodia. In this study, the long-run demand for money in Cambodia is estimated using the recent econometric technique developed by Pesaran *et al.* (1996, 2001), known as Autoregression Distributed Lag (ARDL) approach to cointegration.

As in many other transition countries, during the transitional period of economic reforms toward the market-oriented system in the end of 1980s and early 1990s, Cambodia experienced high inflation and unstable exchange rates. After nearly two decades since the adoption of market-oriented economic system, over the last few years, Cambodia has achieved good performance of economic growth, and the development of its financial sector is also remarkable with the plan of establishment of its first ever stock exchange market in 2009.

The study on money demand function in Cambodia is of interest for several reasons. First, although there are remarkable changes in both financial sector and economy as a whole, the research on Cambodian economy is very scarce. Taking the money demand as the case, as mentioned above, no published study has been reported yet so far. Thus, there is a need to fill this gap in the literature. Second, it is widely known that, the currency substitution phenomenon may cause the instability of money demand function. This affects the effectiveness of monetary policy. As found in some studies such as Zamaróczy and Sa (2002), Kang (2005) and Samreth (2008), there is evidence that Cambodia is experiencing the currency substitution phenomenon. In such a circumstance, to examine the money demand function in Cambodia is very important for policy makers.

The structure of this paper is organized as follows. In section 2, the model of money demand function is reviewed. Section 3 presents the estimation

[1]For the cases of developed countries, see for examples, Arango and Nadiri (1981), McNown and Wallace (1992), Hoffman *et al.* (1995) and Bohl (2000). For developing countries, see for examples, Weliwita and Ekanayake (1998), Arize *et al.* (1999), Oomes and Ohnsorge (2005) and Bahmani-Oskooee and Tanku (2006).

methodology, data, sample, and results; section 4 is the conclusion.

2 Estimation Model

In macroeconomic literature, it is common to assume that the demand for money depends on scale variable and the opportunity cost of holding it. The scale variable is usually defined as the real income or the real consumption expenditure, whereas the opportunity cost variable is usually considered as the interest rate on alternative asset. The general specification of money demand function is assumed to take the following functional form.

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

where M is the demand of money balances; P is the price level; y is the real income level which represents the scale variable; x is the opportunity cost variable. The variable, representing the opportunity cost, is usually considered as interest rate on alternative asset. However, when dealing with the case of developing countries whose financial sectors are not well developed, researchers often use the inflation rate as the proxy for the interest rate variable.[2] Moreover, taking the currency substitution phenomenon into account, many studies on the demand for money in developing countries often include exchange rate variable in money demand function. This inclusion of exchange rate variable in the standard function of money demand is first suggested by Mundell (1963). For recent empirical studies on this kind of money demand function, see, for example, Bahmani-Oskooee (1996), Bahmani-Oskooee and Techaratanachai (2001), Bahmani-Oskooee and Tanku (2006), Akinlo (2006) and Budina *et al.* (2006). Some studies such as Zamaróczy and Sa (2002), Kang (2005) and Samreth (2008) provide information and empirical evidence on the currency substitution phenomenon in Cambodia. Taking this into account, the money demand function becomes:

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

where π and E are respectively the inflation and nominal exchange rates. The exchange rate, here, is defined as the amount of domestic currency per unit of

[2] See, for example, Bahmani-Oskooee (1996), Bahmani-Oskooee and Tanku (2006) and Budina *et al.* (2006).

foreign currency. Therefore, the increase (decrease) of E is interpreted as the depreciation (appreciation) of domestic currency against foreign currency. The estimation equation takes the following form.

$$\text{Ln}\frac{M_t}{P_t} = b_0 + b_1\text{Ln}y_t + b_2\pi_t + b_3\text{Ln}E_t + \varepsilon_t, \tag{3}$$

where ε represents the error term. Based on the conventional economic theory, the income elasticity coefficient, b_1, is expected to be positive; the coefficient of inflation, b_2, is expected to be negative. For the elasticity coefficient on the exchange rate variable (b_3), it can be either positive or negative (Arango and Nadiri, 1981). If the increase in exchange rate (depreciation) is perceived as the increase in wealth and leads to the rise of domestic money, the coefficient of exchange rate is positive. But, if the increase in exchange rate leads to the decrease in domestic money demand (currency substitution), then the coefficient of exchange rate is negative.

