ESSAYS ON STRUCTURAL BREAKS AND STABILITY OF THE MONEY DEMAND FUNCTION

by

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B.S., King Saud University, Riyadh, 2000
M.A., Ohio University, Athens, 2006

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

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Abstract

This dissertation consists of three chapters. The first chapter surveys recent studies on the stability of the money demand function in selected developing countries. This chapter presents specific details about modeling and estimating the money demand function. Also, reasons behind the mixed results in the literature on the stability of the money demand function are explored as well as providing a guideline for future research on the stability of the money demand function in developing countries.

The second chapter empirically investigates the stability of the money demand function in South Korea and Malaysia. The conventional money demand specification and cointegration framework with a single unknown structural break are conducted. The results of the residual-based tests for cointegration reveal that the M1, M2, and M3 demand are stable in the long run in Malaysia. However, there is no evidence of the stability for all three measures of the money demand in South Korea. The results of the residual-based tests suggest that structural breaks in the cointegration vectors are important and need to be accounted for in the specification of the M1, M2, and LF demand in South Korea, where LF includes M2 in addition to the reserves of nonbanking financial institutions and long-term deposits.

The third chapter complements the previous chapter. It aims to evaluate the stability of the money demand function in South Korea and Malaysia using a cash in advance model and cointegration framework with one unknown structural break. This theoretical model adds short-term foreign interest rates and real exchange rates in addition to short-term domestic interest rates and real income. Also, the Granger causality and currency substitution analysis are conducted in this chapter. The results of the residuals-based tests indicate that the M2 and LF demand in South Korea, and M1, M2, and M3 demand in Malaysia are stable in the long run.

The structural breaks may not be fairly absorbed when a cash in advance model is used for M1 in South Korea. Thus, the residual-based tests suggest that the structural break is still important and needs to be included in the specification of the M1 demand in South Korea.

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Dedication

I dedicate this work to my mother, wife, and children: Hton, Rakan, and Ryan. Their intangible contribution to my research have made this possible.

Chapter 1 - The Money Demand: Theories and Evidence

1.1 Introduction

The relationship between money demand and its determinants is a crucial concern for policymakers, since it allows policymakers to formulate an appropriate monetary policy and increase the level of accuracy in targeting money growth. The issue of the stability of the money demand function in the long run has received extensive attention in the past. However, mixed results are found in the literature. Some studies indicate that money demand is unstable, while others claim it is stable. For instance, Goldfeld (1976) claims that the money demand is unstable in the US during the 1970s; and Stock and Watson (1993) claim that M1 money demand in the US is unstable when post-war data are used. However, when the sample period of Stock and Watson is extended to 1996 by Ball (2001), the results show stability of M1 demand. Ericsson, Hendry, and Prestwich (1998) show that the M2 demand in the UK is stable for the period of 1878 to 1975 despite the two world wars. However, when they evaluate M2 demand on data spanning only 1976 to 1993, they find that M2 demand is unstable. They indicate that the model performs better in the sample period 1878 to 1975 than the 1976 to 1993 period. Thus, they conclude that M2 demand in the UK is unstable over the period 1976 to 1993.

Furthermore, Choi and Jung (2009) find that M1 demand in the US, as it is narrowly defined, is unstable for the period 1959Q1 to 2000Q4. When they estimate the unknown structural break points in the money demand function and test to see if the long run relationship exists in each sub-sample period of the structural break points, they find evidence of stability within each sub-sample but not for the full sample. On the other hand, some studies claim that money demand is stable and that a long run relationship exists between the money balances and their determinants. Orden and Fisher (1993) find evidence of a long run relationship between M3 money demand and its determinants in New Zealand. Moreover, Ericsson and Sharma (1998) find that the M3 money demand is stable in both the long run and the short run in Greece.

Some studies attribute the instability of the money demand function to structural changes arising from innovations in the financial sector and financial deregulation (Boucher and Lippert (1996); Ericsson, Hendry, and Prestwich (1998); Cho and Miles (2007); Pradhan and Subramanian (2002); and Chio and Jung (2009)). In addition, Haug and Lucas (1996) show that the stability of the money demand function depends on the type of cointegration tests used and the combination of money and interest rates. Furthermore, the data frequency can play an important role when testing for stability (Gregory and Hansen (1996)). Cheong (2001) infers that the instability of the money demand function could be caused by misspecification in dynamic models, error correction models, that omit important lags.

The purpose of this study is to provide reference points for the stability of the money demand function in developing countries during the 2000s. Thus, this chapter can be helpful to future research on the relationship between the money demand and its determinants. The motivation for writing this chapter is that most of the survey papers on the stability of the money demand function cover the period before 2000 (Goldfeld and Sichel (1990); Laidler (1993); and Sriram (2001)). Therefore, this chapter reviews more recent studies on the money demand function. This chapter presents specific information about theories of the money demand, specification of the money demand, techniques used, the sample period, the frequency of the data, and the long run income elasticities. This information will provide a concise synopsis of recent studies that can be used with future research on the stability of the money demand function and help policymakers to choose an appropriate monetary policy.

The chapter is organized in the following manner. Section 2 discusses the specification of the money demand function, theories of the money demand are presented in Section 3, and Section 4 discusses the current literature. Finally, section 5 provides the conclusion.

1.2 Money Demand Function Specification

The general specification of the money demand function can be written in the following form:

$$(M/P) = f\text{ (scale variable, opportunity cost variables)} \qquad (1.1)$$

where M is the nominal monetary aggregate, P is the price level. Sriram (2001) indicates that economic theory does not suggest a specific form for the money demand function. However, Zarembka (1968) indicates that there is a general consensus that Equation (1) can take the log-linear form, and other studies suggest a non-linear specification to be the most appropriate model (Pradhan and Subramanian (2002); Chen and Wu (2005); and Austin et al. (2007)) since the non-linear models provide a better fit than linear models, and linear models may not be appropriate in the presence of the structural breaks.

As there is a general consensus on forms for the money demand function, most of the recent studies use either the log-linear or the semi-linear models, and a few studies use non-linear models (Austin et al. (2007) and Miteza (2009)). In empirical studies, both the real money balances and the scale variable are in logarithms, while nominal interest rates variables are in linear form. Accordingly, the coefficient on the scale variable is interpreted as the income elasticity, and the coefficient on the opportunity cost variable is interpreted as semi-elasticity. The choice of the opportunity cost variable is crucial especially when examining the stationarity of the money demand in the short run (Ball (2002)). However, Hoffman et al. (1995) show that the choice of the opportunity cost variable is not critical when evaluating the stationarity of the money demand function in the long run.

1.3 Theoretical Models

1.3.1 Quantity Theory

The quantity theory is presented by classical economists and hypothesizes that there is a direct and proportional relationship between the quantity of money and the price level. This relationship was developed by two classical economists, Fisher and Pigou.

1.3.1.1 Fisher Equation of Exchange

The Fisher equation of exchange can be written as

$$M\ V = P\ T, \tag{1.2}$$

where M is the quantity of money, V is the transactions velocity of money, P is the price level, and T is the number of transactions. Money is neutral and only can be used to facilitate transactions. Thus, Fisher emphasizes only one of the functions of money, the medium of exchange function.

Since it is hard to measure the number of transactions, T, economists use income (output) , y, instead of the number of transactions (Mankiw p. 83). Thus, the quantity equation can be written as

$$M\ V = P\ y. \tag{1.3}$$

V is now the income velocity of money, rather than the transactions velocity. Fisher assumes that the velocity of money is constant in the short run because the velocity is affected by institutions that change slowly over time. Also, he assumes that total output is constant in the short run, as the flexibility of prices and wages causes the output to be at the full employment level. Under these assumptions, Equation (3) shows that a change in the quantity of money, M, leads to an equal percentage change in the price level, P. Fisher believes that interest rates do not affect money demand in the short run.

1.3.1.2 The Cambridge Approach

The Cambridge approach is attributed to two Cambridge economists, Alfred Marshall and A. C. Pigou. They focused on two of the functions of money. Money serves as a medium of exchange, and individuals use it to facilitate transactions. Accordingly, they agreed with Fisher's view that the money demand is proportional to nominal income. Also, they emphasize that money functions as a store of wealth. Therefore, they suggest that the demand for money is affected by wealth. When wealth increases, people tend to store it by holding assets, and money is considered to be one of these assets. Marshall and Pigou assume that nominal wealth is proportional to nominal income and that the wealth component of the demand for money is proportional to nominal income. Thus, the money demand is proportional to nominal income. According to their view, the money demand can be written as

$$M = k\,P\,y, \tag{1.4}$$

where k is a constant that represents how much money individuals want to hold for every dollar of income. Equation (4) states that the quantity of nominal money balances is proportional to nominal income. What distinguishes the Cambridge approach from the Fisher equation of exchange is that Cambridge approach allowed k to fluctuate in the short run, meaning that velocity is not constant in the short run. This is due to the second function of money, store of wealth, since decisions about storing wealth in money depend on yields and expected returns on other assets. Thus, the Cambridge economists believe that both interest rates and nominal income affect money demand.

1.3.2 Keynesian Theory

Keynesians assume that there are three motives for holding money. First, they agreed with Fisher and the Cambridge economists that money is a medium of exchange. Thus, money is held to facilitate transactions; this is called the transaction motive. The expected relationship between income and money demand is positive because an increase in income and expenditures requires people to hold more money. Keynesians' second motive for holding money is the precautionary motive, which shows that people hold money for unexpected events. The precautionary motive depends on the expected amount of transactions that people want to make in the future. Therefore, the relationship between precautionary money demand and income is positive. The third Keynesian motive is the speculative motive or liquidity preference; this motive emphasizes that money functions as a store of wealth. Keynesians believe that people can store wealth in either money or bonds. Money can be less attractive than bonds, when interest rates are high. However, when interest rates are low, money is considered to be more attractive than bonds. In essence, when interest rates are high, people expect that interest rates would fall in the future so that bond prices would increase. When interest rates are low, people expect that interest rates would increase in the future and bond prices would decrease. Accordingly, there is an inverse relationship between money demand and interest rates. The money demand function under the Keynesian theory can be written as

$$(M/P) = f\,(y, i), \tag{1.5}$$

where (M/P) is real money balances, and i is interest rate. What distinguishes Keynesians thought from Fisher's is that both interest rates and income play an important role in determining money demand. Thus, velocity is not constant in the short run and fluctuates with interest rates. High interest rates reduce speculative money demand and thus increase velocity.

1.3.3 Inventory Theory (The Baumol-Tobin Model)

Building on Keynes' theory, William Baumol (1952) and James Tobin (1956) independently recognized that the choice of when and how often to exchange bonds for money is an important choice for individuals. They argued that the benefit of holding money is convenience and that the cost is the interest income foregone by holding money rather than holding interest-yielding assets. They assume that each exchange of interest bearing bonds for money involves a brokerage fee or transaction cost. Thus, larger money balances may decrease the transaction costs, but this would increase the interest income foregone. The individual aims to minimize the brokerage fee and the interest income foregone. This can be expressed by the following well-known square root formula

$$(M/P) = \tfrac{1}{2}\sqrt{(2by)/i} \qquad (1.6)$$

where b is the brokerage fee. Equation (6) suggests that the demand for real money balances is proportional to the square root of real income (y) and inversely proportional to the square root of the interest rate (i). There would be no demand for money when the brokerage costs are zero. Therefore, transaction costs play an important role in determining the money demand. The money demand emerges from a tradeoff between interest earnings and transaction costs. In addition, what distinguishes the Baumol-Tobin model from the quantity theory is that the Baumol-Tobin model implies economies of scale in the money demand and a non-zero interest elasticity[1]. This difference between the Baumol-Tobin model and the classical quantity theory of money led Karl Brunner and Allan Meltzer (1967) to reformulate the Baumol-Tobin model. Brunner and Meltzer show that for large values of real income, y, or small values of transaction

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[1] According to the Baumol-Tobin model, the economies of scale can be defined as a rise in real spending leads to a less than proportionate increase in real money balances (The coefficient of the real income equals to 0.5).

costs, b, there will be no economies of scale in the use of money. In the Brunner-Meltzer view, the Baumol-Tobin model is not considered to be an alternative to the classical quantity theory but implies it. However, Baumol-Tobin would disagree on the basis that changes in interest rates initiated by changes in the money supply, would invalidate the strict quantity theory outcome.

1.3.4 Friedman's Theory

Milton Friedman believed that money demand is a function of wealth and expected returns on other assets relative to the expected return on money. Thus, the specification of the money demand function can be written as

$$(M/P) = f\,(y_p,\ i_s^e - i_m,\ i_b^e - i_m,\ \pi^e - i_m), \tag{1.7}$$

where y_p is the permanent income; i_s^e is the expected returns on stocks; i_m is the expected returns on money; i_b^e is the expected returns on bonds; and π^e is the expected inflation rate.

The expected relationship between permanent income and the demand for money is positive. According to this theory, permanent income is considered to be the long run average of both current and expected future income. Therefore, changes in permanent income will not be the source of instability of the money demand. The expected relationship between the money demand and the expected return on bonds, stocks, and goods relative to the return on money is negative. When the return on bonds, stocks, and goods relative to the return on money increases, the quantity of money demanded decreases. Friedman assumed that the expected return on money, i_m, depends on the interest payments on checkable deposits and services provided by banks on deposits. Unlike Keynesian theory, Friedman believed that changes in interest rates have little or no effect on the money demand. Thus, the money demand is stable and insensitive to changes in interest rates.

1.3.5 Cash in Advance Model

According to Hueng (1998), a cash in advance model has three advantages. First, it provides a broad specification of the money demand function, since it adds more variables as determinants for money demand.

Second, it explicitly models the liquidity services provided by money through the agent's budget constraint instead of the utility function. The rationale is that it is the service that provides utility to agents rather than money itself.

Finally, it allows researchers to determine the effect of the interest rate on money demand using comparative statics.

Hueng (1998) believes that the money demand function can be expressed as

$$(M/P) = f\,(y, y^*, i, i^*, q), \tag{1.8}$$

where y denotes the domestic output and y* denotes the foreign output. The variables i and i^* refer to the domestic and foreign interest rates, respectively, and q denotes real exchange rates. The relationship between the money demand and income is expected to be positive, indicating that an increase in income increases the demand for money. The expected relationship between the domestic interest rate and money demand is negative because an increase in the domestic interest rate increases the opportunity cost of holding money. On the other hand, the expected relationship between foreign interest rates and the money demand is positive, indicating that an increase in foreign interest rates decreases the opportunity cost of holding money. The effect of the real exchange rate is indeterminate. Thus, the relationship between money demand and the real exchange rate can be positive or negative.

1.4 Current Literature

Most of the studies on the stability of the money demand function provide mixed results. This section highlights current studies with a focus on the techniques selected, frequency of the data, measures of the money demand, scale variable, opportunity cost variables, and findings. Focusing on these specific details may lead to a clear answer about the reasons behind these mixed results.

Table A.1 in appendix A summarizes the reviewed literature on the stability of the money demand in selected developing countries. Specifically, Table A.1 provides information about the measures of money, frequency of the data, determinants of the money demand, unit root and cointegration tests, stability tests, long run income elasticity, and the main findings. This information summary may help researchers to have a better idea about how to model and estimate the money demand function in developing countries. For instance, some of the studies use the inflation rate instead of the domestic interest rates as a proxy for opportunity cost, while others use both. Domestic interest rates are controlled by the government and heavily administered in developing countries. Moreover, administrative nominal interest rates in most of developing countries are not adjusted for changes in inflation. Thus, the real interest rates become negative. As a result, they are not reliable (Hossain and Chowdhury (1996); Austin et al. (2007); Baharumshah et al. (2009); and Darrat and Al-Sowaidi (2009)). Based on the determinants of the money demand, we can conclude that most of the studies on the stability of the money demand function do not depend on theoretical models. Consequently, the studies may get mixed results.

Most of the recent studies conduct both cointegration and stability tests to examine the issue of the stability of the money demand. It is worth noting that most of these studies deal with structural breaks exogenously by adding dummy variables to the model; however, a few studies use cointegration tests that take into account these structural breaks (Pradhan and Subramanian (2002); Ramachandran (2004); and Lee and Chien (2008)).

Using data for India, Pradhan and Subramanian (2002) study the stability of the money demand function in India using monthly data covering the 1970:04-2000:03 period. They use two cointegration techniques to investigate the stability of the money demand function in the long run. However, they find mixed results. The Johansen test reveals that both M1 and M3 are cointegrated with their determinants, industrial production, nominal long run interest rates, real exchange rate, foreign interest rates, and the price level. Yet, Gregory and Hansen (1996) show that only M1 is cointegrated with its determinants. They conclude that structural breaks are important and need to be accounted for in the specification of money demand using a non-linear specification.

A study by Ramachandran (2004) establishes a stable demand for M3 in India in the long run during the 1951-2001 period using annual data. Stability and cointegration tests are conducted. To examine the stability of the parameters, the author estimates the real money demand function and the results of the recursive residuals, one-step and N-step forecast tests indicate that the money demand was unstable during the 1978-1980 period. Also, the results of CUSUM test show that the demand for M3 was unstable during the 1991-1995 period, coinciding with the reform period in India. The results of Johansen and Juselius (1990) and Gregory and Hansen (1996) are consistent with what Pradhan and Subramanian (2002) found in their paper, even though they use a different specification of the money demand. Ramachandran (2004) defines the specification of the money demand such that the nominal money demand is a function of real income and the price level. The results of Johansen and Juselius (1990) reveal that there is more than one cointegration vector. However, the results of Gregory and Hansen

(1996) show that the null hypothesis of no cointegration can not be rejected. The author mentions that the instability of M3 is transitory since it is caused by the structural breaks that occurred during the 1978-1980 period and found by both the stability and Gregory and Hansen (1996) tests. Thus, the demand for M3 is stable in the long run in India.

Austin et al. (2007) investigate the stability of the money demand function over the 1987-2004 period in China using quarterly data. They use different specifications of the money demand function. First, the linear form of the money demand M0 is tested by Johansen (1991) and the results show that there is at most one cointegration relationship between the real M0 and its determinants, real GDP and inflation rate. Next, the STR model (Smooth Transition Regression) is used as a non-linear model and estimated by conditional maximum likelihood[2]. The results confirm that the money demand M0 is stable in China. Finally, Austin et al. test the parameter constancy using the auxiliary regression equation. The test results are consistent with the previous findings and reveal stability of the money demand function in China.

Another study by Baharumshah et al. (2009) focuses on the stability of the money demand function in China over the 1990Q4-2007Q2 period using quarterly data. They conduct the autoregressive distributed lag model (ARDL) cointegration procedure proposed by Pesaran et al. (2001) in addition to Hansen (1992) and CUSUM and CUSUMSQ stability tests. Baharumshah et al. stress the importance of the specification of the money demand function. The authors identify the money demand function as a linear model examining the long run relationship between the real M2 demand and its determinants, real GDP, short-term domestic and foreign interest rates, and stock prices. They believe that the inclusion of the stock prices in the model would improve the specification of the money demand function in China. This

[2] The authors conduct a form of the Newton-Raphson algorithm to estimate the non-linear model (The STR).

research deals with foreign interest rates as a substitution for the exchange rate. Thus, the impact of the foreign interest rate is expected to be negative[3]. Moreover, the inflation rate, instead of the domestic interest rate, is used as a measure of the opportunity cost of holding money. Before including stock prices in the model, the results of Pesaran et al. (2001) cointegration tests show that the variables in the M2 model are cointegrated, while the results of the CUSUM and CUSUMSQ tests show that the parameters of the M2 money demand function are unstable. However, after including stock prices in the model, the results of the cointegration and stability tests become consistent and indicate that M2 demand is stable in China.

Lee and Chien (2008) also evaluate the stability of M1 and M2 demand in China using annual data covering the 1977-2002 period. Two different cointegration techniques are used, Johansen (1988) and Gregory and Hansen (1996). The results from the Johansen test suggest that there is one cointegrating vector, implying that a long run relationship exists between M1 and M2 demand and their determinants, real GNP and nominal short run interest rate. However, the results of the Gregory and Hansen test indicate that only M2 demand is stable, while M1 demand is not. They mention that the results of the Gregory and Hansen (1996) test suggest that a structural break is important in the cointegration vector and needs to be included in the specification of the money demand function. Accordingly, the authors indicate that the specification of the money demand, which envelopes unstable economic and financial crises and reforms, raises important questions about the relationship between the money demand and its determinants in the long run. The authors attribute the inconsistent results of their paper and

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[3] The cash in advance model expects the sign on the foreign interest rates to be positive which indicates that an increase in the foreign interest rate decreases the opportunity cost of holding money.

previous studies to the specifications of the money demand function, the length of the data, and the econometric techniques used.

Zuo and Park (2011) analyze the stability of the real M2 demand for the sample period 1996Q1 to 2009Q1 using quarterly data in China. They estimate four versions of the money demand models. First, the real M2 demand is assumed to be determined by real GDP, the interest rate, and stock prices, the Benchmark model. Second, the real M2 demand is determined by real industrial value added (IVA), the interest rate, and stock prices. The third model assumes that the real M2 demand is determined by the real GDP (IVA), expected inflation, and stock prices. In the final model, the real M2 demand is determined by real GDP (IVA) and the expected inflation (interest) rate. Zuo and Park find a long run relationship between M2 demand and its determinants for all four models when the smooth time-varying cointegrating approach is used. To take into account the gradual structural breaks, they allow the parameters to evolve smoothly during the time horizon. They find that the income elasticities are around 0.6 - 0.75 which are inconsistent with the result of Baharumshah et al. (2009) (Table A.1).

Using Indonesian quarterly data for M2 demand over the period 1983Q1 through 2000Q4, James (2005) finds evidence of a long run relationship between real M2 demand and its determinants, real GDP, nominal short run domestic and foreign interest rates, and a time trend[4]. Also, two impulse dummy variables are added to the model to capture the structural breaks that may have occurred in 1990Q4 and 1998Q2. The Pesaran et al. (2001) cointegration test and CUSUM and CUSUMSQ tests are conducted. The author emphasized that the stability of the money demand function could not be found without taking into account the financial liberalization in the specification of the money demand. Narayan (2007) utilizes both the

[4] The time trend is used as a proxy for financial liberalization.

Johansen (1988) cointegration test and Hansen (1992) parameter instability test to investigate the stability of the money demand function in Indonesia. Narayan uses annual data that covers the 1970 to 2005 period. The results from the Johansen cointegration test show that there is evidence of a long run relationship between real M1, M2 demand, and their determinants, which are real GDP, nominal short term domestic and foreign interest rates, and real exchange rates. However, the results from the Hansen test show that both real M1 and M2 demand are unstable. The author concludes that both M1 and M2 demand are unstable in Indonesia.

Sriram (2002) analyzes both the long run and the short run demand for M2 in Malaysia. Monthly data that cover the 1973:08 to 1995:12 period are used to examine the long run relationship between real M2 demand and its determinants, including the industrial production index, own-rate (returns on money), the discount rate (returns on other assets), and the inflation rate. The Johansen (1988) and Johansen and Juselius (1990) cointegration tests are conducted. The structural breaks are treated exogenously by adding two dummy variables to the model. The first dummy refers to the structural break that may have occurred in 1994:01 when the Malaysian government introduced a temporary set of control measures to reduce excess liquidity from the banking system. The second dummy denotes the interest rate regime[5]. The results of trace and maximum eigenvalue tests indicate that there is at least one cointegration vector. In addition, the short run relationship is tested by using an error correction model (ECM). The model is estimated using ordinary least square method, and the results show that M2 demand is stable in the short run. For robustness, the author evaluates the parameter constancy. Therefore, three stability tests are performed to evaluate the stability of the M2 money demand in the long run

[5] According to Sriram (2002), the second dummy has a value of zero for 1973:08-1978:09 and 1985:10-1987:01 to indicate the periods of the presence of market controls and a value of one for 1978:10-1985:09 and 1987:02-1995:12 to denote the liberal regime.

and the short run. The results indicate that the money demand function is unstable in both the long run and the short run due to the structural changes.

Nair et al. (2008) utilize an autoregressive distributed lag model (ARDL) to test the stability of the money demand function in Malaysia. They use annual data for the period 1970 to 2004 for real M1, M2, M3 demand, and their determinants, which include real GDP and interest rates. The results show that all three measures of money have a long run relationship with their determinants. However, the income elasticities are inconsistent with quantity theory of money for all three measures, since they are not approximately one (Table A.1). Furthermore, Nair et al. find that the interest rates are positively related with M2 and M3 demand, which is inconsistent with theoretical expectations. Moreover, this research also uses the Gregory and Hansen test to investigate whether the stability of the money demand is affected by the Asian financial crisis. However, instead of determining the structural break endogenously, the authors pre-selected the structural break of 1997, which is the date of the Asian financial crisis. The results of the Gregory and Hansen test indicate that there is no long run relationship between the demand for M1, M2, and M3, and their determinants.

In 2009, Manap also studies the stability of the money demand function in Malaysia. He uses quarterly data from 1977Q1 to 2009Q4. The Johansen (1988) and Johansen and Juselius (1992) tests are conducted. The results are consistent with Nair et al. (2008) and posit that there is at least one cointegration vector in the M1 and M2 series. Thus, there is a long run relationship between M1 and M2 demand and their determinants, which include real GDP and short term interest rates. Manap believes that the evidence of cointegration does not necessarily suggest a stable money demand function over time. Therefore, the Hansen parameter instability test is applied. The findings show that M1 demand is stable, while M2 demand is not. The author attributes the instability of M2 to the existence of a structural break caused by the Asian financial crisis.

Hwang (2002) uses quarterly data from 1973Q1 to 1997Q2 to evaluate the stability of the money demand function in South Korea using Johansen (1988) and Johansen and Juselius (1990) cointegration techniques. M1 and M2 are used as proxies for the money demand, while the real GDP is used as a scale variable. For the opportunity cost, the author tries two types of interest rates, short term and long term interest rates. The results show that both real demand for M1 and M2 are unstable when the short term interest rates are used as the opportunity cost. However, when the long term interest rates are used, the results reveal that both real demand for M1 and M2 are cointegrated with their determinants. For the M1 demand model, the income elasticity of -19.35 is implausible, because it is negative and greater than unity in absolute value. The normalized equation with M2 demand as the dependent variable shows the expected signs and significant coefficients. In addition, the error correction model is used to examine the short run relationship between M1 and M2 demand and their determinants, real GDP and long term interest rates. The results indicate that the M1 model is unstable in the short run. However, the results of the CUSUM test indicate that M1 and M2 demand are stable.

Cheong (2003) evaluates the money demand function in South Korea using quarterly data for the period from 1972Q3 to 1997Q7. Using the Johansen (1988) test, Cheong tests the long run relationship between real M2 demand and the determinants of real GDP, a 1-year time deposit rate, a 3-year corporate bond rate, and the inflation rate. The results show that there is only one cointegrating vector in the system. The income elasticity of 1.28 is greater than unity, meaning that the M2 demand in South Korea responds more than proportionally to real income and that there are no economies of scale[6]. Furthermore, the relationship between M2 demand and its determinants is investigated using an error correction model (ECM) equivalent to a fifth-order autoregressive distributed lag (ADL) model. In the ECM, seasonal dummies are included with real income and interest rates. This model is recursively estimated by one-step residuals with two standard error bands and Chow tests to evaluate the parameter constancy, and the results indicate that the M2 demand is stable. For robustness, two dummy variables are added to the ECM. The first dummy variable is created to capture the period of the financial deregulation in 1981, and the second dummy is created to capture the effect of the massive reduction in regulated banks' interest rates in 1982. The Chow test is applied, and the results reveal that both dummies are statistically insignificant at the 5% level. Accordingly, these structural breaks do not affect the stability of the money demand, M2, in South Korea.

In 2007, Cho and Miles examine the impact of the financial innovation on the stability of the money demand function in South Korea. This study uses quarterly data that covers the sample period from 1976Q4 to 1998Q3. A Johansen (1988) cointegration test is conducted. To account for financial innovation, the authors add a linear trend to the conventional money demand specification. The results suggest that there is a long run relationship between the real demand for M2 and the determinants that include real GDP, nominal long term interest rate, and the time trend. Thus, the results imply that monetary targeting could be an option in monetary policy choices.

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[6] Baharumshah et al. (2009) indicate that if the income elasticity equals 1, the finding is consistent with the quantity theory of money. If the income elasticity equals 0.5, the finding is consistent with the Baumol-Tobin inventory theory. Finally, if the income elasticity is greater than 1, money can be considered a luxury good or as a sign of neglecting the effect of wealth in the model specification.

Two recent studies examined the M2 demand function in Nigeria. Anorou (2002) investigates the stability of M2 demand and its determinants, industrial production and short term real interest rates. This study covers the sample period in Nigeria from 1986Q2 to 2000Q1. Anorou finds evidence of a long run relationship between real M2 demand and its determinants using the Johansen and Juselius (1990) cointegration test. To investigate parameter constancy, three tests are conducted, including Hansen (1992), Hansen (1991), and CUSUM and CUSUMSQ. The results of all three tests indicate that M2 demand is stable. Chukwu et al. (2010) reevaluate the stability of M2 demand in Nigeria using quarterly data covering the period from 1986Q1 to 2006Q4. They conduct Gregory and Hansen (1996) tests to evaluate the long run relationship between real M2 demand and its determinants, including real economic activity, interest rates swap spread, and inflation rate. The results reveal that M2 demand is stable in the long run. Also, the stability of M2 demand in the short run is examined using the ECM, and the results show that M2 demand is stable in the short run. The results are consistent with Anorou (2002).

Shu Wu et al. (2005) examine the stability of the money demand function in Taiwan. The paper covers the period from 1978Q1 to 1999Q4. The authors focus on the specification of the money demand. Different models are used to test the stability of the money demand function. First, a Goldfeld-type of money demand function is estimated using the Beach and Mackinnons (1978) maximum likelihood estimation method[7]. The results of the rolling estimation show that

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[7] $M_t = \alpha_0 + \alpha_1 M_{t-1} + \beta_0 y + \beta_1 i + \epsilon_t$. where M_t denotes the current money demand, and M_{t-1} denotes the first lag of the dependent variable. This model is known as the Goldfeld (1973) short run money demand function. According to this model, the money demand is a function of the first lag of the money (the dependent variable), income and interest rates.

M1B demand is unstable[8]. Next, the authors add another explanatory variable to the model, real stock market transactions, yet the results remain unchanged. However, the ARMAX model, a statistics-oriented approach, and the Johansen maximum likelihood estimation method are conducted. The results from both approaches reveal that M1B demand is stable in Taiwan. The authors note that including a constant term in a model with a lagged dependent regressor can produce results that indicate an unstable money demand function.

Using annual data of five developing countries, Bangladesh, India, Pakistan, Srilanka, and Nepal, for M2 demand over the 1974-2002 period, Narayan et al. (2008) finds evidence of cointegration between M2 demand and its determinants, which include real GDP, nominal short term domestic and foreign interest rates, and real exchange rates. The authors treat the structural breaks endogenously by applying Westerlund (2006) panel cointegration tests. The results of a Hansen (1992) test reveal that the money demand function is stable for all the countries except Nepal. Darrat and Al-Sowaidi (2009) utilize the Johansen and Juselius (1990) cointegration test and Hansen and Johansen (1993) parameter constancy test to evaluate the stability of the money demand in Bahrain, the United Arab Emirates (UAE), and Qatar. The study uses annual data covering the period from 1973 to 2005. To control for structural breaks that might be caused by financial developments, dummy variables are added to the money demand specification. In all three countries, the results of the Johansen and Juselius test indicate that there is a long run relationship between real M1 and M2 demand and the determinants that are real GDP, foreign interest rates, and expected inflation rate. The results of the Hansen and Johansen test reveal that both real M1 and M2 demand are stable in Bahrain; this is consistent with the results of the

[8] M1B is the average of three end of the month monthly money supply amounts.

cointegration test. However, the results also show that only real demand for M2 in the UAE and real demand for M1 in Qatar are stable.

Hossain (2010) uses Bangladesh annual data for the broad money balances over the 1973-2008 period to evaluate the stability of the money demand function. The author applies two different tests, Johansen and Juselius (1990) cointegration test and Hansen and Johansen (1993) constancy test. The results of the cointegration test show that the long run relationship exists between real broad money balances and its determinants, real GDP, nominal foreign and domestic interest rates, and nominal effective exchange rate[9]. However, the constancy test shows mixed results; the results of the Hansen and Johansen test reveal that the broad money demand function is unstable, especially during the early 1990s. The author attributes this instability to financial deregulation and financial innovations. However, the results of Hansen and Johansen test turned out to be the opposite and indicate that the money demand function is stable during the early 2000s.

Kumar (2011) examines the stability of the money demand in 20 developing countries; those include South Africa, Cameroon, Jamaica, Rwanda, Kenya, Ethiopia, Egypt, Nigeria, India, Indonesia, Thailand, China, Philippines, South Korea, Taiwan, Bangladesh, Sri Lanka, Nepal, Malaysia and Singapore. Kumar treats the structural breaks exogenously, choosing 1989 and 1995 as the break dates, since the financial reforms were introduced by most of the developing countries in the late 80s and some during the 90s. According to these break dates, the sample is divided into four sub-samples: 1975-1988, 1989-2005, 1975-1994, and 1995-2005. The error correction method is applied to each sub-sample. The results reveal that M1 demand is stable in all 20 developing countries. Both the income elasticity and the interest rate semi-

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[9] The broad money balances is defined as the stock of broad money BM plus millions of taka.

elasticity are plausible for all countries, since the income elasticity is around unity and the interest rate semi-elasticity has the expected sign and is statistically significant.

In the most recent studies on the stability of the money demand function in Africa, Dagher and Kovanen (2011) examine the stability of the money demand function in Ghana in both the long run and the short run. The Pesaran et al. (2001) cointegration test and CUSUM and CUSUMSQ parameter stability tests are used. The results of the cointegration and the parameter instability tests are consistent with each other and indicate that M2 demand is stable in both the long run and the short run.

From the above discussion, we can conclude that there are several reasons that contribute to the mixed results on the stability of the money demand function. First, the interpretation of the results can be confusing and conflicting. For example, both Sriram (2002) and Manap (2009) analyze the stability of the money demand function in Malaysia. The results of the cointegration tests suggest that there is a long run relationship between M2 demand and its determinants. However, the results of the parameter stability tests indicate that M2 demand is unstable. Manap (2009) points out that the cointegration between M2 demand and its determinants does not necessarily imply that M2 demand is stable. Hence, Manap (2009) concludes that M2 demand is unstable, while Sriram (2002) indicates that M2 demand is stable in the long run. Also, Narayan (2007) conducts both cointegration and stability tests. The results of the cointegration test suggest that there is a long run relationship between M2 demand and its determinants, while the results of the parameter constancy test indicate that M2 demand is unstable. Hence, he concludes that M2 demand is unstable in Indonesia.

Another reason for the mixed results is the specification of the money demand function. For instance, James (2005) and Narayan (2007) examine the stability of the money demand function in Indonesia using different parameter stability tests. James utilizes CUSUM and CUSUMSQ, while Narayan uses Hansen (1992) test. The results of CUSUM and CUSUMSQ suggest that M2 demand is stable, while the results of Hansen test indicate that M2 demand is unstable. These inconsistent results might be due to the specification of the money demand function, since both papers use different specifications of the demand for M2.

Finally, the choice of the opportunity cost and structural breaks are important. Hoffman et al. (1995) indicate that the choice of an interest rate is not critical when evaluating the money demand in the long run. However, Hwang (2002) could not find stability of M1 and M2 demand when the short term interest rate is used as a proxy for the opportunity cost in South Korea. Structural breaks also influence results. Some studies put more weight on the results from the parameter stability tests while these tests do not account for structural breaks[10].

1.5 Conclusion

This chapter provides a useful reference for future research on the stability of the money demand function in developing countries. In addition, it includes a discussion of reasonable explanations for the mixed results of the stability of the money demand function. Most of the research reviews on the money demand function cover periods before 2000s, yet this review focuses on the most recent studies on the money demand function. In fact, this chapter goes on to present various theories of the money demand. This information might help future researchers to choose the appropriate theory when formulating their empirical models of the money demand.

[10] Breuer and Lippert (1996) point out that most of the parameter stability tests centered on whether the coefficient estimates are stable over time without taken into account the structural breaks.

The specific information about the frequency of the data, methodology used, stability tests, unit root tests, cointegration approaches, income elasticity, and the main findings of the various studies is included here and will be helpful to researchers for a quick comparison of the literature. For instance, the researchers will be able to compare their work and methods using this specific information. Thus, this chapter can be considered as a guide to future research on the stability of the money demand function in developing countries.

Chapter 2 - Endogenous Structural Breaks and Stability of the Money Demand Function in a Closed Economy: The Case of South Korea and Malaysia

2.1 Introduction

In the past decades, interest in whether the money demand function is stable has received extensive attention. Different econometric techniques have been applied to investigate the behavior of the money demand in both the long run and short run. There are many studies on the stability of the money demand function in the literature, and most of these studies show mixed results. Wolff (1987) attributes money demand instabilities to financial innovations. Lippert and Breuer (1996) conclude that instability of the money demand function is due to structural breaks. They indicate that studies that do not account for the structural breaks can lead to biased results and deduce that the money demand function is unstable. It is important to have a stable money demand function, because it has vital implications on monetary policy. In fact, a stable money demand is useful for explaining and forecasting the behavior of interest rates, exchange rates and GDP. Poole (1970) shows that instability of the money demand can prevent policymakers from implementing the appropriate policy and lower the level of accuracy of targeting money growth. If a stable money demand increases the ability of policymakers to prevent money market disequilibrium, then it is worth investigating the stability of the money demand function using different techniques such as a cointegration framework that accounts for structural breaks.

The purpose of this research is to examine the stability of the money demand function using the narrow definition of the money supply, M1, and the two broad definitions of the money supply M2 and M3 (LF). This study examines demand for M1, M2, and M3 (LF) in two of the Asian tiger countries, South Korea and Malaysia, and uses both Johansen and Juselius (1990) and Gregory and Hansen (1996) cointegration tests. The Gregory and Hansen cointegration test incorporates structural breaks. Therefore, this test allows one to empirically investigate the stationarity of the money demand functions after allowing for a one time structural break in the relationship among the three dependent money demand variables, nominal short-term interest rates, and real income.

The motivation for examining the stability of the money demand functions in South Korea and Malaysia is that most studies in the literature that examine the stability of money demand focus on developed countries, and little attention has been paid to developing countries[11]. Also, South Korea and Malaysia are two of the Asian countries that experienced a severe economic crisis known as the Asian financial crisis that occurred in July 1997. This crisis likely created a structural break, and the Gregory and Hansen (1996) residual-based test can take this into account when testing for stability of the money demand function. Perron (1989) indicates that the presence of structural breaks in a series can lead to misleading results and negatively affect the properties of the stationary series.

There is no clear answer whether South Korea is considered to be a developed or developing country; in fact, there are mixed classifications of South Korea. According to the World Trade Organization (WTO), South Korea is considered to be one of the developing countries. However, there is no specific definition of the term developed or developing countries in the World Trade Organization. The countries which are members of the WTO declare for themselves if they are developed or developing countries (www.wto.org). Recently, South Korea is treated as a developing country in the literature (Kumar (2011)). In contrast, the International Monetary Fund classifies South Korea as one of the developed countries. This classification is

[11] See Deutsche Bundesbank (1995); Haug and Lucas (1996); and Choi and Jung (2009).

based on the GDP as valued by purchasing power parity (PPP), the population, and the total exports of goods and services.

This chapter is organized in ten sections. Section 2 briefly discusses the Asian financial crisis; section 3 reviews relevant literature. The theoretical framework of the money demand function is discussed in section 4. Section 5 includes a discussion of the unit root tests, and section 6 explains the cointegration methodologies of both Johansen and Juselius and Gregory and Hansen tests. The model and data are presented in section 7. Section 8 briefly reviews Chow, CUSUM and CUSUMSQ, Andrews (1993), and Andrews and Ploberger (1994) tests. Sections 9 and 10 present the empirical results and the conclusions, respectively.

2.2 The Asian Financial Crisis

South Korea was hit harder by the Asian financial crisis than Malaysia. During 1994-1996, the Korean government allowed Korean banks and firms to borrow from foreign investors to invest in Korean assets. The cumulative foreign supply of capital was at its highest level, $108 billion. Most of the foreign debt was invested in long run foreign assets instead of short run Korean assets. GDP growth fell from eight percent in the period 1994-1996 to six percent over the first three quarters of 1997 and plummeted to 3.9 percent in the last quarter of 1997. In the first quarter of 1998, GDP growth fell to negative four percent and continued falling until the third quarter. Most of this drop occurred in the manufacturing sector, which is weighted heavier than all sectors in GDP. In 1997, a large number of leveraged conglomerates went into bankruptcy and caused severe damage to South Korean financial institutions. Chandrasekhar and Ghosh (1999) indicate that the Korean government dealt with the crisis by adopting a tight monetary policy, so the call rate was increased from 12.5 percent on the first of December to 30 percent on December 24, 1997. The purpose of this policy was to attract foreign investors back to the economy. Also the Korean government adopted a fiscal contraction policy to deal with this crisis. When these two contraction policies failed to correct the economy, the South Korean government adopted a combination of both stimulative fiscal and monetary policy, but these adjustments were too late to prevent the collapse of the GDP. In 1997, corporate bankruptcies were the main reason behind the sharp increase in the non-performing credit of the South Korean banking system

Ping and Yean (2007) indicate that Malaysia was not as badly affected by the Asian financial crisis as South Korea, even though the crisis started with the Malaysian currency. The value of the Malaysian ringgit started to fluctuate rapidly; in June 1997, the value of the ringgit was 2.52 USD and then dropped to 3.20 USD in September 1997. The depreciation of the ringgit continued and reached a new low level of 4.5 USD in January 1998. The Malaysian stock market was negatively affected by the depreciation of the ringgit against the US dollar. Malaysian enterprises were affected by the decline in both the stock market and the currency. These enterprises were unable to pay the interest on loans, so this put a lot of pressure on bank liquidity. As a result, there was a sharp decline in the economy; it went from a 7.3% growth rate in 1997 to -7.4% in 1998. Unlike South Korea, Malaysia formed a National Economic Action Council (NEAC) to deal with this crisis and did not rely on the IMF. The NEAC made some good decisions that led to the recovery of the Malaysian economy. The growth rate of the economy changed from -7.4% in 1998 to 6.1% in 1999, and this increased growth continued afterward.

2.3 Literature Review

In the literature, there are several empirical studies on the stability of the money demand function. These studies use different econometric techniques to empirically investigate the stability of the long and short run relationship between the money demand and its determinants. This section provides a brief review some of the recent studies on the stability of the money demand function in South Korea and Malaysia. The studies selected are divided into two groups. The first group includes studies on the stability of the money demand function in South Korea (Hwang (2002); Bahmani-Oskooee (2002); Cheong (2003); Cho and Miles (2007); Miteza (2009); Kumar (2011)). The other group focuses on the stability of the money demand function in Malaysia (Sriram (2002); Tang (2007); Nair et al. (2008); Tang (2009); Manap (2009); Kumar (2011)). Table B.1 in appendix B summarizes these recent empirical studies.

Hwang (2002) conducts the Johansen (1988) and Johansen and Juselius (1990) cointegration tests and CUSUM parameter constancy test to examine the stability of the M1 and M2 demand functions in South Korea using quarterly data from the period 1973Q1 to 1997Q2. Two different measures of the opportunity cost are applied, long term and short term interest rates. When the short term interest rate was used as a proxy for the opportunity cost, the results show that there is no cointegrating relationship between the M1 and M2 demand and their determinants, real income and short term interest rates. However, when the long term interest rate was used as a proxy for the opportunity cost, the results indicate the existence of a long run relationship between M1 and M2 demand and their determinants, real income and long term interest rates. The results of the error correction model (ECM) show that only M2 demand is stable in both the long run and the short run. On the other hand, the CUSUM test shows that M1 and M2 demand are stable. The author suggests that using the long term interest rates as a measure for the opportunity cost is much better than using the short term interest rates in the case of South Korea.

Another study by Bahmani-Oskooee (2002) analyzes the stability of the M1, M2, and M3 demand functions in South Korea. The results of Johansen and Juselius (1990) test show that there is no evidence of a long run relationship between M1 and M3 demand and their determinants, real GDP, long term interest rates, nominal effective exchange rate. However, the results of the cointegration test indicate that the demand for M2 is cointegrated with its determinants, but the results of the stability test, CUSUMSQ, reveal that M2 demand is unstable. Accordingly, the author puts more weight on the results of the stability test rather than the cointegration test and concludes that M2 demand is unstable. The paper provides evidence of instability of the M1, M2, and M3 demand functions in South Korea.

Using South Korean quarterly data, Cheong (2003) conducts a study to analyze the stability of the M2 demand function in the short and long run. The paper covers the period from 1972Q3 to 1997Q4. Both cointegration and parameter constancy tests are applied, and the results reveal that the M2 demand model is stable in both the short and long run. The structural breaks are treated exogenously by adding two dummy variables to the model.