Additionally, here, the dummy variable representing the effect of political upheaval in Cambodia during 1997-1998 is included in equation (3). Therefor, we obtain the estimation equation below.

$$\text{Ln}\frac{M_t}{P_t} = b_0 + b_1\text{Ln}y_t + b_2\pi_t + b_3\text{Ln}E_t + b_4 DU_t + \varepsilon_t, \tag{4}$$

where $DU_t = 1$ for the period of 1997:07-1998-06 and $DU_t = 0$ elsewhere.

3 Estimation Methodology, Sample, Data and Results

3.1 Estimation Methodology

There are various techniques for conducting the cointegration analysis on money demand function. The popular approaches are: the well-known residual-based approach proposed by Engle and Granger (1987) and the maximum likelihood-based approach proposed by Johansen and Julius (1990) and Johansen (1992). When there are more than two I(1) variables in the system, the maximum likelihood approach of Johansen and Julius has the advantage over residual-based approach of Engle and Granger; however, both of the approaches require that the variables have the same order of integration.[3] This requirement often causes difficulty to the researchers when the system contains the variables with different orders of integration. To overcome this problem, Pesaran *et al.* (1996, 2001) proposed a new approach known as Autoregressive Distributed Lag (ARDL) for cointegration test that does not require the classification of variables into I(0) or I(1). Therefore, adopting the ARDL approach for cointegration test, we do not need to conduct the unit root test, which is prerequisite for residual-based and maximum likelihood-based approach. For these advantages, ARDL approach has gained popularity over recent years and its adoption for empirical analysis on money demand can be found in many published works.

For the reasons above, in this paper, we also adopt ARDL approach to cointegration technique as the methodology for our empirical analysis on money demand function in Cambodia. The specified money demand function of equation (4) can be written as unrestricted error correction version of ARDL model below.

$$\begin{aligned}\Delta \mathrm{Ln}\frac{M_t}{P_t} &= \alpha + \sum_{i=1}^{n}\varphi_i \Delta \mathrm{Ln}\frac{M_{t-i}}{P_{t-i}} + \sum_{i=1}^{n}\beta_i \Delta \mathrm{Ln} y_{t-i} + \sum_{i=1}^{n}\gamma_i \Delta \pi_{t-i} \\ &\quad + \sum_{i=1}^{n}\mu_i \Delta \mathrm{Ln} E_{t-i} + \lambda_1 \mathrm{Ln}\frac{M_{t-1}}{P_{t-1}} + \lambda_2 \mathrm{Ln} y_{t-1} \\ &\quad + \lambda_3 \pi_{t-1} + \lambda_4 \mathrm{Ln} E_{t-1} + \lambda_5 DU_t + \mu_t \end{aligned} \tag{5}$$

As stated in Pesaran and Pesaran (1997, p. 304), the ARDL procedure contains two steps. First, the existence of the long-run relation between the variables in the system is tested. In other words, the null hypothesis of no cointegration or no long-run relationship defined by $H_0: \ \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ is tested against its alternative $H_1: \ \lambda_1 \neq 0, \ \lambda_2 \neq 0, \ \lambda_3 \neq 0, \ \lambda_4 \neq 0$ by computing the F-statistics. The distribution of this F-statistics is non-standard irrespective of whether the variables in the system are I(0) or I(1). The critical values of the F-statistics in this test are available in Pesaran and Pesaran (1997) and Pesaran *et al.* (2001). They provide two sets of critical values in which one set is computed with the assumption that all the variables

[3] I(1) and I(0) represent the integration process of order 1 and 0 respectively. Pesaran and Pesaran (1997, p. 291) explains that the residual-based cointegration are inefficient and can lead to contradictory results, especially when there are more than two I(1) variables under consideration.

in the ARDL model are I(1), and another with the assumption that they are I(0). For each application, the two sets provide the bands covering all the possible classifications of the variables into I(0) or I(1), or even fractionally integrated ones. If the computed F-statistics is higher than the appropriate upper bound of the critical value, the null hypothesis of no cointegration is rejected; if it is below the appropriate lower bound, the null hypothesis cannot be rejected, and if it lies within the lower and upper bounds, the result is inconclusive.