Cho and Miles (2007) study the stability of the M2 demand function in South Korea over the period from 1976Q4 to 1998Q3 using quarterly data. To account for a structural break, they add a time trend in addition to real GDP and long term interest rates. The cointegration framework is conducted to investigate the stability of the M2 demand model in the long run. The results of the Johansen (1988) test indicate that the M2 demand model is stable in the long run.

Miteza (2009) also empirically investigates the stability of the M2 demand model in the short and long run in South Korea over the period from 1976Q4 to 2006Q4 using quarterly data.

Miteza uses the nonlinear model, the STR, and the error correction model, ECM. The Salkkonuen and Luthepohl (2000a,b,c) cointegration test indicates the existence of a long run relationship between the real M2 money demand and its determinants, real GDP, short term nominal interest rate, and nominal exchange rate. However, when the same cointegration test was applied on the model without the nominal exchange rate, the author could not find a long run relationship between real M2 demand and its determinants, real GDP and short term nominal interest rate. Next, Miteza tests the parameter constancy using CUSUM and CUSUMSQ on the error correction model (ECM). The results of these stability tests confirm the results of the cointegration test, the M2 demand model in South Korea is stable.

In addition, Kumar (2011) examines the stability of the M1 demand model in 20 developing countries (Table B.1), including South Korea and Malaysia. He divides the full sample into four sub-samples based on the dates of two structural breaks. The selection of the dates of the structural breaks is arbitrary. The four sub-samples are 1975-1988, 1989-2005, 1975-1994, and 1995-2005. The single equation time series approach (GETS) and the CUSUM and CUSUMSQ parameter stability tests are conducted. The results of both tests indicate the existence in all countries of a stable short and long run relationship between M1 demand and its determinants, real GDP and nominal short term interest rates.

In short, these studies agree that the M2 demand function is stable in South Korea. However, Miteza (2009) could not find a stable relationship between M2 and its determinants without including the nominal exchange rate in both the nonlinear model and the ECM. Moreover, Hwang (2002) could not find a long run relationship between M1 and M2 demand and their determinants, when short term interest rate was used as a proxy for opportunity cost. In contrast, Kumar's recent study documents the existence of a long run relationship between M1 demand and its determinants when using a short term interest rate as the proxy for opportunity cost.

Other studies analyze the stability of the money demand function in Malaysia. Sriram (2002) utilizes cointegration and parameter stability tests to examine the stability of the M2 demand model in Malaysia using monthly data over the period from 1973:08 to 1995:12. Sriram deals with the structural breaks exogenously by adding two dummy variables to the model. He adds two measures of opportunity cost to the model, nominal interest rates and inflation rate. The results of the cointegration tests and the ECM document stability for the M2 demand model in the long run and the short run. In contrast, the results of the parameter stability tests reveal that M2 demand is unstable in both the long run and the short run. The author attributes the instability to the structural breaks.

Tang (2007) examines the stability of the M2 demand model in five Southeast Asian economies: Malaysia, Singapore, the Philippines, Thailand, and Indonesia. The Autoregressive Distributed lag (ARDL) and the CUSUM and CUSUMSQ tests are conducted to examine the relationship between M2 demand and its determinants, real final consumption expenditure, real expenditure on investment goods, real expenditure on exports, nominal exchange rate, and inflation rate. The results of the ARDL show that the cointegrating relationship between M2 demand and its determinants exists only for Malaysia, the Philippines, and Singapore. On the other hand, the CUSUM and CUSUMSQ results, based on the short term specification, document stability of M2 demand for all the countries, except Indonesia.

Using annual data for the period from 1970 to 2004, Nair et al. (2008) empirically investigate the stability of the M1, M2, and M3 demand functions in Malaysia. Two cointegration techniques are applied, the ARDL and the Gregory and Hansen (1996). The

Gregory and Hansen results indicate that there is no long run relationship between M1, M2, and M3 demand and their determinants, real GDP and domestic interest rates. However, this result may be unreliable, since the authors pre-selected the date of the structural break as 1997 rather than estimating it endogenously. Based on the results of the Gregory and Hansen test, the authors suggest that M1, M2, and M3 demand are not affected by the Asian financial crisis. The paper documents the existence of a long run cointegration for M1, M2, and M3 demand using the ARDL cointegration approach. Accordingly, the paper concludes that M1, M2, and M3 demand functions are stable in the long run.

A study by Tang (2009), covering the period from 1971Q1 to 2007Q3, analyzes the stability of the M2 demand model in Malaysia using quarterly data. Tang conducts the Johansen and Juselius (1990) cointegration test and rolling regression procedure. The Johansen and Juselius cointegration results indicate the existence of a long run relationship between M2 demand and its determinants, real income, inflation rate, and exchange rate. However, the results of the rolling regression procedure reveal that the M2 demand function is unstable due to the structural breaks.

Manap (2009) empirically examines Malaysia's demand for narrow and broad money demand functions, M1 and M2, respectively. The paper covers the period from 1977 to 2009 using quarterly data. Two different approaches are used, cointegration techniques and parameter constancy tests. The Johansen multivariate cointegration results indicate that a long run cointegrating relationship exists between M1 and M2 demand and their determinants, real GDP and nominal short term interest rates. On the other hand, the results of Hansen (1992) show that only demand for M1 is stable, while demand for M2 is unstable. The author attributes the instability of the M2 demand function to the structural breaks. Manap indicates that the M2 demand model was stable before the Asian financial crisis.

2.4 The Theoretical Framework

The theoretical model, traditional specification, of the money demand function can be written as

$$(M/P) = L\ (y, i). \tag{2.1}$$

This equation states that the real money balance, (M/P), is a function of both income, y, and the nominal interest rate, i. As income increases, the demand for real money balance increases. The lower the nominal interest rate the higher the demand for real money balances.

Equation (1) can be rewritten as

$$(M/P) = L\ (y, r + \pi^e), \tag{2.2}$$

where $i = r + \pi^e$ is the Fisher equation or Fisher effect; r is the real interest rate; and π^e is the expected inflation rate.

Equation (2) can be rewritten as

$$(M/P) = \beta_0 + \beta_1\ y + \beta_2\ i + \varepsilon_t, \tag{2.3}$$

The econometric specification, which represents equation (1) can be written as

$$(M/P) = \lambda_0 + \lambda_1\ y + \lambda_2\ i + \varepsilon_t. \tag{2.4}$$

Hossain and Chowdhury (1996) indicate that the nominal interest rate in developing countries does not fully account for the opportunity costs of holding money due to the weaknesses of the financial markets. Moreover, the nominal interest rate in developing countries does not take into account the changes in inflation rate, since it is institutionally determined. Thus, the real interest rate appears to be negative. Some studies in the literature (Bahmani – Oskooee and Tanku (2006)) dealt with this problem by using the inflation rate as a determinant of money demand instead of the nominal interest rate variable, while others (Bahmani – Oskooee and Rhee (1994) and Lee and Chung (1995)) add real exchange rates as well as interest rates as determinants of the money demand.

The expected signs of the coefficients in equation (4) are positive and negative for income elasticity and interest rate semi-elasticity, respectively, e.g., $\lambda_1 > 0$, and $\lambda_2 < 0$. In addition, the properties of the error sequence (ε_t) are an integral part of the theory. If (ε_t) has a stochastic trend, then the deviation from money market equilibrium will not be eliminated (Enders, p 357). The theory assumes that the ε_t sequence is stationary. In essence,

$$\varepsilon_t = m_t - \lambda_0 - \lambda_1 y - \lambda_2 i, \tag{2.5}$$

where m_t is the real money balance. Theoretically, the (ε_t) sequence must be stationary, so the linear combination of integrated variables on the right hand side of equation (5) must be stationary.

2.5 Unit Root Tests

Many studies in the literature use the Augmented Dickey-Fuller (ADF) to test for a unit root, but the ADF test does not allow for structural breaks. Perron (1989) indicates that the results of ADF are more likely to be biased towards not rejecting a unit root. Thus, to account for structural breaks, a dummy variable is introduced to the ADF test. By adding a dummy variable to the ADF test, a structural break is exogenously determined. This is criticized by Zivot and Andrews (1992), since the pre-selection of a structural break could lead to an over rejection of a unit root. In this research, both ADF and Zivot and Andrews, ZA, tests are conducted to test for a unit root for all variables to determine the order of integration.

The ADF test takes the functional form:

$$\Delta y_t = a_0 + \gamma\, y_{t-1} + a_2\, t + \sum \beta_i\, \Delta\, y_{t-i+1} + \varepsilon_t. \tag{2.6}$$

where y is a vector consisting of each of the variables in the model, t is an index of time, Δy_{t-i+1} is the lagged first difference and ε_t is the error term. The ADF tests the null of unit root against the alternative of a trend stationary. Both the null of unit root and the alternative can take the following form: H_0: $\gamma = 0$ vs. H_a: $\gamma < 0$.The Akaike Information Criterion (AIC) is used to choose the appropriate lag length.

The ZA test allows for a one unknown structural break in the series. According to the procedure of Zivot and Andrews, a break point is endogenously determined. Zivot and Andrews use three models to test for a unit root.

Model (A): A mean shift

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \gamma\, DM_t + \sum \rho_i\, \Delta y_{t-j} + \varepsilon_t. \tag{2.7}$$

Model (B): A trend shift

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \theta\, DT_t + \sum \rho_i\, \Delta y_{t-j} + \varepsilon_t. \tag{2.8}$$

Model (C): Both mean and trend shifts

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \theta\, DT_t + \gamma\, DM_t + \sum \rho_i\, \Delta y_{t-j} + \varepsilon_t. \tag{2.9}$$

In equations (7) through (9), DM_t is a dummy variable for a mean shift, and DT_t is a dummy variable for a trend shift. These dummies can be defined as DM_t equals 1 if $t > b$ and 0 if $t \leq b$, while DT_t equals t-k if $t > b$ and 0 if $t \leq b$ where b denotes the time at which the structural break occurs. Equation (7) detects any possible structural break in the mean, and equation (8) detects any structural break in the slope. Equation (9) detects a structural break in both the mean and the slope. The date of a structural break is determined according to the smallest t-statistics.

Perron (1989) indicates that any of the time series can be sufficiently modeled using either model A or model C. Thus, many studies in the literature focus on these two models when testing for a unit root. Sen (2003) mentions that using model A instead of model C can lead to a substantial power loss, if the break occurs in model C. However, if the break occurs in model A when model C is used, then the power loss is minimal. Thus, model C is conducted to test for unit root in this research. The lag length is determined using the Akaike Information Criterion (AIC). Asymptotic distribution of the minimum t-statistics and critical values are provided by Zivot and Andrews (1992).

2.6 Cointegration Tests

2.6.1 Johansen's Multivariate Cointegration Test

Johansen and Juselius (1990) cointegration test is applied to the sample periods 1990:01-2010:12 for South Korea and 1992:02-2011:01 for Malaysia. This method is based on the vector autoregressive, VAR, model, which can be written as follows.

$$\Delta x_t = \delta + \prod x_{t-1} + \sum_{i=1} \Gamma \, \Delta x_{t-i} + \varepsilon_t. \qquad (2.10)$$

In the VAR model, x_t is a vector of non-stationary in-level variables; δ is a constant; $\prod$ is a long run impact matrix, which can be decomposed as $\prod = \alpha \gamma$. In the decomposition, γ is a matrix containing the cointegrating vectors, and α measures the average speed of adjustment. This method recommends two types of tests, the trace and the maximum eigenvalue test statistics, to determine the number of cointegrating vectors.

2.6.2 The Gregory and Hansen Approach

Gregory and Hansen's (1996) method is an extension of the residual-based tests for cointegration that takes into account the possibility of an unknown regime shift in the intercept alone or in both the intercept and coefficient vector. Gregory and Hansen test the null hypothesis that there is no cointegration with a structural break against the alternative hypothesis that there is cointegration with a structural break. Gregory and Hansen indicate that the standard ADF test, when it is used in the cointegration analysis without taking into account one time regime shift, may lead to an incorrect conclusion that there is no long run relationship between the dependent variable and its determinants. With the Gregory and Hansen test, the chance to reject the null of no cointegration is higher.

Gregory and Hansen (GH) propose three models with different assumptions about structural breaks.

Level Shift (GH1):

$$Y_t = \lambda_1 + \lambda_{11} DU_{tb} + \lambda_2 X_t + \varepsilon_t. \tag{2.11}$$

Level Shift with Trend (GH2):

$$Y_t = \lambda_1 + \lambda_{11} DU_{tb} + \delta t + \lambda_2 X_t + \varepsilon_t. \tag{2.12}$$

Regime Shift (GH3):

$$Y_t = \lambda_1 + \lambda_{11} DU_{tb} + \lambda_2 X_t + \lambda_{22} X_t DU_{tb} + \varepsilon_t. \tag{2.13}$$

In these equations, Y_t is the dependent variable, X is the independent variable, λ_1 is the intercept before the structural break, λ_2 is the slope coefficient before the structural break, λ_{11} is the intercept after the structural break, λ_{22} is the slope coefficient after the structural break, and t refers to a time trend. DU_{tb} is a dummy variable that is equal to zero for $t \leq b$ and one for $t > b$, where b denotes the date at which the structural break occurs.

Gregory and Hansen show that the selection of the lag length, K, is chosen on the basis of a t-test following a procedure similar to Perron and Vogelsang (1992). The maximum lag length is set to 12, and then the lag length is reduced by one and tested until the last lag of the first difference included is found to be significant at the 5% level.

The Gregory and Hansen test assumes that the time of the structural break is unknown, so the structural break is endogenously determined. They propose three test statistics: $ADF^* = \inf_{t \in T} ADF(t)$, which is the modified version of the Engel and Granger (1987) cointegration test, and

$Z_t^* = \inf_{t \in T} Z_t(t)$ and $Z_a^* = \inf_{t \in T} Z_a(t)$, which both are modified versions of Phillips and Quliaris (1990).The smallest value of these three test statistics is considered to be the break point. Gregory and Hansen use modified Mackinnon (1991) critical values for their cointegration test, which differ from the critical values used for the Engle and Granger approach. The three models of Gregory and Hansen can be extended to have more than one explanatory variable.

2.7 The Model and Data

This study uses monthly data starting from 1990:01 to 2010:12 for South Korea and 1992:02 to 2011:01 for Malaysia to test if there is cointegration between the money demand and its determinants, real income and interest rates[12]. All data are taken from the International Financial Statistics website. All the monetary aggregates are deflated by the price level, CPI. The money demand specification can be written as

$$m = \lambda_1 + \lambda_2\, y + \lambda_3\, i + \epsilon, \tag{2.14}$$

where m denotes the three definitions of the real money supply M1, M2, and M_3 (LF)[13]. In equation (14), y is the industrial production, and i is the discount rate for South Korea and 3-month Treasury bills for Malaysia. All the variables are in natural logs except nominal interest rates. The three models of Gregory and Hansen can be written as

Level Shift (GH1)

$$m_t = \lambda_1 + \lambda_{11}\, DU_{tb} + \lambda_2\, y_t + \lambda_3\, i_t + \epsilon_t. \tag{2.15}$$

Level Shift with Trend (GH2)

$$m_t = \lambda_1 + \lambda_{11}\, DU_{tb} + \delta\, t + \lambda_2\, y_t + \lambda_3\, i_t + \epsilon_t. \tag{2.16}$$

---

[12] The two digits following the colon indicate the generic month of data, i.e. 01 indicates month 1.

[13] LF includes M2 in addition to the reserves of nonbanking financial institutions and long term deposits.

Regime Shift (GH3)

$$m_t = \lambda_1 + \lambda_{11}\, DU_{tb} + \lambda_2\, y_t + \lambda_{22}\, y_t\, DU_{tb} + \lambda_3\, i_t + \lambda_{33}\, i_t\, DU_{tb} + \epsilon_t. \qquad (2.17)$$

If the results from these three models indicate that there is cointegration between money demand and its determinants, then money demand function in these two countries is considered stable or stationary. However, if the results show that there is no cointegration, then money demand is unstable or non-stationary.

2.8 Testing for Structural Breaks

2.8.1 Chow Test

A Chow test is conducted to test for a structural break. A structural break is pre-selected as the Asian financial crisis that occurred in July 1997. The Chow test splits the data into two parts, pre–break data and post–break data. If the two models are the same, then sum of the squared residuals for the individual models, SSR1 + SSR2, should equal the SSR from the full sample. If these are equal, then it is an indication that there is no structural break in the data generating process (Enders, p 104). Table 2.1 shows the results of Chow test for the South Korea and Malaysia.

Table 2.1 Results of the Chow Test

Country	Variable	Chow test	P-Value	5% CV	H_0: No structural break
South Korea	M1	6.3296	0.0000	2.6413	Reject H_0
	M2	219.96	0.0000	2.6413	Reject H_0
	LF	297.18	0.0000	2.6413	Reject H_0
Malaysia	M1	34.952	0.0000	2.6453	Reject H_0
	M2	5.9876	0.0010	2.6453	Reject H_0
	M3	6.3046	0.0000	2.6453	Reject H_0

The results indicate that there is evidence of structural break in the money demand for both South Korea and Malaysia, since the null hypothesis of no structural break for all types of monetary aggregates is rejected at the 5% significance level.

2.8.2 CUSUM and CUSUMSQ Tests for Parameter Instability

The CUSUM and CUSUMSQ methods of testing parameter instability estimate models recursively. Figures 2.1 to 2.12 show the results of both the CUSUM and CUSUMSQ tests of money demand functions in both South Korea and Malaysia. These results are based on the long run specification of the money demand function. Hansen (1992) indicates that the CUSUM test detects instability in the intercept alone, while CUSUMSQ detects instability in the variance of the regression error. The CUSUM method is based on the cumulative sum of recursive residuals, while CUSUMSQ is based on the cumulative sum of squares of recursive residuals. These results indicate that the magnitude of the coefficients lies outside the confidence interval bands in all models; these bands show the confidence intervals for the estimated coefficients. Thus, any departure from these bands means that these models are unstable, and this instability may be due to structural breaks or misspecification of the models. In other words, if the magnitude of the coefficients deviates from the 5% significance level, it may be an indication of a structural break.

Figure 2.1 CUSUMSQ for South Korea M1

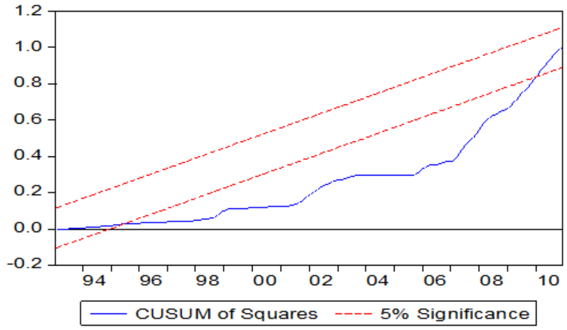


Figure 2.4 CUSUM for South Korea M1

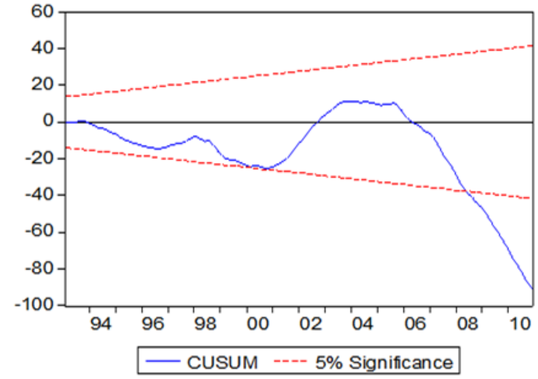


Figure 2.2 CUSUMSQ for South Korea M2

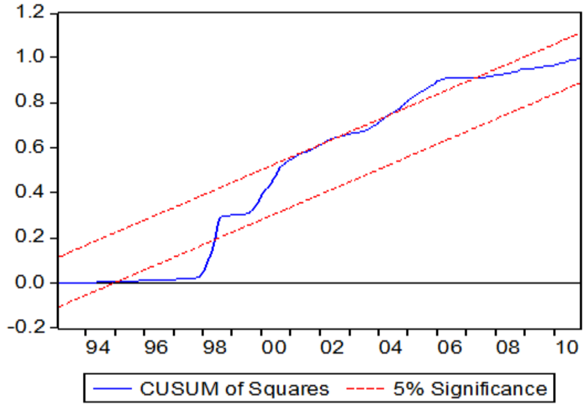


Figure 2.5 CUSUM for South Korea M2

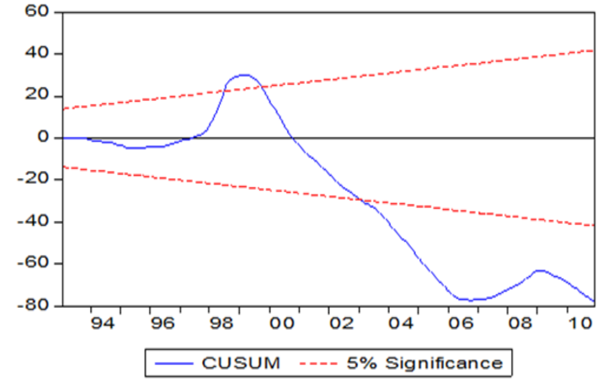


Figure 2.3 CUSUMSQ for South Korea LF

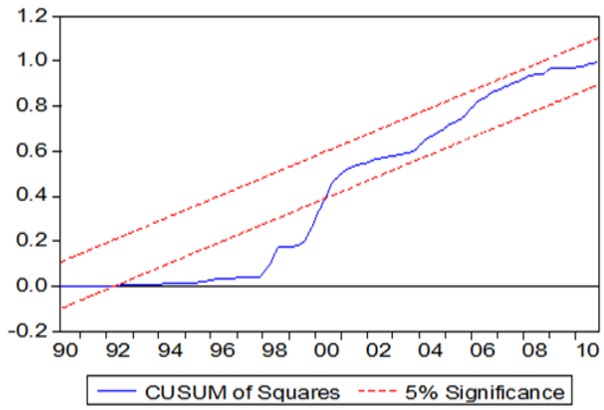


Figure 2.6 CUSUM for South Korea LF

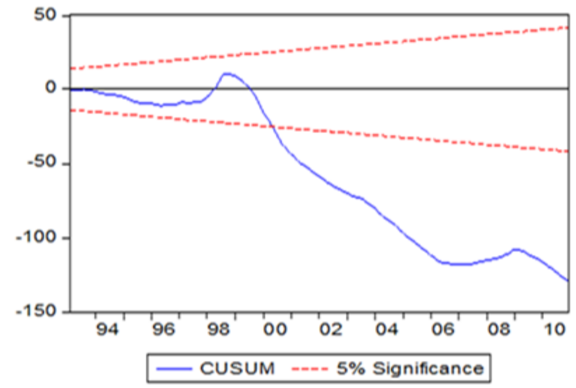


Figure 2.7 CUSUMSQ for Malaysia M1

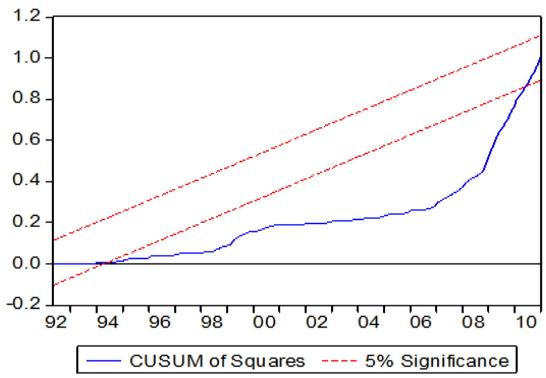


Figure 2.10 CUSUM for Malaysia M1

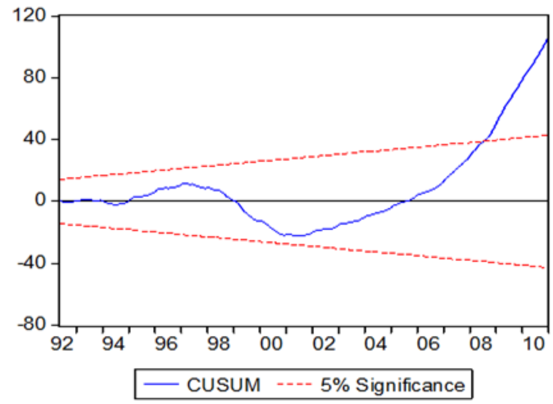


Figure 2.8 CUSUMSQ for Malaysia M2

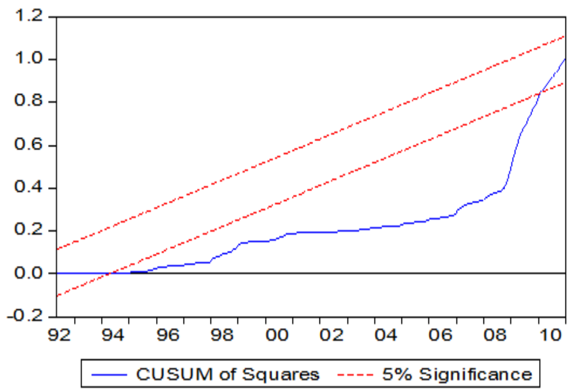


Figure 2.11 CUSUM for Malaysia M2

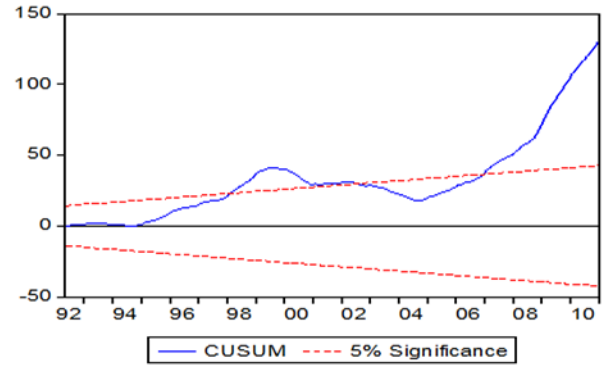


Figure 2.9 CUSUMSQ for Malaysia M3

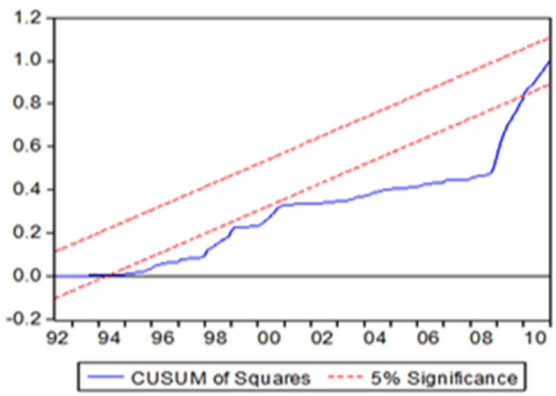
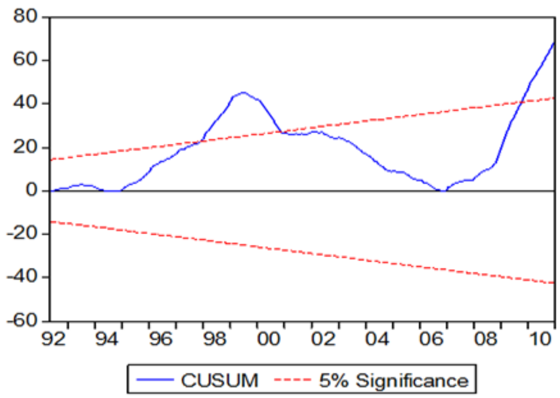


Figure 2.12 CUSUM for Malaysia M3



2.8.3 Andrews and Andrews and Ploberger Tests

Andrews (1993) and Andrews and Ploberger (1994) methods are used to check for a one unknown structural break in both individual time-series and the model as a whole. These methods estimate structural breaks endogenously; therefore, they do not require a priori knowledge of the dates of the structural breaks. Both methods are computed on the basis of the Wald test, and they test the null of no structural break. The existence of a structural break implies that the linear relationship between the money demand and its determinants does not hold. The Andrews test is computed as

$$\text{SupF} = \text{sup}F_{t/T}\ , \qquad (2.18)$$

where $F_{t/T}$ is considered to be the F-test statistic. The Andrews and Ploberger (1994) is computed as

$$\text{ExpF} = \log\left[(1/L_2 - L_1 + 1) \sum (0.5\, F_{t/T}\, (L))\right], \qquad (2.19)$$

where L_1 and L_2 denote the trimmed region [0.15T, 0.85T] respectively. According to Hansen (2000), the ExpF is considered to be more powerful test that has almost zero size distortion. Since both tests assume that all variables are stationary, the first difference data are used.

Table 2 contains the results of both SupF and ExpF tests. The results of both tests support the idea that there is a structural break for all the variables as a whole in M1, M2, and M3 (LF) demand in South Korea and Malaysia. Thus, these results indicate that the demand for M1, M2, and M3 (LF) is unstable due to structural breaks. It is worth noting that the break dates correspond to recognizable events in the history of these countries, such as the period of the financial liberalization (1993-1996) and the period of the Asian financial crisis (1997-1998).

Table 2.2 Results of Quandt-Andrews and Andrews-Ploberger Tests

Variables	Break date	Quandt-Andrews		Andrews-Ploberger		H_0: No structural break
Panel A: South Korea		P-value	T-stat	P-value	T-stat	
when M1 is the dependent variable						
y	1998/06	0.0684	7.9197*	0.0308	2.4409**	Reject H_0
i	1998/10	0.1379	6.3506	0.0414	2.1973**	Reject H_0 only for Andrews-Ploberger
All variables	2000/01	0.0387	12.1709**	0.0185	4.1740**	Reject H_0
when M2 is the dependent variable						
y	1996/05	0.0036	14.2255***	0.003	4.0785***	Reject H_0
i	2007/08	0.8463	1.756	0.6822	0.2714	Don't reject H_0
All variables	1996/05	0.0151	14.3498**	0.0189	4.1506**	Reject H_0
when LF is the dependent variable						
y	1996/01	0.0002	20.7539***	0.0000	7.3516***	Reject H_0
i	2007/08	0.9961	1.0296	0.8088	0.1927	Don't reject H_0
All variables	1996/01	0.0008	20.8863***	0.001	7.4207***	Reject H_0
Panel B: Malaysia						
when M1 is the dependent variable						
y	1998/02	0.1554	6.0788	0.1914	1.0184	Don't reject H_0
i	1994/12	0.0595	8.2266*	0.0796	1.6672*	Reject H_0
All variables	1998/05	0.0357	12.3574**	0.0492	3.2177**	Reject H_0
when M2 is the dependent variable						
y	2006/01	0.949	1.3138	1.0000	0.1119	Don't reject H_0
i	1994/12	0.0131	11.4938**	0.0199	2.7911**	Reject H_0
All variables	1994/12	0.0506	11.5309**	0.0741	2.8272*	Reject H_0
when M3 is the dependent variable						
y	2006/01	0.5812	2.8712	0.5159	0.4139	Don't reject H_0
i	1994/12	0.0066	12.9671***	0.019	2.8277**	Reject H_0
All variables	1994/12	0.0254	13.1611**	0.0611	3.0103*	Reject H_0

*, **, *** denote the level of significance at the 10, 5, and 1 percent, respectively.

2.9 Empirical Results

2.9.1 Unit Root Tests Results

The results of the ADF and ZA unit root tests are reported in Tables 3 and 4, respectively.

Table 2.3 Results of Augmented Dickey Fuller Test

Country	Variable	ADF in level	ADF in difference
South Korea	M1	-1.3348(2)	- 9.1635 (1)
	M2	-1.5016 (4)	- 4.0484 (6)
	LF	-2.0405 (1)	- 10. 420 (1)
	y	-0.57717 (1)	-15.525 (0)
	i	-2.3763(1)	-15.174(0)
Malaysia	M1	-2.5902(1)	-14.105(0)
	M2	-2.0211(1)	- 13.631(0)
	M3	-2.7525(3)	-6.9364(2)
	y	-2.1446(3)	-10.454(2)
	i	-2.7049(2)	-4.0774 (11)

The critical values are – 3. 96 – 3.41 – 3.13 for 1, 5, and 10 percent , respectively. The numbers in parentheses refer to the number of lags.

Table 2.4 Results of Zivot and Andrews Unit Root Test

Country	Model	Variables	T-statistics	Break date
South Korea	C	M1	-3.641(1)	1999/04
		M2	-3.875(0)	1999/08
		LF	-4.340(0)	1994/08
		y	-4.121(0)	1999/02
		i	-3.889(0)	1998/09
Malaysia	C	M1	-5.893(0)	1998/02
		M2	-3.332(0)	1998/02
		M3	-4.287(2)	1998/02
		y	-3.326(2)	2008/09
		i	-4.995 (3)	1998/06

The critical values for both the mean and the trend shift are -5.57 and -5.08 for the 1 and 5 percent levels, respectively. The numbers in parentheses are the numbers of lags.

The results of the ADF test for both countries (Table 3) indicate that all variables are non-stationary in level. Thus, the null hypothesis of a unit root for all variables could not be rejected at the 1 percent significance level. However, all variables are stationary in first differences, and the null hypothesis of a unit root is rejected for all the variables at the 1 percent significance level. The choice of the lag length is chosen based on the AIC, and the results from the first differences indicate that all variables are integrated of order one, which can be written as I (1).

The results of the ZA unit root test are presented in Table 4. In the case of South Korea, the results show that all the variables are non-stationary in level. However, the results for Malaysia indicate that M1 is stationary in level.Therefore, the null of a unit root is rejected at the 1 percent significance level for M1 demand, but the null could not be rejected for the remaining 4 variables, M2, M3, i, and y, meaning that these four variables are non-stationary in level.

For South Korea, the break dates from the ZA are consistent between series. Some break dates correspond with the liberalization of the financial sector between 1994 and 1996, while others correspond to the global and Asian financial crises 2008 and 1997-1998, respectively. From 1997 to 1998, the Asian currency crisis occurred, and the value of the won fell sharply. In 1998, the Bank of Korea started a new monetary policy targeting inflation. In 1999, the economy of South Korea experienced some improvement from the Asian crisis.The GDP growth jumped from -5.8% in 1998 to 10% in 1999; the industry production increased from -7.3% to 20%; and the current balance went from $ 8.2 billion in 1997 to $ 20 billion in 1999.

In addition, the ZA break dates for Malaysia are consistent between series. The break dates correspond with the Asian financial crisis in 1997-1998 and the global financial crisis in 2008. In 1998, the economy of Malaysia experienced a sharp recession due to the Asian financial crisis. The fall in exports affected the economy of Malaysia in 2008. Khoon and Mah-Hui (2010) indicate that Malaysia is considered to be the second most trade-dependent country in the Association of Southeast Asian Nations Region.

Most of the break points that are determined endogenously by Zivot and Andrews do not refer directly to July 1997, the date when the Asian financial crisis occurred. This does not mean that Asian financial crisis is an unimportant event. In fact, many break dates occurred between 1997 and 1998, and this period is considered to be the period of Asian financial crisis. Enders, p 106, states that, “Even if we could precisely determine the date of the start of an event, the full effect of this event may not occur instantly.” This may explain why the exact date of Asian financial crisis did not appear as one of the break points in the ZA results.

The results of the ADF unit root test indicate that all series are integrated from order one, I (1), for both countries, while the results from ZA test indicate that M1 is integrated from order zero, I (0) for Malaysia. In the case of Malaysia, we should perform cointegration tests only on non-stationary series with the same order of integration indicating that cointegration tests should not be performed on Malaysian M1. However, since we got mixed results, it is worth performing cointegration tests on M1 demand too. In fact, testing for cointegration is still necessary and valid, despite that the variables are not from the same order. Harris (1995) points out that it is common to test for cointegration when the variables are not from the same order, because unit root tests in most cases suffer from statistical power problems and size distortion.

2.9.2 Johansen and Juselius (1990) Cointegration Test Results

The Johansen and Juselius cointegration test is applied to the sample period 1990:01-2010:12 for South Korea and 1992:02-2011:01 for Malaysia. The results are reported in Table 5. Since the results of Johansen’s method are known to be sensitive to the selection of the lag length, I use both AIC and the final prediction error (FPE) to choose the optimal lag length.

Using the results for the M1, M2, and LF demand in South Korea, trace test suggests that the null hypothesis r = 0 is rejected in favor of r > 0 at the 5 percent significance level while the result of the maximum eigenvalue test suggests that the null hypothesis r = 0 is rejected in favor of r = 1 at the 1 percent significance level for the M1 demand model. These results from both tests together indicate that there is at least one cointegrating vector. For M2 demand model, the results of the trace test reveal that the null hypothesis $r \leq 2$ is rejected in favor of r > 2 at the 1 percent significance level. However, the results of maximum eigenvalue test suggest that the null hypothesis r = 0 is rejected in favor of r = 1 at the 1 percent significance level. The results from both tests together indicate that there is at least one cointegrating vector. In the case of LF demand, the results from the trace and the maximum eigenvalue tests reveal that there are at least three cointegrating vectors.

Despite the structural changes, the results from Johansen's multivariate cointegration tests indicate that there is evidence of a long run relationship between M1, M2, and LF demand and their determinants in the case of South Korea while there is no evidence of the existence of a long run relationship between M1, M2, and M3 demand and their determinants in the case of Malaysia.

Table 2.5 Results of Johansen Cointegration Test

Panel A	Monetary aggregate	H_0	H_1	λ_{trace}	5% CV	1% CV
South Korea K = 3	M1	r = 0	r > 0	30.63071*	29.68	35.65
		r ≤ 1	r > 1	4.933996	15.41	20.04
		r ≤ 2	r > 2	0.139219	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	25.69672**	20.97	25.52
		r = 1	r = 2	4.794777	14.07	18.63
		r = 2	r = 3	0.139219	3.76	6.65
South Korea K = 1	M2	H_0	H_1	λ_{trace}	5% CV	1% CV
		r = 0	r > 0	64.468**	29.68	35.65
		r ≤ 1	r > 1	21.01377**	15.41	20.04
		r ≤ 2	r > 2	8.455237**	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	43.45424**	20.97	25.52
		r = 1	r = 2	12.55853	14.07	18.63
		r = 2	r = 3	8.455237**	3.76	6.65
South Korea K = 1	LF	H_0	H_1	λ_{trace}	5% CV	1% CV
		r = 0	r > 0	62.07583**	29.68	35.65
		r ≤ 1	r > 1	26.67223**	15.41	20.04
		r ≤ 2	r > 2	8.785838**	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	35.40359**	20.97	25.52
		r = 1	r = 2	17.8864*	14.07	18.63
		r = 2	r = 3	8.785838**	3.76	6.65

,* denote the level of significance at the 5 and 1percent, respectively. K denotes the number of the optimal lag length, based on AIC and FPE.

Table 2.5 Continued

Panel B	Monetary aggregate	H_0	H_1	λ_{trace}	5% CV	1% CV
Malaysia K = 12	M1	r = 0	r > 0	20.83486	29.68	35.65
		r ≤ 1	r > 1	6.671565	15.41	20.04
		r ≤ 2	r > 2	0.038501	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	14.1633	20.97	25.52
		r = 1	r = 2	6.633064	14.07	18.63
		r = 2	r = 3	0.038501	3.76	6.65
Malaysia K = 12	M2	H_0	H_1	λ_{trace}	5% CV	1% CV
		r = 0	r > 0	23.44368	29.68	35.65
		r ≤ 1	r > 1	7.754601	15.41	20.04
		r ≤ 2	r > 2	1.566451	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	15.68908	20.97	25.52
		r = 1	r = 2	6.188149	14.07	18.63
		r = 2	r = 3	1.566451	3.76	6.65
Malaysia K = 12	M3	H_0	H_1	λ_{trace}	5% CV	1% CV
		r = 0	r > 0	24.68786	29.68	35.65
		r ≤ 1	r > 1	9.885802	15.41	20.04
		r ≤ 2	r > 2	2.093886	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	14.80206	20.97	25.52
		r = 1	r = 2	7.791916	14.07	18.63
		r = 2	r = 3	2.093886	3.76	6.65

2.9.3 The Long Run Elasticities before considering Structural Breaks

Since a long run relationship exists between M1, M2, and LF demand and their determinants in South Korea, the long run elasticities of the income and the short-term interest rates are estimated using the Phillips and Hansen (1990) fully modified OLS (FMOLS). The results are reported in Table 6. Income is positively related to M1, M2, and LF demand, and this result is statistically significant at the one percent level. The income elasticity is less than unity and greater than zero. Also, the results reveal that there is a negative relationship between M1, M2, and LF demand and short-term interest rates, and this result is statistically significant at the one percent level. These results are consistent with the theoretical predictions.

Table 2.6 Long Run Elasticities before considering Structural Breaks

Country	Regressor	FMOLS
South Korea	when M1 is endogenous	
	y	0.6474***(0.0473)
	i	-0.0520***(0.0052)
	constant	2.2920***(0.1050)
	when M2 is endogenous	
	y	0.7187***(0.0506)
	i	-0.0464***(0.0056)
	constant	2.7046***(0.1123)
	when LF is endogenous	
	y	0.7288*** (0.0460)
	i	-0.0387***(0.0051)
	constant	2.7867***(0.1020)

*** denotes the level of significance at the 1 percent. The numbers in the parentheses are the standard errors.

2.9.4 Gregory and Hansen (1996) Cointegration Test Results

The three models of the Gregory and Hansen (1996) cointegration test are estimated using monthly data from 1990:01 to 2010:12 for South Korea and 1992:02 to 2011:01 for Malaysia. The results for the three monetary aggregates M1, M2, M3 (LF) for both countries are reported in Table 7. In this chapter, I follow exactly the same set up as the Gregory and Hansen did in their research. The selection of the lag length is chosen on the basis of a t-test following a procedure similar to Perron and Vogelsang (1992). The maximum lag is set to 12 and tested downward until the last lag of the first difference included is significant at the 5 percent level using normal critical values.

For South Korea, the results indicate that ADF^* statistics, Z_t^* statistics, and Z_a^* statistics are insignificant at the 5 and 10 percent significance levels in all three models. As a result, we could not reject the null hypothesis of no cointegration with a structural break for M1, M2 and LF demand. In South Korea, the ADF^*, Z_t^*, and Z_a^* tests suggest that structural change in the cointegrating vector is important and needs to be accounted for in the specification of the money demand M1, M2, and LF.

For Malaysia, M1 demand registers significant ADF^* and Z_a^* values at the 1 percent level and Z_t^* at the 5 percent level in the GH2 model. Also, M1 demand shows significant Z_t^* statistics, and Z_a^* statistics at the 5 and 10 percent significance levels, respectively, in the GH1 model. On the other hand, M2 demand indicates significant Z_t^* and Z_a^* statistics at the 5 and 10 percent significance levels, respectively, in both the GH1 and GH3 models. In addition, M3 demand appears to be stationary showing significant Z_t^* and Z_a^* statistics at the 5 percent level in model GH1 and significant Z_t^* statistics at the 5 percent level in the GH3 model. The results indicate that the three measures of the money demand, M1, M2, and M3, are stationary and have a long run relationship with their determinants, real income and short term nominal interest rate, since the null of no cointegration with a structural break is rejected at the 5 and 10 percent significance level.

The break dates are consistent across models. For instance, the period from 1994 to 1996 correspond with the financial liberalization in South Korea, and the year 1998 could align with the full effect of the Asian financial crisis.The break date of the year 2000 corresponds with the financial innovation caused by the change in the monetary policy regime in South Korea, and the break date of 2008 refers to the global financial crisis.

Table 2.7 Results of Gregory and Hansen (1996) Tests

Panel A	Monetary aggregate	Model	Break date	GH t-statistics (ADF)	GH t-statistics (Z_t)	GH t-statistics (Z_a)
South Korea	M1	GH1	2006 /12	-4.1524 (0)	-4.1607	-33.2572
		GH2	2001/04	-4.2466(0)	-4.2550	-33.8206
		GH3	2001 /10	-4.7794 (0)	-4.7889	-42.1329
	M2	GH1	1995 /12	-3.2809 (0)	-3.2974	-19.4475
		GH2	1995 /09	-3.6033 (0)	-3.6119	-22.4503
		GH3	2000 /01	-3.8925(3)	-3.5939	-24.6370
	LF	GH1	1993 /07	-3.5150 (6)	-3.4041	-19.8425
		GH2	1994 /08	-3.6693 (0)	-3.7196	-22.0989
		GH3	1999 /04	-4.7382 (3)	-4.4884	-37.8212
Panel B						
Malaysia	M1	GH1	2007 /04	-4.0808 (1)	-4.9818**	-44.1176*
		GH2	1998 /05	-7.1538(1)***	-6.7997**	-79.279***
		GH3	2007 /04	-4.1972 (1)	-5.1014	-47.8671
	M2	GH1	2007 /08	-4.4639(5)	-6.0979***	-59.0614***
		GH2	2000 /04	-4.7199 (0)	-4.4268	-35.4707
		GH3	2007 /04	-4.3223 (1)	-6.1886***	-62.1303**
	M3	GH1	2008 /03	-4.2160(5)	-5.3926**	-47.7876**
		GH2	2000 /01	-4.4998 (0)	-3.8863	-26.7504
		GH3	2007 /08	-3.7869(5)	-5.3427*	-47.4142

*,**,*** denotes the significance level at 10, 5 and 1 percent level of statistical significance, respectively, using 2-regressor critical values. The numbers in parentheses refer to the number of lags.