When the results of F-statistics in the first step support the evidence of the existence of cointegration between variables, we move to the second step of ARDL approach. In this step, the lag orders of the variables are chosen using Akaike Information Criteria (AIC) or Schwarz Bayesian Criteria (SBC). The step of selecting the lag orders of variables is very important because the appropriate lag selection enables us to identify the true dynamics of the models. To check the performance of the estimated model, we also present the diagnostic tests associated with the model that examine the serial correlation, functional form and heteroscedasticity. Additionally, in this paper the stability tests, namely, CUSUM (Cumulative Sum) and CUSUMSQ (CUSUM of Squares) of recursive residuals, are also conducted. These tests are originally proposed by Brown *et al.* (1975).

3.2 Estimation Sample and Data

We use monthly data from International Financial Statistics (IFS) published by IMF for our analysis. The sample period is from 1994:12 to 2006:12. This sample period is chosen due to the availability of the data of all variables in the model. Based on the database of IFS published by IMF, the continuity of the data of all variables can be obtained only from 1994:12. Thus the period before 1994:12 cannot be considered for our analysis. The demand of money balances are proxied by the monetary aggregate, M1, which consists of Cambodian Riel in circulation outside banks and Riel-denominated demand deposits in banking system. Due to the fact that time and saving deposits in Cambodia are mostly in foreign currency, M2, which is the sum of M1 and time and saving deposits, is not considered for the study of money demand function here. The seasonally adjusted data of M1 are available from IFS. These data are converted into real balances by using Consumer Price Index (CPI).

The major obstacle for the case of Cambodia is how to choose the scale variable. When dealing with the estimation of money demand function, real income (real GDP) is often considered as the scale variable, and in many studies monthly Manufacturing Production index (MPI) or Industrial Production Index (IPI) is used as its proxy. However, for the case of Cambodia, both of the data series are not available. To overcome this, we adopt the method of *quadratic interpolation* to generate the annual data of real GDP into its monthly value. This method is often used by many researchers for empirical studies of money demand function in developing countries (*e.g.*, Darrat and Al-Mutawaa (1996), Weliwita and Ekanayake (1998) and Chaisrisawatsuk *et al.* (2004) and so forth.). The nominal exchange rate (period average) data are defined as the amount of Cambodian Riel per unit of US dollar.

3.3 Estimation Results

First, we present the results of the F-statistics to justify the existence of the cointegration or long-run relationship among variables in the system. Table 1 provides the results of the F-statistics according to various lag orders.

Table 1: F-statistics of Bound Tests, 10% CV [2.425, 3.574], 5% CV [2.850, 4.049], 1% CV [3.817,5.122]

Lag order	1	2	3	4	5
F-statistics	1.1635	1.0952	2.2476	3.9380**	7.0547***
Lag order	6	7	8	9	10
F-statistics	7.0025***	5.9799***	3.1159	2.7918	1.3720

Note: The asterisks *** and ** are respectively the 1% and 5% of the significant level.

As we can see from the results of Table 1, even not all, some of the values of F-statistics are above the upper bounds of the critical values (CV) of standard significant levels provided by Pesaran and Pesaran (1997). These values support the existence of cointegration or long-run relationship between variables in the equation. However, the results in this stage should be considered as preliminary.

In the second step, we estimate equation (5) and use SBC to justify the lag orders of each variable in the system. The maximum lag order is set to 6. Note that, with this maximum lag order, the adjusted sample period for analysis becomes 1995:06 to 2006:12. This setting also helps us save the degree of freedom, as our available sample period for analysis is quite small. Using Microfit 4.0, based on SBC, ARDL(1,0,0,0) is obtained. These results are summarized in Table 2. The diagnostic tests of the short-run model are also provided in the table.[4]

Table 2: Autoregressive Distributed Lag Estimation Results (Dependent Variable: $\text{Ln}\,(M1/P)$)

Variable	SBC-based ARDL(1,0,0,0)
$\text{Ln}\,(M1/P)_{t-1}$	0.9500 (0.0280)***
$\text{Ln}y_t$	0.0875 (0.0421)**
π_t	-0.9949 (0.1556)***
$\text{Ln}E_t$	-0.0381 (0.0194)*
DU_t	0.0114 (0.0077)
Constant	-0.7556 (0.4238)*
$\bar{R}^2$	0.9968
DW-statistics	1.8457
SE of Regression	0.02273
Diagnostic tests	Serial Correlation: F(12, 121)=1.2096 [0.284] Functional Form: F(1, 132)=2.7424 [0.100] Heteroscedasticity: F(1, 137)=7.6481 [0.006]

Note: 1. *, **, and *** are respectively the 10%, 5%, and 1% of the significant level.
2. The numbers in parentheses are standard deviations.
3. The numbers in the brackets are p-values of the tests.