In the presence of structural breaks, the expected result of the Johansen and Juselius test is that there is no evidence of a cointegration relationship between the money demand and its determinants as this test does not account for structural breaks. When structural breaks are found to be significant, the expected result of the Gregory and Hansen cointegration test is evidence of a long run relationship between the money demand and its determinants. For Malaysia, the results presented in this chapter show that the Johansen and Juselius cointegration test did not reject the null hypothesis of no cointegration between the M1, M2, and M3 demand and their determinants because of the existence of structural breaks. However, the results of the Gregory and Hansen cointegration test indicate that there is a long run relationship between M1, M2, and

M3 demand and their determinants, after controlling for one unknown structural break. This result is consistent with the expected results of both tests.

In the case of South Korea, the results of both cointegration tests are inconsistent with the expected results. The results of the Johansen cointegration test show that M1, M2, and LF demand are cointegrated with their determinants, while the results of the Gregory and Hansen test indicate that the demand for M1, M2, and LF are not cointegrated with their determinants even after taking into account one unknown structural break[14]. These results may be explained by several factors. First, the results of the Johansen cointegration test might be problematic since all of the parameter stability tests show that there is evidence of structural breaks. Second, there might be more than one structural break, and the Gregory and Hansen test is a joint test for cointegration with only one structural break. Thus, in the presence of more than one structural break, the Gregory and Hansen results may not be reliable. Third, the present chapter utilizes the conventional money demand specifications that ignore the influence of foreign monetary developments, such as foreign interest rates and exchange rates. Since South Korea depends heavily on exports, excluding the influence of foreign monetary developments from the money demand specification may lead to a misspecification problem; the conventional money demand specification may not reflect the domestic demand for real money balances in South Korea. Fourth, the structural breaks may not be accurately absorbed when the conventional money demand specification is used. The results of the Gregory and Hansen test do suggest that a structural break is important and needs to be taken care of in the specification of the money demand in South Korea. Finally, the Gregory and Hansen test has low power against the null

[14] Several papers have found the same results from both tests when investigating the stability of the money demand function in India, China, and the US (Pradhan and Subramanian (2003); Ramachandran (2004); Lee and Chien (2008); and Rao and Kumar (2011)).

hypothesis of no cointegration. Accordingly, discretion is important when interpreting the results of this test.

2.9.5 The Long Run Elasticities after considering Structural Breaks

For Malaysia, the long run income elasticity and interest rate semi-elasticity are estimated using Phillips and Hansen (1990) FMOLS procedure; the results are reported in Table 8. The long run elasticities for M1 demand are consistent with theoretical expectations. However, the GH1 model seems to be more plausible, since the income elasticity of 0.93 is close to unity as is suggested by the quantity theory of money. On the other hand, I find interesting results for the interest rate semi-elasticity for both M2 and M3 demand. In the case of M2 demand, λ_3 is positive but not significant when there is only a shift in the intercept (GH1). However, in the regime shift model (GH3), λ_3 is positive and statistically significant before the shift, and λ_{33} is negative and statistically significant after the shift. In the case of M3 demand, the FMOLS estimate of the interest rate semi-elasticity, λ_3, is positive and significant only when there is a shift in the intercept (GH1). In the GH3 model, both income elasticity and interest rate semi-elasticity before the shift, λ_1 and λ_3, are positive and significant at the 1 percent level; however, after the shift, λ_{22} and λ_{33}, become negative and statistically significant at the 1 percent level.

Table 2.8 Long Run Elasticities after considering Structural Breaks

Country	Regressor	FMOLS	FMOLS	FMOLS
		GH1	GH2	GH3
Panel A: Malaysia (when M1 is endogenous)	Constant	1.2106***(0.0846)	2.2689*** (0.0792)	
	y	0.9316*** (0.0411)	0.2775*** (0.0474)	
	i	-0.0084***(0.0029)	-0.0144***(0.0017)	
	dummy 2007/04	0.1468***(0.0104)		
	Trend		0.0028***(0.0001)	
	dummy 1998/05		-0.1581*** (0.0075)	
	Regressor	GH1	GH2	GH3
Panel B: Malaysia (when M2 is endogenous)	Constant	0.9646***(0.0821)		0.9054*** (0.0698)
	y	1.3884*** (0.0397)		1.4131***(0.0339)
	i	0.0035 (0.0028)		0.0065 *** (0.0024)
	dummy 2007/08	0.1340*** (0.0104)		
	dummy 2007/04			-1.1534(0.9917)
	y dummy 2007/04			1.0813*** (0.1869)
	i dummy 2007/04			-1.4572*** (0.2793)
	Regressor	GH1	GH2	GH3
Panel C: Malaysia (when M3 is endogenous)	Constant	1.4788*** (0.0638)		1.4423 ***(0.0641)
	y	1.1674 *** (0.0307)		1.1830*** (0.0309)
	i	0.0045 ** (0.0023)		0.0062*** (0.0022)
	dummy 2008/03	0.0914 ***(0.0086)		
	dummy 2007/08			1.8086 ***(0.5939)
	y dummy 2007/08			-0.7981***(0.3017)
	i dummy 2007/08			-0.0420***(0.0120)

, * denote significant level at the 5 and 1 percent, respectively. The numbers in the parentheses are the standard errors.

2.10 Summary and Conclusion

This chapter includes research that empirically investigates the stability of the money demand functions in the long run for South Korea and Malaysia. This research uses monthly data for South Korea between 1990:01 and 2010:12 and for Malaysia between 1992:02 to 2011:01. Three measures of monetary aggregates are used, the narrow definition of money, M1, and the broad definitions of money, M2 and M3 (LF). The industrial production (IP) is used as a proxy for the scale variable, while the opportunity cost is proxied by short-term interest rates.

In the case of South Korea, this research finds evidence that M1, M2, and LF demand are stable in the long run when the Johansen and Juselius (1990) test is conducted. However, given the specification of the model and the data set, the results of the Gregory and Hansen (1996) test, which allows for a one unknown structural break, suggest that M1, M2, and LF demand are unstable in the long run. This result raises serious doubts about the existence for South Korea of a long run relationship between the money demand aggregates, M1, M2 and LF, and their determinants. This result could be due to several reasons. First, the results of the Johansen and Juselius test may be problematic, since all tests of the structural breaks indicate the existence of the structural breaks in all of the models. Second, there may be more than one structural break. Third, there may be misspecification problems, since the foreign factors, such as foreign interest rates and exchange rate, are not included in the models.

For Malaysia, the results indicate that the demand for M1, M2, and M3 are unstable in the long run when the Johansen cointegration test is used. However, given the specification of the model and data set, the results of the Gregory and Hansen test indicate that stability of the money demand M1, M2, and M3 exists in the Malaysian economy. The results of the cointegration test with a one unknown structural break raise some questions about the stability of the money demand function in South Korea when the specification of the money demand function with a closed economy framework is used.

For future research, I would suggest departing from using the traditional money demand specification or quantity theory of money and draw on the cash in advance model in an open economy framework. This model adds nominal foreign interest rates and real exchange rate as determinants of the money demand, as well as real income and nominal interest rates. These factors are considered to be important, since both countries depend heavily on exports. In fact, most of the mixed results in the literature may be due to the determination of the determinants of the money demand.

Chapter 3 - Estimating Money Demand Function in South Korea and Malaysia: Evidence from a Cash in Advance Model with a Cointegration Test allowing for a Structural Break

3.1 Introduction

Most of the previous work on the stability of the money demand function in South Korea and Malaysia focuses on the traditional money demand specification, such as a Keynesian model[15]. Some studies added other variables as determinants for money demand in addition to income and domestic interest rates. For instance, Bahmani-Oskooee and Rhee (1994) find that M1 demand is stable, while M2 demand is unstable in South Korea. However, when they add the real exchange rate as a determinant for the money demand, they find that both M1 and M2 demand are cointegrated and have a long run relationship with their determinants. Cho and Miles (2007) also find evidence of a long run relationship between M2 demand and its determinants in South Korea, after adding a time trend as a determinant for M2 demand. Miteza (2009) claims that the stability of the M2 demand function in South Korea could not be found when the traditional money demand function was used. Yet, when the nominal exchange rate is added as a determinant for money demand, the author finds evidence of a long run relationship between M2 demand and its determinants, real GDP, short term nominal interest rates, and nominal exchange rate.

Moreover, most of the traditional studies on the stability of the money demand function do not take into account the influence of foreign monetary developments, foreign interest rates, and the exchange rate. Mundell (1963) conjectures that the exchange rate could be one of the determinants of the money demand function as are income and domestic interest rates. Bahmani-

[15] See Hwang (2002); Cheong (2003); Nair et al. (2008); Manap (2009); Kumar (2011).

Oskooee (1991) indicates that the exchange rate should be included as a determinant for the money demand function. He includes the exchange rate in his model, but excludes the foreign interest rate, when he estimates the money demand function for the UK over the period 1973-1987. Hueng (1998) indicates that monetary developments in foreign countries may influence the domestic demand for real money balances.

Bahmani-Oskooee (2002) examines the stability of the money demand function in South Korea using real GDP, long term interest rates, and nominal effective exchange rates as determinants for the money demand function, without including foreign interest rates. According to Hueng (1998), most open economy studies do not provide a theoretical model to justify the specifications of their empirical money demand functions. Many of the money demand specifications face a misspecification problem due to possible omission of important variables.

Having a stable money demand function is important for policymakers for the following reasons. First, it has important implications on how to conduct a monetary policy. Second, it is important for explaining and forecasting the behavior of real exchange rates and interest rates. Finally, it allows policymakers to choose an appropriate policy and increase the level of accuracy for targeting money growth.

The purpose of this chapter is to empirically evaluate the money demand function in South Korea and Malaysia, focusing on two main issues. The first is to test whether or not the money demand functions in the two countries are stable in the long run using the Hansen (1992) test for parameter instability. The second is to investigate the long run relationship, or stationarity, between the money demand and its determinants, real income, the real exchange rate, foreign short-term interest rates, and domestic short-term interest rates. To reach this goal, two cointegration tests are conducted: Johansen and Juselius (1990) and Gregory and Hansen

(1996). What distinguishes this chapter from previous work is that this chapter uses the cash in advance model in an open economy framework instead of the traditional money demand specification. In addition, this chapter extends the data set to include 1990:01 to 2010:07 for both South Korea and Malaysia. Other studies in the literature have not analyzed the money demand function for both South Korea and Malaysia for data up to 2010. Furthermore, this chapter conducts Granger causality tests to establish any causal relationships among the variables.

The motivation for evaluating the stability of the money demand function in South Korea and Malaysia is that most developing countries have experienced both reforms in financial sector and severe economic crises, such as the Asian financial crisis and the global financial crisis. The effects of these reforms and financial crises on the stability of the money demand are rarely investigated endogenously. These reforms and financial crises likely created structural breaks and need to be accounted for in the estimation of the long run money demand function. In addition, the findings from the second chapter support the idea that structural breaks are important and need to be included in the specification of M1, M2, and LF money demand function in South Korea. Most of the previous work treats the structural breaks exogenously, but this chapter deals with the structural breaks endogenously. Enders (pp. 106) indicates that even if it is possible to determine the exact date of a structural break, the full effect of this structural break would not occur instantly. Furthermore, a criticism of treating a structural break exogenously is that a model with exogenous breaks may suffer from data mining.

This chapter is organized into seven sections. Section 2 discusses the theoretical framework. The model and data are discussed in section 3, and Section 4 describes the econometric methodologies. Section 5 briefly reviews the short and long run Granger causality tests. Section 6 presents the empirical results, and finally, section 7 concludes.

3.2 Theoretical Framework

The theoretical framework used in this chapter, draws on the work of Hueng (1998). According to Hueng (1998), the cash in advance model in an open economy framework has three advantages. First, it provides a broad specification of the money demand function, since it adds the short-term foreign interest rates and the foreign exchange rate to real income and short-term domestic interest rates determinants. Second, it explicitly models the liquidity services provided by money through the agent's budget constraint instead of the utility function, since it is the liquidity that provides utility to agents rather than the money itself. Finally, the cash in advance model allows researchers to determine the effect of interest rates on the money demand by doing comparative statics.

Assumptions of the model include: A two-country world; two goods; two monies; one domestic bond and one foreign bond; identical and infinitely lived individual who inhabit both countries. The agent maximizes his multi-period utility as

$$U = u\,(c_t, c_t^*, L_t) + \sum \beta_j\, E_t\, \{\, u\,(c_{t+j}, c^*_{t+j}, L_{t+j})\}, \tag{3.1}$$

where c_t refers to home country real consumption of domestic goods and c_t^* is the home country real consumption of foreign goods, L_t is leisure, $\beta \in (0,1)$ is the discount rate, and E_t represents the expectation conditional on information at time t. The agent's budget constraint can be written as follows:

$$M_t + B_t + e_t\, M_t^* + e_t\, B_t^* = M_{t-1} + (1 + i_{t-1})\, B_{t-1} + e_t\, M_{t-1}^* + e_t\, (1+ i_{t-1}^*)\, B^*_{t-1} + P_t\,(w_t - c_t) - e_t\, P_t^*\, c^*_t\,, \tag{3.2}$$

where M_t and M_t^* are holdings of domestic and foreign money, respectively, B_t and B_t^* are holdings of domestic and foreign bonds, respectively, i_t and i_t^* denote domestic and foreign nominal interest rates, respectively, P_t and P_t^* denote domestic and foreign price levels, respectively, e_t denotes the nominal exchange rate defined as a unit of domestic currency per unit of foreign currency, and w_t is the real endowment.

To covert to real terms, equation (2) is divided by the price level (P_t). Hence, equation (2) can be written as

$$m_t + b_t + q_t m_t^* + q_t b^* = (1 + \pi_{t-1})^{-1} m_{t-1} + (1 + \pi_{t-1})^{-1} (1 + i_{t-1}) b_{t-1} + q_t (1 + \pi^*_{t-1})^{-1} m^*_{t-1} + q_t (1 + \pi^*_{t-1})^{-1} (1 + i^*_{t-1}) b^*_{t-1} + w_t - c_t - q_t c_t^*, \quad (3.3)$$

where π_t and π^*_t are domestic and foreign inflation rates, respectively, and q_t is the real exchange rate.

The representative agent is subject to two cash in advance constraints that can be written as

$$c_t = N_t m_t \quad \text{and} \quad c_t^* = N_t^* m_t^*, \quad (3.4)$$

where N_t and N_t^* represent the number of times the individual withdraws domestic and foreign currencies, respectively.

The time constraint can be written as

$$1\text{-}L_t = f(N_t) + f(N_t^*). \quad (3.5)$$

Using equations (4) and (5), the indirect utility function can be written as

$$W = u \{ c_t, c^*_t, 1\text{-} f(c_t/m_t) - f^* (c^*_t/m^*_t)\} + \sum \beta_j E_t \{ u [c_{t+j}, c^*_{t+j}, 1\text{-} f(c_{t+j}/m_{t+j}) - f^* (c^*_{t+j}/ m^*_{t+j})]\}, \quad (3.6)$$

where equation (6) is considered to be the objective function subject to the budget constraint (3).

The first order conditions for the optimality of the individual choices imply that

$$[\, U_m(\, c_t, c^*_t\,, m_t, m^*_t\,) \,/\, U_c\,(\, c_t, c^*_t\,, m_t, m^*_t\,)\,] = 1 - (1/1+i_t), \tag{3.7}$$

$$[\, U^*_m(\, c_t, c^*_t\,, m_t, m^*_t\,) \,/\, U^*_c\,(\, c_t, c^*_t\,, m_t, m^*_t\,)\,] = 1 - (1/1+i^*_t), \tag{3.8}$$

$$[\, U_c(\, c_t, c^*_t\,, m_t, m^*_t\,) \,/\, U^*_c\,(\, c_t, c^*_t\,, m_t, m^*_t\,)\,] = 1 \,/\, q_t\,. \tag{3.9}$$

Both equations (7) and (8) show that the marginal rate of substitution (MRS) between real cash balances and consumption equals the opportunity cost of holding money. Equation (9) shows that the marginal rate of substitution (MRS) between domestic and foreign goods equals their relative price.

Hueng (1998) claims that because the indirect utility function and the budget constraint are twice continuously differentiable and an optimal solution exists, the domestic money demand function in an open economy can be written as

$$(M \,/\, P) = f\,(y\,,\, y^*,\, i,\, i^*,\, q), \tag{3.10}$$

where y_t and y^*_t refer to the domestic and foreign output, respectively.

3.3 Model and Data

Monthly data from 1990:01 to 2010:07 for South Korea and Malaysia are used to empirically investigate whether a long run relationship between the money demand and its determinants exists. This research uses the money demand function, drawing on the work of Hueng (1998). The money demand specification can be written as

$$(M/P) = \lambda_1 + \lambda_2\, y + \lambda_3\, i + \lambda_4\, i^* + \lambda_5\, q + \varepsilon, \tag{3.11}$$

where m_t is the real money demand M1, M2, and M3 (LF), y is industrial production.The short-term domestic interest rate, i is proxied by the 3-month Treasury bill for Malaysia, and the discount rate for South Korea, i^* is the short-term foreign interest rate that is proxied by the US discount rate. The variable q is the real exchange rate of South Korea and Malaysia against the US dollar, and ε is the error term. All terms are in natural logarithms. All the data are from the International Financial Statistics database. The expected signs are $\lambda_2 > 0$, indicating that an increase in income increases the demand for money; $\lambda_3 < 0$, indicating that an increase in the domestic interest rate increases the opportunity cost of holding money; and $\lambda_4 > 0$, indicating that an increase in the foreign interest rate decreases the opportunity cost of holding money. Because the effect of the real exchange rate is indeterminate, the relationship between the money demand and the real exchange rate may be positive or negative. Narayan (2007) indicates that if the real exchange rate increases, meaning a depreciation of domestic currency, the value of the foreign assets in terms of domestic currency increases, and as a result, there is a positive effect on the real money demand. However, if the depreciation of the domestic currency leads to more devaluation, then the domestic residents would prefer to hold foreign currency instead of domestic currency, and as a result, there is a negative effect on real money demand. In this chapter, I do not include foreign income in the model because other empirical studies on money demand do not include it[16].

[16] See Hueng (1998); Narayan (2007); and Narayan et al. (2009).

3.4 Econometric Methodologies

3.4.1 Testing for Structural Breaks and Parameter Instability

3.4.1.1 Hansen Instability Test

Hansen (1992) proposes three test statistics, SupF, MeanF, and Lc, to test for instability of the parameters. The null hypothesis for these tests is that there is no structural break, cointegration, while the alternative hypothesis is that there is a structural break or no cointegration. The SupF test is appropriate when one is looking for a shift in regime. Hansen shows that the SupF test is based on the Chow F-tests. It can be calculated as SupF = $\text{sup}F_{t/T}$, where $F_{t/T}$ denotes the F-test statistic. The MeanF test is the average of the F-test statistic, and it is suitable when testing whether or not the specified model captures a stable relationship. Lc is appropriate if testing whether the model is correctly specified.

3.4.1.2 Andrews and Andrews and Ploberger Tests

Andrews (1993) and Andrews and Ploberger (1994) tests are also conducted. These test the null hypothesis of no structural break. The SupF denotes the Andrews test, while the ExpF denotes the Andrews and Ploberger test. Like the Hansen parameter instability test, Andrews and Andrews and Ploberger estimate a structural break endogenously. Thus, there is no need to know the dates of the structural break in advance. These tests require truncation of the sample size T, Trimmed region. Therefore, these tests use the subset [0.15T, 0.85T]. Moreover, since both tests assume that all variables are stationary, the first difference data is used. Based on the experiment by Hansen (2000), the ExpF test is considered to be a more powerful test that has almost zero size distortion.

The SupF can be computed as

$$\text{SupF} = \text{sup}F_{t/T}\,, \tag{3.12}$$

where $F_{t/T}$ is the F-test statistic.

The ExpF is computed as

$$ExpF = \log [(1/L_2\text{-}L_1+1) \sum (0.5\, F_{t/T}(L))], \quad (3.13)$$

where (L_1, L_2) denote the trimmed region (0.15T, 85T), respectively.

3.4.2 Unit Root Tests

Two types of unit root tests are conducted. The Augmented Dickey–Fuller (ADF) test takes the following regression form:

$$\Delta y_t = a_0 + \gamma\, y_{t-1} + a_2 t + \sum \beta_i\, \Delta y_{t-i+1} + \varepsilon_t, \quad (3.14)$$

where y consists of each of the variables in the model, t is an index of time, Δy_{t-i+1} is the lagged first differences, and ε_t is the error term. The ADF tests the null hypothesis of a unit root against the alternative of a trend stationary process. The null and the alternative hypotheses can be written as

$$H_0: \gamma = 0 \text{ vs. } H_1: \gamma < 0.$$

The Akaike Information Criterion (AIC) is used to choose the appropriate lag length (K).

The Zivot and Andrews (1992) unit root test (ZA) allows for a one unknown structural break in the series. For this test, the model takes the form,

$$\Delta y_t = \alpha + \beta\, y_{t-1} + \delta\, t + \theta\, DT_t + \gamma\, DM_t + \sum_{j=1} \rho^d\, \Delta y_{t-j} + \varepsilon_t, \quad (3.15)$$

where DM_t is a dummy variable for a mean shift, and DT_t is a dummy variable for a trend shift. DM_t= 1 if $t > b$ and 0 if $t \leq b$, while DT_t = t-1 if $t > b$ and 0 if $t \leq b$ where b denotes the time at which the structural break occurs. The break point is determined to be the value of b for which the ADF t-statistic is minimized. The lag length is determined by the Akaike Information Criterion (AIC). Asymptotic distributions of minimum t-statistics and critical values are provided by Zivot and Andrews (1992).

3.4.3 Cointegration Tests

3.4.3.1 Johansen's Multivariate Cointegration Test

The Johansen and Juselius (1990) method is conducted to test for cointegration without taking into account the structural breaks. This method is based on the vector autoregressive model, VAR,

$$\Delta x_t = \delta + \prod x_{t-1} + \sum^{k}_{i=1} \Gamma_i \Delta x_{t-i} + \varepsilon_t , \tag{3.16}$$

where x_t is a vector of non-stationary variables in level, δ is a constant, $\prod$ is a long-run impact matrix, which can be decomposed as $\prod = \beta \gamma`$ where $\gamma`$ is a matrix containing the cointegrating vectors, and β measures the average of the speed of adjustment. This method recommends two types of tests, the trace and the maximum eigenvalue test statistics, to determine the number of cointegating vectors.

3.4.3.2 The Gregory and Hansen Approach

The Gregory and Hansen (1996) approach is used to test for a long run relationship between the money demand and its determinants. This test allows for an unknown regime shift in the intercept alone or in both the intercept and the coefficient vector. It can take the following regression forms:

Level shift (GH1):

$$Y_t = \lambda_1 + \lambda_{11} DU_{tb} + \lambda_2 X_t + \varepsilon_t . \tag{3.17}$$

Level shift with trend (GH2):

$$Y_t = \lambda_1 + \lambda_{11} DU_{tb} + \delta t + \lambda_2 X_t + \varepsilon_t . \tag{3.18}$$

Regime shift (GH3):

$$Y_t = \lambda_1 + \lambda_{11} DU_{tb} + \lambda_2 X_t + \lambda_{22} X_t DU_{tb} + \varepsilon_t . \tag{3.19}$$

In equation (17) through (19), Y_t is the dependent variable, X_t is the independent variable, λ_1 and λ_2 are the intercept and the slope coefficients before the structural break, respectively, λ_{11} and λ_{22} are the intercept and the slope coefficients after the structural break. The time ternd is t, $DU_{tb} = 1$ if $t > b$ and $DU_{tb} = 0$ if $t \leq b$, and b is the date at which the structural break occurs.

The maximum lag length is set to 12 and then tested downward until the last lag of the first difference included is found to be significant at the 5 percent level. Gregory and Hansen (1996) propose three test statistics. The $ADF^* = \inf_{t \in T} ADF(t)$ is a modified version of the Engle and Granger (1987) cointegration test. The $Z_t^* = \inf_{t \in T} Z_t(t)$ and $Z_a^* = \inf_{t \in T} Z_a(t)$ are modified versions of the Phillips and Quliaris (1990) tests.

The smallest value of these three test statistics is considered to be the break point. The null hypothesis of the Gregory and Hansen test is that there is no cointegration with a structural break, while the alternative is that there is cointegration with a structural break. It is easy to extend these three models to include more than one explanatory variable.

3.5 Long Run and Short Run Granger Causality Tests

Granger causality analysis is widely used in policy modeling. Granger (1988) indicates that when there is evidence of cointegration among variables, there should be at least one unidirectional Granger causality among the variables. A Granger causality test can be carried out by using the framework of the Error Correction Model (ECM):

$$\Delta \ln (M/P)_t = \alpha_1 + \sum d_{11k} \Delta \ln (M/P)_{t-k} + \sum d_{12k} \Delta \ln y_{t-k} + \sum d_{13k} \Delta \ln q_{t-k} + \sum d_{14k} \Delta \ln i_{t-k} + \sum d_{15k} \Delta \ln i^*_{t-k} + \beta_1 ECT_{t-1} + v_{1t}, \quad (3.20)$$

$$\Delta \ln y_t = \alpha_2 + \sum d_{21k} \Delta \ln y_{t-k} + \sum d_{22k} \Delta \ln (M/P)_{t-k} + \sum d_{23k} \Delta \ln i_{t-k} + \sum d_{24k} \Delta \ln i^*_{t-k} + \sum d_{25k} \Delta \ln q_{t-k} + \beta_1 ECT_{t-1} + v_{2t}, \quad (3.21)$$

$\Delta \ln q_t = \alpha_3 + \sum d_{31k} \Delta \ln q_{t-k} + \sum d_{32k} \Delta \ln y_{t-k} + \sum d_{33k} \Delta \ln (M/P)_{t-k} + \sum d_{34k} \Delta \ln i_{t-k} + \sum d_{35k} \Delta \ln i^*_{t-k} + \beta_2 ECT_{t-1} + v_{3t},$ (3.22)

$\Delta \ln i_t = \alpha_4 + \sum d_{41k} \Delta \ln i_{t-k} + \sum d_{42k} \Delta \ln y_{t-k} + \sum d_{43k} \Delta \ln (M/P)_{t-k} + \sum d_{44k} \Delta \ln i^*_{t-k} + \sum d_{45k} \Delta \ln q_{t-k} + \beta_4 ECT_{t-1} + v_{4t},$ (3.23)

$\Delta \ln i^*_t = \alpha_5 + \sum d_{51k} \Delta \ln i^*_{t-k} + \sum d_{52k} \Delta \ln y_{t-k} + \sum d_{53k} \Delta \ln (M/P)_{t-k} + \sum d_{54k} \Delta \ln q_{t-k} + \sum d_{55k} \Delta \ln i_{t-k} + \beta_5 ECT_{t-1} + v_{5t},$ (3.24)

In these equations, k denotes the lag length, ECT is the error term, which is derived from the long run cointegration relation, t is time subscript, and Δ refers to the first differences.

This framework for the Granger causality test allows researchers to distinguish between long run and short run Granger causality. In order to capture the short run Granger causality, a joint F-test is applied on the following null hypothesis of each equation. In equation (20): H_0: $d_{12k} = 0$, H_0: $d_{13k} = 0$, H_0: $d_{14k} = 0$, H_0: $d_{15k} = 0$ for all k. In equation (21): H_0: $d_{22k} =0$, H_0: $d_{23k} = 0$, H_0: $d_{24k} = 0$, H_0: $d_{25k} = 0$ for all k. In equation (22): H_0: $d_{32k} = 0$, H_0: $d_{33k} = 0$, H_0: $d_{34k} = 0$, H_o: $d_{35k} = 0$ for all k. In equation (23): H_0: $d_{42k} = 0$, H_0: $d_{43k} = 0$, H_o: $d_{44k} = 0$, H_0: $d_{45k} = 0$ for all k. In equation (24): H_0: $d_{52k} = 0$, H_o: $d_{53k} = 0$, H_0: $d_{54k} = 0$, H_o: $d_{55k} = 0$ for all k.

Toda and Phillips (1994) show that the long run Granger causality can be captured through the coefficients of the lagged ECT in each equation. Because the lagged ECT captures the long run equilibrium between the cointegrated variables, t-statistics of the coefficient of this term can indicate whether the dependent variable responds to the deviation in the long run equilibrium or not. In fact, the coefficient of the ECT in each equation shows the speed of convergence to the equilibrium.

3.6 Empirical Results

3.6.1 Testing for the Joint Significance

In this section, the significance of the short-term foreign interest rates and the real exchange rate is tested using the F-test. Both the null hypothesis and the alternative hypothesis can be written as H_0: $\lambda_4 = \lambda_5 = 0$ and H_1: $\lambda_4 \neq \lambda_5 \neq 0$, respectively.

The null hypothesis states that the short-term foreign interest rates and the real exchange rate do not have predictive power. The results are reported in Table 1. The results suggest that short-term foreign interest rates and the real exchange rate are statistically significant in all three models of the money demand in both countries.

Table 3.1 Results of F-Test

Country	Model	F-test	H_0: $\lambda_4 = \lambda_5 = 0$
South Korea	M1	16.93***	Reject H_0
	M2	83.62***	Reject H_0
	LF	17.92***	Reject H_0
Malaysia	M1	145.45***	Reject H_0
	M2	49.90***	Reject H_0
	M3	39.54***	Reject H_0

*** denotes statistical of significance at the 1 percent level.

3.6.2 Parameter Instability Test Results

The stability of the parameters of the money demand function is an appropriate indicator for policymakers to consider money targeting as a monetary policy option. The results of the Hansen (1992) test are presented in Table 2 with their probability values.

The results for South Korea show signs of instability. The three test statistics of Lc, MeanF, and SupF indicate that the null hypothesis of cointegration, no sudden shift in the regime for all three definitions of money, is rejected at the 5 and 10 percent significance level. In the case of Malaysia, the results of the Hansen (1992) test indicate that the money demand function is unstable because all three test statistics, Lc, MeanF, and SupF, reject the null hypothesis of cointegration. Gregory et al. (1996) indicate that Hansen's test can perform well when there is no structural break. Breuer and Lippert (1996) show that tests of the stability of the money demand only focus on whether the coefficient estimates are stable over time without taking into account the structural break. They mention that these tests of stability do not take into consideration the underlying time series aspects of the variables in money demand, the properties of the time series, or their joint relationship prior to estimation.

Table 3 shows the results of Andrews and Andrews and Ploberger tests. The results from both tests suggest that there is a structural break for all the variables considered together. Thus, there is strong evidence against parameter stability of the M1, M2, M3 (LF) money demand functions in South Korea and Malaysia. These results confirm those of the Hansen test. The break dates correspond to the period of the financial liberalization, 1993-1996, and the period of the Asian financial crisis, 1997-1998.

Table 3.2 Results of Hansen (1992) Test

Country	Monetary aggregate	Lc	MeanF	SupF
South Korea	M1	0.8760 (0.0696)*	27.0732 (0.01)**	97.2935 (0.01)**
	M2	1.3387 (0.01)**	86.6541 (0.01)**	372.5791(0.01)**
	LF	1.4633(0.01)**	37.8452(0.01)**	97.4366(0.01)**
Malaysia	M1	0.8576 (0.0755)*	11.4115(0.0293)**	40.5127(0.01)**
	M2	1.5011(0.01)**	29.5978(0.01)**	57.2031(0.01)**
	M3	1.5371(0.01)**	30.3461(0.01)**	59.4223(0.01)**

*,** denote the level of significance at the 10 and 5 percent, respectively.

Table 3.3 Results of Quandt-Andrews and Andrews-Ploberger Tests

Variables	Break date	Quandt-Andrews		Andrews-Ploberger		H_0: No structural break
South Korea		P-value	T-stat	P-value	T-stat	
when M1 is the dependent variable						
y	1997/11	0.221	5.2645	0.1372	1.2532	Don't reject H_0
i	1998/06	0.0441	8.8824**	0.1122	1.4023	Reject H_0 only for Quandt-Andrews
i^*	1993/05	0.0264	9.9933**	0.0095	3.3482***	Reject H_0
q	1994/01	0.0791	7.5966*	0.0779	1.6846*	Reject H_0
All variables	1997/10	0.0033	23.0410***	0.0054	7.5018***	Reject H_0
when M2 is the dependent variable						
y	1998/04	0.0007	17.6382***	0.0000	6.0408***	Reject H_0
i	1998/02	0.5643	2.9504	0.2785	0.7727	Don't reject H_0
i^*	1993/08	0.124	6.5916	0.2169	0.9342	Don't reject H_0
q	1993/08	0.0008	17.4177***	0.0002	5.2334***	Reject H_0
All variables	1993/08	0.0009	26.1164***	0.0008	9.3915***	Reject H_0
when LF is the dependent variable						
y	1997/11	0.0001	21.7564***	0.0000	7.6638***	Reject H_0
i	1996/08	0.7467	2.1576	0.4021	0.5519	Don't reject H_0
i^*	1993/04	0.0018	15.7113***	0.0009	4.6698***	Reject H_0
q	1993/08	0.0021	15.3688***	0.0024	4.1945***	Reject H_0
All variables	1993/08	0.0000	38.0007***	0.0000	15.0164***	Reject H_0

Table 3.3 Continued

Variables	Break date	Quandt-Andrews		Andrews-Ploberger		H_0: No structural break
Malaysia		P-value	T-stat	P-value	T-stat	
when M1 is the dependent variable						
y	1998/03	0.9154	1.4677	0.901	0.1477	Don't reject H_0
i	1994/03	0.4495	3.5433	0.1256	1.3182	Don't reject H_0
i^*	1994/05	0.0988	7.1015*	0.0655	1.8228*	Reject H_0
q	1998/11	0.0014	16.2566***	0.0001	5.7646***	Reject H_0
All variables	1998/10	0.0047	22.2040***	0.0023	8.3782***	Reject H_0
when M2 is the dependent variable						
y	1994/08	0.6058	2.7583	0.4044	0.5488	Don't reject H_0
i	1994/01	0.3802	3.9628	0.7345	0.2363	Don't reject H_0
i^*	1993/12	0.0123	11.6338**	0.0134	3.0961**	Reject H_0
q	1998/10	0.1113	6.8347	0.0352	2.3302**	Reject H_0 only for Andrews-Ploberger
All variables	1994/01	0.0503	16.2080**	0.0399	5.3943**	Reject H_0
when M3 is the dependent variable						
y	2006/01	0.9985	1.0030	0.9426	0.1308	Don't reject H_0
i	1994/01	0.2589	4.8919	0.7406	0.2325	Don't reject H_0
i^*	1993/12	0.0091	12.2695***	0.0143	3.0452**	Reject H_0
q	2006/09	0.241	5.0613	0.0732	1.7332*	Reject H_0 only for Andrews-Ploberger
All variables	1994/01	0.0332	17.3145**	0.0786	4.6419*	Reject H_0

*,**,*** denote the statistical significance at the 10, 5, and 1 percent levels, respectively. The maximum of the LM statistics is used by Andrews-Quandt test, while the exponentially weighted average of the LM statistics is used by Andrews-Ploberger test. The P-values are calculated using Hansen's approximations (1997) approach.

3.6.3 Unit Root Test Results

Two unit root tests are conducted in this chapter. First, the ADF test is applied to test for unit root without taking into account the structural break in the data series. Perron (1989) shows that if a structural break in the data series is not taken into account when testing for a unit root, then the researchers are more likely to falsely accept the null hypothesis of a unit root. To avoid this problem, I apply the Zivot and Andrews (ZA) test that takes into account one unknown structural break. The test statistics of the conventional ADF test are reported in Table 4, and the results of the ZA test are reported in Table 5.The results of the conventional ADF test indicate that all the series of both countries are non-stationary in levels. As a result, the null hypothesis of a unit root is not rejected at the 1 percent significance level. However, all the series are stationary in first differences. Thus, the null hypothesis of a unit root is rejected at the 5 percent significance level. The results suggest that all series, M1, M2, M3 (LF) demand, real income, short-term domestic interest rates, short-term foreign interest rates, and real exchange rates are integrated of order one, I (1).

In the case of Malaysia, the results of the ZA test indicate that the test statistics for M1 demand and the real exchange rate are less than the critical value at the 1 percent level. Unlike the ADF test, this result implies that these two variables are stationary in levels form. Consequently, the null hypothesis of a unit root is rejected. However, the remaining variables, M2 and M3 demand, the short-term domestic interest rate, the short-term foreign interest rate, and the real income, are non- stationary in their levels form. Thus, the null hypothesis of a unit root is not rejected at the 1 percent significance level. For South Korea, the null hypothesis of a unit root for all seven variables, M1, M2 ,LF demand, the real exchange rate both the foreign and the domestic interest rates and the real income, is not rejected at the 1 percent level. It is still necessary and valid to test for cointegration, even though the variables are not integrated of the same order. According to Harris (1995), it is common to test for cointegration when the variables are not integrated of the same order because unit root tests often suffer from statistical power problems and size distortion.

Table 3.4 Results of Augmented Dickey Fuller Test

Country	Variable	ADF in level	ADF in difference
South Korea	M1	-1.5521(3)	-7.2092(2)***
	M2	-1.7257(7)	-4.0580(6)***
	LF	-2.2527(1)	-10.151(1)***
	y	-2.7915(4)	-8.9563(3)***
	i	-2.9885(8)	-4.6361(11)***
	i^*	-1.3972(4)	-6.3497(3)***
	q	-2.3059(3)	-4.7463(8)***
Malaysia	M1	-2.8083(1)	-15.065(0)***
	M2	-1.6192(2)	-13.976(0)***
	M3	-1.8887 (3)	-7.4320 (2)***
	y	-3.0029(17)	-3.7009 (16)**
	i	-2.3841(4)	-7.7904(2)***
	i^*	-1.3972(4)	-6.3497(3)***
	q	-2.3313(2)	-14.903(1)***

*, **,*** denote the level of significance at the 10, 5, and 1 percent, respectively. The numbers in the parentheses are numbers of lags

Table 3.5 Results of Zivot and Andrews Unit Root Test

Country	Variables	T-statistics	Break date
South Korea	M1	-3.615(2)	1999/04
	M2	-3.590(3)	1997/05
	LF	-4.405(1)	1995/10
	y	-5.029(3)	1998/11
	i	-5.073(3)	1998/07
	i^*	-3.383(3)	2005/07
	q	-4.163(2)	1997/11
Malaysia	M1	-6.409(0)***	1998/02
	M2	-3.575(1)	1998/02
	M3	-4.424(2)	1998/02
	y	-4.268(3)	2005/03
	i	-4.753(3)	1998/09
	i^*	-3.383(3)	2005/07
	q	-7.711(3)***	1997/08

*** denotes the level of significance at the1 percent. The numbers in the parentheses are numbers of lags.

3.6.4 Cointegration Test Results

3.6.4.1 The Results of Johansen and Juselius (1990) Cointegration Test

The Johansen and Juselius cointegration test is conducted on the sample period 1990:01 to 2010:07 using monthly data for South Korea and Malaysia. The results are presented in Table 6. The selection of the lag length is based on the Akaike Information Criterion (AIC) and the Final Prediction Error (FPE).

In the case of South Korea, the results for the M1 model indicate that the trace test reveals that the null hypothesis $r \leq 1$ is rejected in favor of $r > 1$ at the 1 percent level. The maximum eigenvalue test reveals that the null hypothesis $r = 1$ is rejected in favor of $r = 2$ at the 1 percent level. The results from the trace and maximum eigenvalue tests indicate that there are at least two cointegrating vectors among M1 demand and its determinants, real income, the real exchange rate, and short-term domestic and foreign interest rates. For both the M2 and the LF models, the results of the trace test suggest that the null hypothesis of $r = 0$ is rejected in favor of $r > 0$ at the 1 percent level, while the maximum eigenvalue test suggests that the null hypothesis of $r = 0$ is rejected in favor of $r = 1$ at the 1 percent level. Taken together, these results reveal that there is at least one cointegrating vector among both M2 and LF demand and their determinants, real income, the real exchange rate, and the short-term domestic and the foreign interest rates.

For Malaysia, the results of both the trace and maximum eigenvalue tests reveal the possibility of rejecting the null hypothesis of $r = 0$, no cointegration, and indicate that there is at least one long run relationship among all the measures of money M1, M2, and M3, and their determinants, real income, the real exchange rate, and the short-term domestic and foreign interest rates.

Table 3.6 Results of Johansen Cointegration Test

Country	Monetary aggregate	H_0	H_1	λ_{trace}	5% CV	1% CV
South Korea K = 4	M1	r = 0	r > 0	101.1877***	68.52	76.07
		r ≤ 1	r > 1	56.6396***	47.21	54.46
		r ≤ 2	r > 2	20.6979	29.68	35.65
		r ≤ 3	r > 3	7.1103	15.41	20.04
		r ≤ 4	r > 4	0.0215	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	44.5481***	33.46	38.77
		r = 1	r = 2	35.9417***	27.07	32.24
		r = 2	r = 3	13.5875	20.97	25.52
		r = 3	r = 4	7.0888	14.07	18.63
		r = 4	r = 5	0.0215	3.76	6.65
South Korea K = 4	M2	H_0	H_1	λ_{trace}	5% CV	1% CV
		r = 0	r > 0	93.9911***	68.52	76.07
		r ≤ 1	r > 1	44.3532	47.21	54.46
		r ≤ 2	r > 2	21.3169	29.68	35.65
		r ≤ 3	r > 3	6.1993	15.41	20.04
		r ≤ 4	r > 4	0.3144	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	49.6379***	33.46	38.77
		r = 1	r = 2	23.0363	27.07	32.24
		r = 2	r = 3	15.1176	20.97	25.52
		r = 3	r = 4	5.8848	14.07	18.63
		r = 4	r = 5	0.3144	3.76	6.65
South Korea K = 4	LF	H_0	H_1	λ_{trace}	5% CV	1% CV
		r = 0	r > 0	101.9951***	68.52	76.07
		r ≤ 1	r > 1	46.7743	47.21	54.46
		r ≤ 2	r > 2	16.8106	29.68	35.65
		r ≤ 3	r > 3	5.0790	15.41	20.04
		r ≤ 4	r > 4	0.0679	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	55.2208***	33.46	38.77
		r = 1	r = 2	29.9637**	27.07	32.24
		r = 2	r = 3	11.7316	20.97	25.52
		r = 3	r = 4	5.0111	14.07	18.63
		r = 4	r = 5	0.0679	3.76	6.65

Table 3.6 Continued

Country	Monetary aggregate	H_0	H_1	λ_{trace}	5% CV	1% CV
Malaysia	M1	r = 0	r > 0	88.7311***	68.52	76.07
K = 12		r ≤ 1	r > 1	39.8419	47.21	54.46
		r ≤ 2	r > 2	18.1774	29.68	35.65
		r ≤ 3	r > 3	4.3493	15.41	20.04
		r ≤ 4	r > 4	1.5388	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	48.8892***	33.46	38.77
		r = 1	r = 2	21.6645	27.07	32.24
		r = 2	r = 3	13.8282	20.97	25.52
		r = 3	r = 4	2.8105	14.07	18.63
		r = 4	r = 5	1.5388	3.76	6.65
Malaysia	M2	H_0	H_1	λ_{trace}	5% CV	1% CV
K = 10		r = 0	r > 0	74.3015**	68.52	76.07
		r ≤ 1	r > 1	38.4860	47.21	54.46
		r ≤ 2	r > 2	19.4182	29.68	35.65
		r ≤ 3	r > 3	3.1052	15.41	20.04
		r ≤ 4	r > 4	0.0456	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	35.8155**	33.46	38.77
		r = 1	r = 2	19.0678	27.07	32.24
		r = 2	r = 3	16.3130	20.97	25.52
		r = 3	r = 4	3.0597	14.07	18.63
		r = 4	r = 5	0.0456	3.76	6.65
Malaysia	M3	H_0	H_1	λ_{trace}	5% CV	1% CV
K = 12		r = 0	r > 0	77.0254***	68.52	76.07
		r ≤ 1	r > 1	42.6574	47.21	54.46
		r ≤ 2	r > 2	23.6346	29.68	35.65
		r ≤ 3	r > 3	9.3283	15.41	20.04
		r ≤ 4	r > 4	1.5513	3.76	6.65
		H_0	H_1	λ_{max}		
		r = 0	r = 1	34.3680**	33.46	38.77
		r = 1	r = 2	19.0228	27.07	32.24
		r = 2	r = 3	14.3064	20.97	25.52
		r = 3	r = 4	7.77696	14.07	18.63
		r = 4	r = 5	1.5513	3.76	6.65

** and *** denote the statistical significance at the 5 and 1 percent levels, respectively.
K refers to the lag length.

3.6.4.2 The Long Run Elasticities before considering Structural Breaks

Since a long run relationship exists between M1, M2, and M3 (LF) demand and their determinants in both countries, the long run elasticities are estimated by Phillips and Hansen (1990) fully modified OLS (FMOLS) method. The results are reported in Table 7, which is divided into six panels. Panels A, B, and C contain the results for the M1, M2, and LF demand models, respectively, for South Korea, and panels D, E, and F contain the results for the M1, M2, and M3 demand models, respectively, for Malaysia.