Table 2 indicates that the overall goodness of fits of the estimated equations are very high with the result $\bar{R}^2 = 0.9968$. From the diagnostic tests, we can see that the model passes two of three tests, serial correlation and functional form. Given the fact that the variables in the estimation model have different lag orders, it is not surprising that the model fails heteroscedasticity test.

In Table 3, we provide the results of error correction representations of estimated ARDL model. From the table, it is clear that the error correction

[4] It is worth noting that ARDL (1,0,0,0) is consistent with the conventional Partial Adjustment Model (PAM) of money demand function proposed by Chow (1966) and Goldfeld (1973). Thus, the estimation results, here, can also be interpreted as the PAM approach results.

term (EC_{t-1}) has the right sign (negative) and is statistically significant. This result provides the evidence of cointegration among variables in the model. Specifically, the estimated value of EC_{t-1} is -0.049. The absolute value of the coefficient of EC_{t-1} is very small, indicating the very low speed of adjustment to equilibrium following short-run shocks; only about 5% of the disequilibrium, caused by previous period shocks, converges back to the long-run equilibrium.

Table 3: The Error Correction Representation for the Selected ARDL model (Dependent Variable: $\text{Ln}\,(M1/P)$)

Variable	SBC-based ARDL(1,0,0,0)
$\Delta\text{Ln}y_t$	0.0875 (0.0421)***
$\Delta\pi_t$	-0.9949 (0.1556)***
$\Delta\text{Ln}E_t$	-0.0381 (0.0194)*
$\Delta\text{Ln}DU_t$	0.0114 (0.0077)
ΔConstant	-0.7556 (0.4238)*
$\text{EC}_{\text{t}-1}$	-0.0499 (0.0280)*
$\bar{R}^2$	0.2368

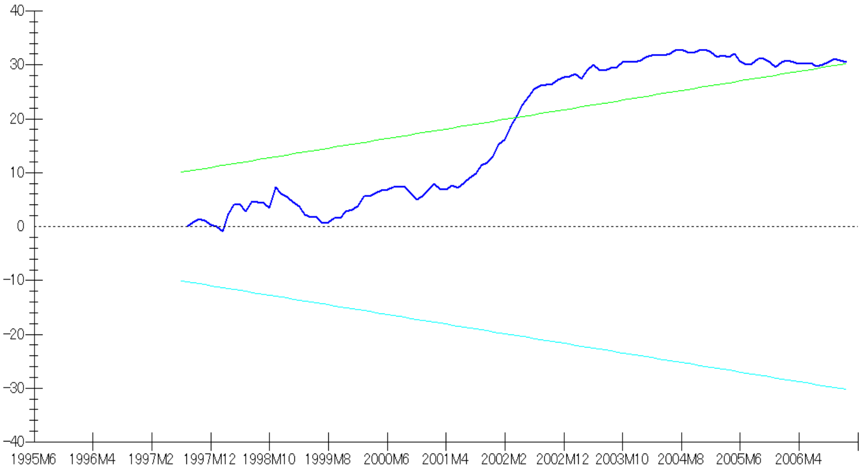
$$EC_{t-1} = \text{Ln}\left(\frac{M_1}{P}\right)_{t-1} - 1.753\text{Lny}_{t-1} + 19.917\pi_{t-1} + 0.764\text{Lny}_{t-1} - 0.229DU_{t-1} + 15.126C$$

Note: 1. *, **, and *** are respectively the 10%, 5%, and 1% of the significant level.
2. The numbers in parentheses are standard deviations.

To confirm the stability of the estimated model, the tests of CUSUM and CUSUMSQ are employed in this study. Figure 1 and 2 respectively provide the graphs of CUSUM and CUSUMSQ tests. Figure 1 indicates that the plot of CUSUM is not completely stable within 5% of critical bands; however, the deviation seems to be transitory as there is sign that the plot of CUSUM is returning back toward the criteria bands. Figure 2 is also the evidence confirming that the deviation is just transitory; the plot of CUSUMSQ statistic returns completely back to inside the criteria bands. Thus, judging from this, we can argue that the estimated model is roughly stable.