In the case of South Korea, the results of the FMOLS estimator indicate that there is a positive and significant relationship between the three measures of money and real income and the foreign interest rate. The results also suggest that there is a negative and insignificant relationship between the real exchange rate and M1 demand. On the other hand, the results show that there is a positive and significant relationship between the real exchange rate and M2 and LF demand. This result indicates that the domestic currency is more attractive to the Korean people than foreign currency. The domestic interest rate is negatively related with M1, M2, and LF demand and it has a statistically significant impact on only M1 and M2 demand.

For Malaysia, the FMOLS results show that income has a positive and significant impact on M1, M2, and M3 demand. The income elasticity of 1.31 from the M1 model is closer to unity as suggested by the quantity theory of money. The relationship between the real exchange rate and M1 and M2 demand is negative, but it has a statistically insignificant effect on M2 demand. In contrast, the real exchange rate has a positive but insignificant impact on M3 demand. The FMOLS estimator provides interesting results about both short-term domestic and foreign interest rates. While the domestic interest rate has a negative and statistically insignificant impact on M1 demand, it has a positive and statistically significant impact on M2 and M3 demand, which is inconsistent with theory. Moreover, the foreign interest rate has a negative and statistically significant impact on M1, M2, and M3 demand, which is inconsistent with theoretical expectations.

Table 3.7 Long Run Elasticities before considering Structural Breaks

Country	Regressor	FMOLS
Panel A: South Korea (when M1 is endogenous)	Constant	0.5773 ** (0.2516)
	y	1.5409 *** (0.0854)
	i	-0.2824 *** (0.0315)
	i^*	0.0499 *** (0.0126)
	q	-0.0146 (0.0700)
Panel B: South Korea (when M2 is endogenous)	Constant	-0.9337*** (0.1128)
	y	2.0891*** (0.0382)
	i	-0.0458*** (0.0141)
	i*	0.0339*** (0.0056)
	q	0.2619 *** (0.0313)
Panel C: South Korea (when LF is endogenous)	Constant	-0.2935*** (0.1079)
	y	2.1127 *** (0.0366)
	i	-0.0071 (0.0135)
	i^*	0.0207 *** (0.0054)
	q	0.0697 ** (0.0300)

Table 3.7 Continued

Country	Regressor	FMOLS
Panel D: Malaysia (when M1 is endogenous)	Constant	0.8439*** (0.0702)
	y	1.3087 *** (0.0342)
	i	-0.0012 (0.0282)
	i^*	-0.0860*** (0.0089)
	q	-0.6064*** (0.0703)
Panel E: Malaysia (when M2 is endogenous)	Constant	0.6189*** (0.0941)
	y	1.5795 *** (0.0459)
	i	0.1383*** (0.0378)
	i^*	-0.0885*** (0.0120)
	q	-0.0457 (0.0943)
Panel F: Malaysia (when M3 is endogenous)	Constant	1.1472*** (0.0833)
	y	1.3129*** (0.0406)
	i	0.1375 *** (0.0334)
	i^*	-0.0714*** (0.0107)
	q	0.0624 (0.0835)

*,**, *** denote statistical significance at the 10, 5, and 1 percent level, respectively. The standard errors are presented parenthetically.

3.6.4.3 The Results of Gregory and Hansen (1996) Cointegration Test

The results of Gregory and Hansen (GH) test are reported in Table 8. In the case of South Korea, the results show that all three test statistics, ADF^*, Z_t^*, and Z_a^*, are insignificant in all M1 demand GH (GH1, GH2, GH3) models. This indicates that M1 demand is non-stationary and has no long run relationship with its determinants, real income, the nominal short-term domestic interest rates, the nominal short-term foreign interest rates, and real exchange rates. Thus, M1 demand is unstable in the long run. However, the results of the ADF^* test show that M2 demand is stationary in all GH models. For example, both GH1 and GH2 suggest that M2 demand is stationary at the 10 percent level, while GH3 suggests that M2 demand is stationary at the 5 percent level. Thus, M2 demand is stable and has a long run relationship with its determinants. Also, all three GH models suggest that LF demand is stationary. LF demand records significant ADF^* statistics and Z_t^* statistics at the 1 and 5 percent significance level, respectively, in the

GH2 model and significant ADF^* statistics and Z_t^* statistics at the 1 and 10 percent significance level, respectively, in the GH3 model. Thus, M2 and LF demand could play an important role in the conduct of monetary policy of South Korea since both are stable.

The results of the GH test for Malaysia are also reported in Table 8. All three models of GH suggest that M1 demand is cointegrated and has a long run relationship with its determinants, real income, short-term domestic and foreign interest rates, and the real exchange rates. All test statistics, ADF^*, Z_t^*, and Z_a^*, are significant at the 1 percent level. However, for M2 and M3 demand, only the Z_t^* and Z_a^* statistics are significant at the 1 and 5 percent levels, respectively, in both the GH1 and GH3 models. These results indicate that both M2 and M3 demand are cointegrated with their determinants. Thus, in the case of Malaysia, M1, M2, and M3 demand are stable, meaning that all three measures of money could play a more important role in the conduct of monetary policy of Malaysia.

As supplemental data, the graphs of the regime shifts with the ADF* are reported in Appendix C. These graphs illustrate when the structural breaks occur by taking the minimum t-statistics of the ADF^*. The test statistic is computed for each break point in the interval (0.15T, 0.85T), which means that a structural break could not occur at the start and the endpoint of the sample. Thus, 2008, the year of global financial crisis, did not appear as one of the break dates that may affect money demand functions in both countries.

Table 3.8 Results of the Gregory and Hansen Cointegration Test

Country	Monetary aggregate	model	Break date	GH statistics (ADF*)	GH statistics (Zt*)	GH statistics (Za*)
South Korea	M1	GH1	2007/07	-3.9993(1)	-3.8096	-27.9120
		GH2	2000/08	-5.0365(1)	-4.5912	-40.1242
		GH3	2000/08	-5.5707 (1)	-5.1609	-50.0885
	M2	GH1	2003/03	-5.4209 (1)*	-4.8397	-39.5999
		GH2	2006/08	-5.7371 (1)*	-4.9083	-41.4304
		GH3	2000/11	-6.4545 (1)**	-5.8248	-57.8911
	LF	GH1	2004/04	-6.7215 (1)***	-5.7959**	-57.5674 *
		GH2	2004/05	-6.9379 (1)***	-5.9756 **	-59.9209
		GH3	2003/05	-7.3616 (1)***	-6.1982 *	-62.6868
Malaysia	M1	GH1	2007/03	-7.3847(0)***	-7.1797***	-81.6952***
		GH2	1998/07	-7.6489(1)***	-7.2775***	-90.5979***
		GH3	1994/09	-8.4799(0)***	-8.1735***	-101.3548***
	M2	GH1	1997/10	-4.9958(1)	-6.4306***	-67.1085**
		GH2	2001/10	-4.7835(2)	-4.3582	-36.8156
		GH3	1997/10	-5.2428(1)	-7.2598***	-81.8926**
	M3	GH1	1997/10	-5.1108(1)	-6.7214***	-67.9099**
		GH2	1997/09	-4.5431(0)	-4.2405	-31.7119
		GH3	1999/07	-5.7771(3)	-7.9605***	-94.3245***

*,**,*** denote the significance at the 10, 5, and 1 percent levels, respectively, using 4 regressors critical values. Lags are presented parenthetically.

For South Korea, most of the break dates refer to various recognizable events. For instance, the years 2000 and 2004 correspond to the financial innovation and the interest rate liberalization, respectively. The break dates 2003 and 2007 may refer indirectly to the foreign exchange market reform that occurred in 2002 and the global financial crisis that occurred in 2008, respectively. In the case of Malaysia, the period of 1997-1998 corresponds to the Asian financial crisis, and the year 1994 refers to the financial liberalization.

As a whole, the results of the GH cointegration test show that the M2 and LF demand in South Korea are stable in the long run. On the other hand, the results show that there are still some serious doubts about the stability of the M1 demand in South Korea. In fact, the cash in advance model along with the GH test raise important questions about the stability of the M1 demand. The structural breaks could not be fairly absorbed by the M1 demand specification in

South Korea. For Malaysia, the results of the GH test suggest that M1, M2, and M3 demand are stable in the long run.

3.6.4.4 The Long Run Elasticities after considering the Structural Breaks

In section 3.6.4.3, I found that there is a long run relationship for South Korea between M2 and LF demand and their determinants. Also, I found that a long run relationship exists between the three measures of money, M1, M2, and M3 and their determinants for Malaysia. In this section, the long run elasticities are estimated by the Phillips and Hansen (1990) fully modified OLS (FMOLS) method to get the optimal estimation of the money demand function in both countries. The results of the FMOLS estimator are presented in Table 9 for both countries.

In the case of South Korea, columns 3, 4, and 5 contain the results of FMOLS for all three models of GH for M2 and LF demand. For Malaysia, columns 3, 4, and 5 contain the results of the FMOLS estimator for all M1 demand models of GH (GH1, GH2, GH3), respectively. However, for M2 and M3 demand, columns 3 and 5 contain the results of the FMOLS estimator for GH1 and GH3, respectively. Table 9 is divided into 5 panels. The first two panels, A, and B contain the results for South Korea for the M2 and LF demand models, respectively, and the last three panels, C, D, and E contain the results for the M1, M2, and M3 demand models, respectively, for Malaysia.

In the case of South Korea, the null hypothesis of no cointegration is rejected by all the models of GH for M2 and LF demand. Therefore, the cointegrating equations are estimated by the FMOLS estimator. For M2 demand, GH1 seems to be the most plausible model, although the estimate of the income elasticity at 2.289 seems to be high. This model shows that real income has a positive and statistically significant impact on M2 demand at the 1 percent level. The domestic interest rate is negatively related with M2 demand and is statistically significant at the

1 percent level. This implies that the opportunity cost increases with the increase in the domestic interest rate, which is consistent with theoretical expectations. The foreign interest rate has a positive and statistically significant impact on M2 demand at the 1 percent level. The results of both interest rates suggest that demand for M2 responds more to the domestic interest rates than to the foreign interest rate in South Korea. An interesting result is found about the relationship between the real exchange rate and M2 demand. The real exchange rate is positively related with M2 demand and is statistically significant at the 1 percent level. This implies that there is no evidence of currency substitution, since an increase in the real exchange rate leads to an increase in the demand for M2 in South Korea. In fact, the depreciation of the Korean currency makes it more attractive for Koreans to hold domestic currency instead of foreign currency.

For LF demand, the GH2 seems to be a more plausible model, even though the estimated income elasticity is high at 2.4. This model shows that real income is positively related to LF demand and is statistically significant at the 1 percent level, which is consistent with theoretical expectations. Also, the short-term domestic interest rate is negatively related with LF demand, and it has a statistically significant impact on LF demand. The short-term foreign interest rate influence is consistent with theoretical expectations, but it has an insignificant impact on LF demand. The results of both interest rates imply that demand for LF responds more to the short-term domestic interest rate than to the foreign interest rate in South Korea. The relationship between the real exchange rate and LF demand shows that there is evidence for currency substitution, since an increase in the real exchange rate leads to a decrease in the demand for LF. This implies that foreign currency is more attractive for Koreans to hold. The income elasticity of 2.29 and 2.4 in the M2 and LF demand models, respectively, indicate that the Korean economy is becoming monetized, meaning that for every one percent increase in real income, the M2 and LF demand increase by 2.29 and 2.4 percent, respectively.

For Malaysia, the null hypothesis of no cointegration is rejected by all the models of GH (GH1, GH2, GH3) for M1 demand. However, the null is only rejected by the GH1 and GH3 models for M2 and M3 demand, respectively. Thus, it is hard to decide which model is the best for estimating the long run elasticities. Therefore, the cointegrating equations are estimated by FMOLS for M1, M2, and M3 demand. The results suggest that GH2 is the most plausible model for M1 demand, even though the income elasticity of 0.24 is low. This model shows that real income and the short-term foreign interest rates have a positive and statistically significant effect on M1 demand at the 1 percent significance level, which is consistent with economic theory. The short-term domestic interest rate has a negative and statistically significant effect at the 1 percent level on the M1 demand. The magnitude, in absolute value, of the short-term domestic interest rate is greater than the magnitude of the short-term foreign interest rate. This result suggests that the demand for M1 responds more to the short-term domestic interest rate than to the short-term foreign interest rate in Malaysia.

In addition, the Malaysian results suggest that there is a negative relationship between the real exchange rate and M1 demand. This implies that an increase in the real exchange rate leads to a decrease in the M1 demand. Thus, the depreciation of the Malaysian currency will reduce the demand for M1, meaning that Malaysians will prefer to hold foreign currency.

The results of the FMOLS for M2 demand suggest that GH1 is the most plausible model for M2 demand. The income elasticity of 1.31 indicates that the Malaysian economy is becoming monetized. The model shows that there is a positive and significant relationship between real income and M2 demand. This means that for every one percent increase in real income, M2 demand increases by 1.31 percent. However, the results of both interest rates are inconsistent with theoretical predictions; the short-term domestic interest rate has a positive and significant relationship with M2 demand, while the short-term foreign interest rate has a negative and significant relationship with M2 demand. In the GH3 model, the domestic interest rate is consistent with theoretical predictions, but it has a statistically insignificant impact on M2 demand. The real exchange rate has a negative relationship with M2 demand and is statistically significant at the 1 percent level.

For M3 demand, the GH1 model seems to be the most plausible model. The income elasticity of 1.05 is close to unity, which is consistent with the quantity theory. The results of this model indicate that real income has a positive and significant impact on M3 demand at the 1 percent level. However, the results of both interest rates are inconsistent with theoretical predictions, but they have a statistically significant impact on M3 demand. The relationship between the real exchange rate and M3 demand is negative. This implies that Malaysians prefer to hold foreign currency instead of the domestic currency. The results of the FMOLS estimator for all monetary aggregates, M1, M2, and M3, indicate the presence of currency substitution in Malaysia.

Table 3.9 Long Run Elasticities after considering Structural Breaks

Panel A	Regressor	FMOLS	FMOLS	FMOLS
South Korea (when M2 is endogenous)		GH1	GH2	GH3
	Constant	-0.7590*** (0.0896)	-2.4870*** (0.2366)	-0.8088*** (0.0730)
	y	2.2890*** (0.0372)	3.1836*** (0.1567)	2.3216*** (0.0335)
	i	-0.0605*** (0.0111)	-0.1256*** (0.0159)	-0.0956*** (0.0099)
	i^*	0.0234*** (0.0046)	0.0368*** (0.0053)	0.0805*** (0.0125)
	q	0.0895*** (0.0304)	0.1794*** (0.0318)	0.0861*** (0.0280)
	dummy 2003/03	-0.0536*** (0.0060)		
	Trend		-0.0019*** (0.0003)	
	dummy 2006/08		0.0427*** (0.0080)	
	dummy 2000 /11			0.9825*** (0.3304)
	y dummy 2000/11			-0.4790*** (0.0899)
	i dummy 2000/11			0.17637*** (0.0259)
	i^* dummy 2000/11			-0.1093*** (0.0152)
	q dummy 2000/11			-0.0471 (0.0637)
Panel B	Regressor	FMOLS	FMOLS	FMOLS
South Korea (when LF is endogenous)		GH1	GH2	GH3
	Constant	0.4125***(0.0957)	-0.3263 (0.2060)	-0.0212 (0.0626)
	y	1.8232*** (0.0358)	2.3609*** (0.1361)	2.4404*** (0.0289)
	i	-0.0313***(0.0097)	-0.0492*** (0.0098)	-0.0252*** (0.0079)
	i^*	0.0045 (0.0041)	0.0031 (0.0038)	0.0259*** (0.0066)
	q	0.0120 (0.0216)	-0.0454* (0.0242)	-0.2160*** (0.0234)
	dummy 2004/05	0.0640*** (0.0055)	0.0496*** (0.0064)	
	Trend		-0.0007*** (0.0002)	
	dummy 2003/05			1.1394*** (0.3347)
	y dummy 2003/05			-0.6668*** (0.0878)
	i dummy 2003/05			0.0847*** (0.0238)
	i^* dummy 2003/05			-0.0531*** (0.0114)
	q dummy 2003/05			0.0333 (0.0730)

Table 3.9 Continued

Panel C	Regressor	FMOLS	FMOLS	FMOLS
Malaysia (when M1 is endogenous)		GH1	GH2	GH3
	Constant	0.9473*** (0.0669)	2.4251*** (0.0849)	2.2853*** (0.3431)
	y	1.2115*** (0.0360)	0.2439*** (0.0538)	0.3277** (0.1319)
	i	-0.0159 (0.0259)	-0.1528*** (0.0187)	-0.4750*** (0.0579)
	i^*	-0.0636*** (0.0096)	0.0202*** (0.0068)	-0.3990*** (0.0493)
	q	-0.4791*** (0.0679)	-0.3762*** (0.0485)	1.0621** (0.4526)
	dummy 2007/03	0.0603*** (0.0119)		
	Trend		0.0029*** (0.0001)	
	dummy 1998/07		-0.1138*** (0.0120)	
	dummy 1994/09			-1.6140*** (0.3506)
	y dummy 1994/09			1.0577*** (0.1366)
	i dummy 1994/09			0.5102*** (0.0620)
	i^* dummy 1994/09			0.3162 *** (0.0498)
	q dummy 1994/09			-1.659*** (0.4557)
Panel D	**Regressor**	**FMOLS**	**FMOLS**	**FMOLS**
Malaysia (when M2 is endogenous)		GH1	GH2	GH3
	Constant	1.6438*** (0.1459)		1.2882*** (0.2105)
	y	1.3082*** (0.0506)		1.3996*** (0.0759)
	i	0.1137*** (0.0321)		-0.0227 (0.0576)
	i^*	-0.0735*** (0.0105)		-0.2299*** (0.0457)
	q	-1.4119*** (0.1837)		-0.4074 (0.2750)
	dummy 1997/10	0.2746*** (0.0337)		0.6913** (0.2948)
	y dummy 1997/10			-0.0200 (0.0980)
	i dummy 1997/10			0.1713** (0.0673)
	i^* dummy 1997/10			0.1646*** (0.0468)
	q dummy 1997/10			-1.3988*** (0.3510)

Table 3.9 Continued

Panel E	Regressor	FMOLS	FMOLS	FMOLS
		GH1	GH2	GH3
Malaysia (when M3 is endogenous)	Constant	2.1412*** (0.1233)		0.8320*** (0.0741)
	y	1.0503*** (0.0428)		1.5805***(0.0423)
	i	0.1126*** (0.0272)		0.0374 (0.0320)
	i^*	-0.0565*** (0.0088)		-0.3076*** (0.0317)
	q	-1.2628*** (0.1553)		0.3175*** (0.0653)
	dummy 1997/10	0.2658*** (0.0285)		
	dummy 1999/09			1.6133*** (0.2094)
	y dummy 1999/09			-0.5194*** (0.0835)
	i dummy 1999/09			-0.1410 (0.0885)
	i^* dummy 1999/09			0.2710*** (0.0337)
	q dummy 1999/09			-1.5321*** (0.2064)

*,**,*** denote the significance at the 10, 5, and 1 percent level, respectively. The numbers in parentheses are standard error.

3.6.5 Granger Causality Test Results

In this section, the Granger-causality test results are discussed for the variables, M1, M2, and M3 (LF) demand, i, i^*, and q. The findings are reported in Table 10 that is divided into 5 panels. Panels A and B contain the results of the Granger causality test for South Korea when M2 and LF demand are endogenous, and panels C, D, and E contain the results of the Granger causality test for Malaysia when M1, M2, and M3 demand are endogenous. Initially, the results that are directly related to the long run model of the money demand are discussed. This discussion centers on whether or not real income, nominal short-term domestic and foreign interest rates, and real exchange rate Granger cause real money demand and vice versa.

It is worth noting that a significant error correction term (ECT) with a negative sign implies that agents correct a proportion of previous disequilibrium in the current period (Rose (1985)). Also, it suggests that the cointegration relationship established previously is valid as per

Granger's representation theorem (Engle and Granger (1987))[17]. Moreover, it implies that when there is a deviation between the actual and the long run equilibrium level, an adjustment occurs back to the long run relationship in subsequent periods to eliminate this discrepancy (Hwang (2002)).

For South Korea, the coefficients of the ECT are around -0.02, and -0.05 for the M2 and LF demand, respectively. These coefficients imply that 2% and 5% of the previous month's discrepancy between the actual and the long run equilibrium of M2 and LF demand, respectively, are corrected each month. For Malaysia, the adjustment coefficients of the ECT are around -0.27, -0.03, -0.02 for M1, M2, and M3 demand, respectively. These coefficients reveal that approximately 27%, 3%, and 2% of the previous month's discrepancy between the actual and the long run equilibrium of M1, M2, and M3 demand, respectively, are corrected each month.

In the case of South Korea, the real income and real exchange rate Granger cause M2 demand at the 1 and 10 percent, respectively, in the short run. The results also indicate that M2 demand Granger causes real income at the 1 percent level. In the long run, all the variables Granger cause M2 demand via the one period lagged error correction term. For LF demand, the short run results indicate that only the real income Granger causes LF demand at the 1 percent level. In addition, there is evidence that LF demand Granger causes only real income at the 1 percent level. However, the long run results indicate that all variables Granger cause LF demand via the one lagged error correction term.

For Malaysia, the short run results indicate that both real income and the short-term domestic interest rate Granger cause M1 demand at the 1 percent level. However, there is no

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[17] According to the Granger's representation theorem, if a set of variables is first order integrated, then cointegration and error correction are equivalent.

evidence of causality running from the short-term foreign interest rate and the real exchange rate to M1 demand. Also, the results show that M1 demand Granger causes real income and the short-term domestic interest rate at the 5 percent level and short-term foreign interest rate at the 10 percent level. In the long run, the results indicate that the one period lagged error correction is statistically significant at the 1 percent level, meaning that all the variables Granger cause M1 demand.

The short run results for M2 demand show that only real income Granger causes M2 demand at the 10 percent level. There is no evidence of causality running from the short-term domestic interest rate, the short-term foreign interest rate, and the real exchange rate to M2 demand. On the other hand, the results show that M2 demand Granger causes both the real exchange rate and the short-term domestic interest rate at the 5 percent level and the short-term foreign interest rate at the 1 percent level. In the long run, the results suggest that all variables Granger cause M2 demand since the one period lagged error correction term is statistically significant at the 5 percent level of significance.