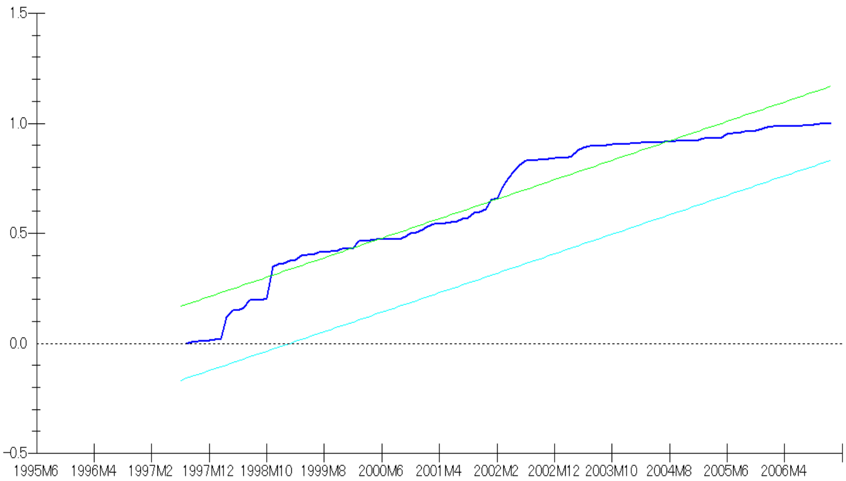
The results of long-run representations of our analysis are presented in Table 4. They indicate that the signs of the estimated coefficients of Lny and $\boldsymbol{\pi}$ are respectively positive and negative as expected. The negative sign of exchange

Figure 1: Plot of Cumulative Sum of Recursive Residuals (CUSUM)



The straight lines represent critical bounds at 5% significance level

Figure 2: Plot of Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ)



The straight lines represent critical bounds at 5% significance level

Table 4: Long-Run Estimation Results (Dependent Variable: Ln $(M1/P)$)

Variable	SBC-based ARDL(1,0,0,0)
Lny_t	1.7533 (0.2942)***
π_t	-19.9173 (11.8955)*
LnE_t	-0.7642 (0.5650)
DU_t	0.2294 (0.1978)
Constant	-15.1266 (4.7365)***

Note: 1. *, **, and *** are respectively the 10%, 5%, and 1% of the significant level.
2. The numbers in parentheses are standard deviations.

rate's estimated coefficient suggests the phenomenon of currency substitution in Cambodia.

Regarding the dummy variable, DU_t, which represents the political turmoil in Cambodia, the estimation results indicate that it has no impact on money demand function as its coefficients are not statistically significant in both cases of short-run (Table 3) and long-run (Table 4).[5]

4 Conclusion

The information on the structure of money demand function is very important for policy makers in designing effective monetary policy. Due to this importance, many studies on money demand function in both developed and developing countries have been conducted. Although there have been a large number of empirical studies on money demand functions, none exists for the case of Cambodia. To fill this literature gap, in this paper, the money demand function in Cambodia is estimated using the recent cointegration technique developed by Pesaran *et al.* (1996, 2001).

Our result, the estimated coefficient of error correction term, indicates that there is cointegration among variables in money demand function. The results also reveal that the estimated elasticity coefficients of real income and inflation are respectively positive and negative as expected. For exchange rate, we obtain the results of negative coefficients which support the

[5]We also conduct analysis of the estimation model without dummy variable. The results of estimated coefficients of Lny, π and LnE are very similar to the current reported results. However, the estimated model without dummy variable fails the functional form test.

currency substitution symptom in Cambodia. Moreover, to confirm the stability of the model, in this paper, CUSUM and CUSUMSQ tests are also conducted with the results that the estimated model is roughly stable. However, it is worth noting that, in long-run, even the coefficient of exchange rate has negative sign, supporting the currency substitution phenomenon in Cambodia, it fails t-test for the standard significant level. This may be due to the mixed currents of both currency substitution and wealth effect in long-run for the case of Cambodia. This is worth further study.

Finally, it is important to bear in mind that, due to the limitation of the data availability, the finding results in this paper should be considered as preliminary and should be interpreted with caution. When the data are more available, more analysis need to be re-conducted. Nevertheless, we believe that this paper will shed some lights or provide an empirical basis for further study on money demand in Cambodia.

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