Moreover, the short run results of M3 demand indicate that there is no evidence of causality running from real income, real exchange rate, and short-term domestic interest rate to M3 demand; however, the short-term foreign interest rate does Granger cause M3 demand. The results show causality running from M3 demand to both real income and the short-term foreign interest rate at the 5 and 10 percent level, respectively. In the long run, the results indicate, at the 5 percent level of statistical significance, that causality runs from all the variables to M3 demand through the one period lagged error correction term.

Table 3.10 Results of Granger Causality Test

Country	Dependent variable	Δ M2	Δ y	Δ q	Δ i	Δ i^*	ECT_{t-1}
South Korea Panel A		F-statistics (probability values)					T-statistics (coefficient)
	Δ M2	-	24.92*** (0.0000)	2.14* (0.0764)	1.50 (0.2039)	0.92 (0.4509)	-1.80* (-0.0238)
	Δ y	20.86*** (0.0000)	-	4.28 *** (0.0024)	2.11* (0.0800)	3.25 ** (0.0128)	-1.89* (-0.0291)
	Δ q	0.39 (0.8146)	0.99 (0.4154)	-	4.12*** (0.0031)	1.66 (0.1610)	-2.14** (-0.0419)
	Δ i	0.83 (0.5098)	1.84 (0.1222)	8.51*** (0.0000)	-	5.75*** (0.0002)	-3.93*** (-0.0746)
	Δ i^*	1.20 (0.3123)	2.61** (0.0362)	9.20*** (0.0000)	1.53 (0.1940)	-	-1.28 (-0.0117)
South Korea Panel B	Dependent variable	Δ LF	Δ y	Δ q	Δ i	Δ i^*	ECT_{t-1}
	Δ LF	-	10.08*** (0.0000)	1.91 (0.1279)	0.95 (0.4157)	0.14 (0.9384)	-3.33*** (-0.0536)
	Δ y	6.06*** (0.0006)	-	1.54 (0.2046)	0.95 (0.4170)	1.55 (0.2031)	-4.99*** (-0.1426)
	Δ q	0.56 (0.6453)	0.33 (0.8034)	-	0.61 (0.6110)	1.21 (0.3063)	-2.04** (-0.0464)
	Δ i	0.17 (0.9175)	1.61 (0.1875)	2.08 (0.1036)	-	2.55 * (0.0562)	-3.17*** (-0.0681)
	Δ i^*	0.69 (0.5563)	0.50 (0.6815)	10.17*** (0.0000)	0.80 (0.4934)	-	-2.21** (-0.0193)

Table 3.10 Continued

Country	Dependent variable	Δ M1	Δ y	Δ q	Δ i	Δ i^*	ECT_{t-1}
Malaysia Panel C		F-statistics (probability values)					T-stat (coefficient)
	Δ M1	-	3.12*** (0.0003)	1.55 (0.1055)	2.27*** (0.0089)	1.22 (0.2674)	-4.09*** (-0.2665)
	Δ y	2.07** (0.0181)	-	1.44 (0.1465)	1.06 (0.3954)	1.92** (0.0310)	-0.83 (-0.0545)
	Δ q	1.24 (0.2566)	1.46 (0.1364)	-	8.45*** (0.0000)	0.78 (0.6818)	-1.59 (-0.0693)
	Δ i	2.06** (0.0192)	1.07 (0.3858)	4.29*** (0.0000)	-	1.26 (0.2402)	-1.69* (-0.0782)
	Δ i^*	1.69* (0.0659)	0.73 (0.7363)	0.96 (0.4970)	0.60 (0.8492)	-	-3.64*** (-0.0565)
Malaysia Panel D	Dependent variable	Δ M2	Δ y	Δ q	Δ i	Δ i^*	ECT_{t-1}
	Δ M2	-	1.63* (0.0822)	1.07 (0.3885)	0.84 (0.6127)	1.10 (0.3641)	-2.22** (-0.0313)
	Δ y	1.05 (0.4019)	-	1.71* (0.0624)	0.79 (0.6751)	1.57* (0.0967)	-1.33 (-0.0768)
	Δ q	2.06** (0.0192)	1.12 (0.3449)	-	8.78 (0.0000)	1.17 (0.3051)	-2.81*** (-0.1217)
	Δ i	1.85** (0.0397)	1.07 (0.3912)	5.83 *** (0.0000)	-	1.46 (0.1360)	-2.90 *** (-0.088)
	Δ i^*	2.49*** (0.0039)	0.54 (0.8938)	1.03 (0.4269)	0.67 (0.7872)	-	-2.61*** (-0.0319)
Malaysia Panel E	Dependent variable	Δ M3	Δ y	Δ q	Δ i	Δ i^*	ECT_{t-1}
	Δ M3	-	1.71 (0.1829)	0.61 (0.5462)	1.03 (0.3588)	2.41* (0.0922)	-2.37** (-0.0195)
	Δ y	3.36** (0.0365)	-	4.91*** (0.0081)	1.55 (0.2146)	5.16*** (0.0064)	-4.45*** (-0.1816)
	Δ q	1.08 (0.3414)	0.96 (0.3839)	-	2.14 (0.1194)	0.37 (0.6921)	-2.90*** (-0.1074)
	Δ i	0.50 (0.6075)	0.52 (0.5978)	2.51* (0.0834)	-	0.13 (0.8789)	-2.09** (-0.0492)
	Δ i^*	2.32* (0.1009)	0.11 (0.8971)	1.36 (0.2585)	0.06 (0.9415)	-	-0.75 (-0.0068)

*,**,*** denote the statistical significance at 10, 5, and 1 percent level, respectively. Probability values are shown in parentheses.

3.7 Summary and Conclusion

This chapter aims to estimate the money demand function for two Asian countries, South Korea and Malaysia, using three monetary aggregates M1, M2, and M3 (LF) as proxies for money demand for the 1990:01 - 2010:07 period. The choice of the specification of the money demand function is based on the cash in advance model. This model provides a broad specification of the money demand function, because it adds short-term foreign interest rates and real exchange rates, in addition to real income and short-term domestic interest rates, as determinants for money demand.

There are several key findings in this chapter. The results of the parameters instability tests reveal that the money demand function is unstable in the two countries in the long run for all monetary aggregates M1, M2, and M3 (LF). Despite the structural changes, the results of the Johansen and Juselius (1990) test indicate that all definitions of money demand in both countries are stable. However, the results of the Gregory and Hansen (1996) (GH) test show that there is still some doubt about the stability of the M1 demand in South Korea. The long run elasticities are estimated by FMOLS estimators before and after considering the structural breaks for both countries. The long run elasticities, after considering the structural breaks, seem to be more plausible.

For South Korea, GH1 and GH2 seem to be more plausible models for M2 and LF demand, respectively. The long run elsticities reveal that real income is positively related with M2 and LF demand and is statistically significant at the 1 percent level. The short-term domestic interest rate is statistically significantly and negatively related to M2 and LF; however, the foreign interest rate is positively related with M2 and LF demand, but only statistically significant for M2 demand. Also, the results reveal that the real exchange rate has a positive and significant effect on M2 demand at the 1 percent level and a negative and significant effect on LF demand at the 10 percent level. This result shows that there is evidence of currency substitution when LF is used as a proxy for money demand.

For Malaysia, the GH2 is suggested to be the most plausible model for M1 demand. The results of this model reveal that the real income and the short-term foreign interest rates have a statistically significant positive effect on M1 demand while both the short-term domestic interest rates and the real exchange rate have a statistically significant negative effect on M1 demand. For both M2 and M3 demand, the GH1 model appears to be the most plausible model. The model shows that there is a positive and significant relationship between real income and both M2 and M3 demand. Inconsistent with theoretical expectations, the short-term domestic interest and foreign interest rates are positively and negatively, respectively, related to M2 and M3 demand. The real exchange rate is negatively related to both M2 and M3 demand and is statistically significant at the 1 percent level. The negative relationship between the real exchange rates and the monetary aggregates M1, M2, and M3 indicate that there is evidence of currency substitution in Malaysia. The M2 demand model indicates that the Malaysian economy is becoming monetized, since the income elasticity is more than unity.

The findings of the Granger causality test reveal that for South Korea, in the short run, both real income and real exchange rate Granger cause M2 demand; however, only real income Granger causes LF demand. In the long run, all variables Granger cause M2 and LF demand. In the case of Malaysia, only real income and the short-term domestic interest rate Granger cause M1 demand in the short run; in the long run all variables Granger cause M1 demand. Also, in the short run, real income and the foreign interest rate Granger cause both M2 and M3 demand, while in the long run all variables Granger cause M2 and M3 demand.

Some policy implications emerge from this chapter. First, there was evidence from both the Johansen and Juselius and GH cointegration tests that a long run relationship exists between M1, M2, and M3 demand and their determinants in the case of Malaysia and between M2 and LF demand and their determinants for South Korea. Therefore, it is possible for policymakers to conduct money targeting using M1, M2 and M3 for the conduct of monetary policy in the case of Malaysia, and in South Korea, M2 and LF may be used by policymakers. Next, the depreciation of the domestic currency decreases the demand for M1, M2, and M3 in Malaysia, and LF in South Korea. This implies that Malaysians and Koreans substitute domestic currency for foreign currency, which indicates the presence of currency substitution in these countries. Due to the currency substitution, South Korea and Malaysia lose revenue from seigniorage. Consequently, policymakers are not able to maintain monetary control.

Using the cash in advance model, instead of the traditional (Keynesian) money demand model, gives policymakers results to indicate if the demand for money responds more to the short-term domestic interest rate or to the short-term foreign interest rate. Also, policymakers are able to determine if the depreciation of the domestic currency can lead to currency substitution.

The cash in advance model and the residual-based tests, which allow for a structural break with unknown timing, raise important questions about the stability of the M1 demand in South Korea. Further research on this issue should depart from linear models and use nonlinear specifications, such as the Smooth Transition Regression models (the STR).

Bibliography

Andrews, D. (1993). Tests for Parameter Instability and Structural Change with Unknown Change Point. *Econometrica*, *61*, 821-856.

Andrews, D. and W. Ploberger (1994). Optimal Tests when a Nuisance Parameter is present only under the Alternative. *Econometrica*, *62*, 1383-1414.

Anoruo, E. (2002). Stability of the Nigerian M2 Money Demand Function in the SAP period. *Economics Bulletin,14*, 1-9.

Austin, D. and B. Ward (2007). The Demand for Money in China 1987-2004: A Non-Linear Modeling Approach. *China Economic Review*, *18*, 190-204.

Bahmani-Oskooee, M. (1991). The Demand for Money in an Open Economy the United Kingdom. *Applied Economics*, *23*, 1037-1042.

Bahmani-Oskooee, M. and H. Rhee (1994). Long-Run Elasticities of the Demand for Money in Korea: Evidence from Cointegration Analysis. *International Economic Journal*, 83-93.

Bahamani-Oskooee, M. (2002). Stability of the Demand for Money in Korea. *International Economic Journal*, *16*, 85-95.

Bahamani-Oskooee, M. and A.Tanku (2006). Black Market Exchange Rate, Currency Substitution and the Demand for Money in LDCs. *Economic Systems*, *30*, 249-263.

Baharumshah, A., S. Mohd and A. Masih (2009). The Stability of Money Demand Function in China: Evidence from the ARDL Model. *Economic Systems*, *33*, 231-244.

Ball, L. (2001). Another Look at Long-Run Money Demand. *Journal of Monetary Economics*, *47*, 31-44.

Ball, L. (2002). Short-Run Money Demand. *NBER Working Paper*, No. 9235.

Baumol, W. (1952). The Transaction Demand for Cash: An Inventory Theoretic Approach. *The Quantity Journal of Economics*, *66*, 545-556.

Breuer, J. and A. Lippert (1996). Breaks in Money Demand. *Southern Economic Journal*, *63*, 496-506.

Brunner, K. and A. Meltzer (1967). Economies of Scale in Cash Balances Reconsidered. *Quarterly Journal of Economics*, *81*, 422-436.

Scharnagl, M. (1998). The Stability of German Money Demand: Not just a Myth. *Emprical Economics*, *23*, 355-370.

Chandrasekhar, C. and J. Ghosh (1999). Financial Crisis and Elusive Recovery: Lessons from South Korea and Thailand. *Economic and Political Weekly*, *34*, 273-286.

Cheong, C. (2003). Regime Changes and Econometric Modeling of the Demand for Money in Korea. *Economic Modelling*, *20*, 437-453.

Cho, W. and W. Miles (2007). Financial Innovation and the Stability of Money Demand in Korea. *Journal of the Southwestern Society Economists*, *34*, 55-60.

Choi, K. and J. Chulho. (2009). Structural Changes and the US Money Demand Function. *Applied Economics*, *41*, 1251-1257.

Chukwu, J., C. Agu and F. Onah (2010). Cointegration and Structural Breaks in Nigerian Long-Run Money Demand Function. *International Research Journal of Finance and Economics*, *38*, 1450-2887.

Dagher, J. and A. Kovanen (2011). The Stability of Money Demand in Ghana: A Bounds Testing Approach. *IMF working paper*.

Darrat, A. and S. Al-Sowaidi (2009). Financial Progress and the Stability of Long-Run Money Demand: Implications for the Conduct of Monetary Policy in Emerging Economies. *Review of Financial Economics*, *18*, 124-131.

Dickey, D. and W. Fuller (1979). Distributions of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, *14*, 1057-1072.

Ericsson, N., D. Hendry, and K. Prestwich (1998). The Demand for Broad Money in the United Kingdom, 1878-1993. *The Scandinavian Journal of Economics*, *100*, 289-324.

Ericsson, N. and S. Sharma (1998). Broad Money Demand and Financial Liberalization in Greece. *Empirical Economics*, *23*, 417-436.

Enders, Walter (2010). *Applied Econometric Time Series*. Hoboken, NJ: John & Sons.

Engle, R. and C. Granger (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, *55*, 251-276.

Friedman, M. (1956). *Studies in Quantity Theory of Money*. Chicago, IL: University of Chicago press.

Goldfeld, S. (1976). The Case of the Missing Money. *Brookings Papers on Economic Activity*, *3*, 683-730.

Goldfeld, S.and D. Sichel (1990). The Demand for Money (Ch.8). *Handbook of Monetary Economics*, *1*, 299-356.

Granger, C. (1988). Some Recent Developments in a Concept of Causality. *Journal of Econometrics*, *39*, 199-211.

Gregory, A. and B. Hansen (1996). Residual-based Tests for Cointegration in Models with Regime Shifts. *Journal of Econometrics*, *70*, 99-126.

Gregory, A., J. Nason, and D. Watt (1996). Testing for Structural Breaks in Cointegrated Relationships. *Journal of Econometrics* , *71*, 321-341.

Hansen, B. (1992). Tests for Parameter Instability in Regressions with I (1) Processes. *Journal of Business & Economic Statistics*, *10*, No. 3.

Hansen, B. (2000). Testing for Structural Change in Conditional Models. *Journal of Econometrics*, *97*, 93-115.

Harris, R. (1995). *Using Cointegration Analysis in Econometric Modeling*. Hemel Hempstead, England: Harvester Wheatsheaf, Prentice Hall.

Haug, A. and R. Lucas (1996). Long-Term Money Demand in Canada: In Search of Stability. *The Review of Economics and Statistics*, *78,* 345-48.

Hossain, A. (2010). Monetary Targeting for Price Stability in Bangladesh: How Stable is its Money Demand Function and the Linkage between Money Supply Growth and Inflation. *Journal of Asian Economics*, *21,* 564-578.

Hossain, M. and A. Chowdhury (1996). *Monetary and Financial Policies in Developing Countries: Growth and Stabilization*. London, England: Routledge.

Hueng, C. (1998).The Demand for Money in an Open Economy: Some Evidence for Canada. *Journal of Economics and finance*, *9*, 15-31.

Hwang, J. (2002). The Demand for Money in Korea: Evidence from the Cointegration Test. *International Advances in Economic Research, 8*, 188-195.

James, G. (2005). Money Demand and Financial Liberalization in Indonesia. *Journal of Asian Economics, 16,* 817-829.

Johansen , S. and K. Juselius (1990). Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics*, *52*, 169-210.

Keynes, J. (1936). *The General Theory of Employment, Interest, and Money*. London, England: Macmillan.

Kumar, S. (2011). Financial Reforms and Money Demand: Evidence from 20 Developing Countries. *Economic Systems*, *35*, 323-334.

Laidler, D. (1993).*The Demand for money: Theories, Evidence, and Problems*. London, England: Harper Collins College Publishers.

Lee, C. and C. Chang (2005). Structural Breaks, Energy Consumption, and Economic Growth Revisited: Evidence from Taiwan. *Energy Economics*, *27*, 857-872.

Lee, C. and M.Chien (2008). Stability of Money Demand Function Revisited in China. *Applied Economics, 40*, 3185-3197.

Lee, T. and K. Chung (1995). Further Results on the Long Run Demand for Money in Korea: A Cointegration Analysis. *International Economic Journal*, *9*, 103-113.

Manap, T. (2009). Stability of Long-Run Money Demand Function: Evidence from Malaysia. *Journal of Economics and Management*, *17*, 261-85

Mankiw, N. (2003). *Macroeconomics*. New York, NY: Worth Publishers.

Miteza, I. (2009). Non-Linear Dynamics in Money Demand: Evidence from Korea. *Journal of International Finance and Economics*, *9*, 81-91.

Mundell, A. (1963). Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates. *Canadian Journal of Economics and Political Science*, *29*, 475-485.

Nair, M., M. Samudram, and S. Vaithilingam (2008). Malaysian Money Demand Function Revisited: The ARDL Approach. *Journal of Asian specific Business, 9*, 193-209.

Nagayasu, J. (2003). A Re-examination of the Japanese Money Demand Function and Structural Shifts. *Journal of Policy Modeling*, *25*, 359-375.

Narayan, P. (2007). Is Money Targeting an Option for Bank Indonesia?. *Journal of Asian Economics, 18*, 726-738.

Narayan, P., S. Narayan, and V. Mishra (2009). Estimating Money Demand Functions for South Asian Countries. *Empire Econ*, *36*, 685-696.

Orden, D. and L. Fisher (1993). Financial Deregulation and the Dynamics of Money, Prices, and Output in New Zealand and Australia. *Jorunal of Money, Credit, and Banking*, *25*, 273-92.

Perron, P. (1989). The Great Crash, the Oil-Price Shock, and the Unit Root Hypothesis. *Econometric*, *57*, 1361-1401.

Ping, L. and T. Yean (2007). Malaysia Ten Years after the Asian Financial Crisis. *Asian Survey*, *47*, 915-929.

Poole, W. (1970). Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model. *Quarterly Journal of Economics*, *84*, 197-216.

Pradhan, B. and A. Subramanian (2003). On the Stability of Demand for Money in a Developing Economy: Some Empirical Issues. *Journal of Development Economics*, *72*, 335-351.

Ramachandran, M. (2004). Do Broad Money, Output, and Prices Stand for a Stable Relationship in India?. *Journal of Policy Modeling*, *26*, 983-1001.

Rao, B. and S. Kumar (2011). Is the US Demand for Money Unstable?. *Applied Financial Economics*, *21*, 1263-1272.

Rehman, H. (2002). *Stability of Money Demand Function in Asian Developing Countries* (Doctoral Dissertation, University of Wisconsin – Milwaukee). Retrieved from ProQuest Dissertations and Theses.

Rose, A. (1985). An Alternative Approach to the American Demand for Money. *Journal of Money, Credit, and Banking, 17*, 439-455.

Sharma, S. (2002). Post-Crisis Asia: Economic Recovery and the Challenges Ahead. *Current History*, 177-183.

Sriram, S. (2001). A Survey of Recent Empirical Money Demand Studies. *IMF Staff Papers*, *47*, No. 3.

Sriram, S. (2002). Determinants and Stability of Demand for M2 in Malaysia. *Journal of Asian Economics*, *13*, 337-356.

Stock, J. and M. Watson (1993). A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems. *Econometrica*, *61*, 783-820.

Tang, C. (2009). How Stable is the Demand for Money in Malaysia: New Empirical Evidence from Rolling Regression. *The IUP Journal of Monetary Economics*, *7*, 85-100.

Tang, C. (2011). Tourism, Real Output and Real Effective Exchange Rate in Malaysia: a View from Rolling Sub-Samples. *MPRA Working Paper*, No. 29379.

Tang, T. (2007). Money Demand Function for Southeast Asian Countries: An Empirical View from Expenditure Components. *Journal of Economic Studies*, *34*, 476-496.

Tobin, J. (1956). The Interest-Elasticity of Transactions Demand for Cash. *The Review of Economics and Statistics*, *38*, 241-247.

Wolff, C. (1987).Time-Varying Parameters and the Out-of-Sample Forecasting Performance of Structural Exchange Rate Models. *Journal of Business & Economic Statistics*, *5*, 87-97.

International Monetary Fund [www.imf.org]. (2011). Retrieved from http://www.imf.org/external/pubs/ft/weo/2011/02.

World Trade Organization [www.wto.org]. (2011). Retrieved from http://www.wto.org/english/tratop_e/devel_e/d1who_e.htm.

Wu, C., J. Lin, G.Tiao, and D. Cho (2005). Is Money Demand in Taiwan Stable?. *Economic Modelling*, *22*, 327-346.

Zarembka, P. (1968). Functional Form in the Demand for Money. *Journal of American Statistical Association*, *63*, 502-511.

Zivot, E. and D. Andrews (1992). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit Root Hypothesis. *Journal of Business & Economic Statistics*, *10*, No. 3.

Zuo, H. and S. Park (2011). Money Demand in China and Time-Varying Cointegration. *China Economic Review*, *22*, 330-343.

Appendix A - Supplemental Data for Chapter 1

Table A.1 Summary of the Literature Review on the Stability of the Money Demand Function in selected Developing Countries

Author	Country	Frequency of the data	Measures of money	Determinants	Unit root tests	Cointegration approaches	Stability tests	Income elasticity	Main findings
Pradhan & Subramanian (2003)	India	1970:04-2000:03 monthly data	log real M1; log real M3	Industrial production; the own rate of return for money; whole price index; exchange rate; foreign interest rate (yield on the US treasury bills); impulse dummy to capture the structural break which occurred in 1995:10	ADF	Johansen cointegration procedure; GH (1996)	None	0.94; 1.28 respectively	Mixed results are found. The Johansen approach suggests at least one cointegration vector for both M1 and M3 demand. However, GH approach indicates that M1 demand is cointegrated with its determinants while M3 is not. The authors mention that the structural breaks are important and need to be taken care of by using different specification of the money demand function.
Ramachandran (2004)	India	1952 - 2001 annual data	log nominal M3	log real GDP; log whole sale price index	PP	JJ (1990); GH (1996)	CUSUM and CUSUMSQ; One step and N step forecast stability tests; Recursive least squares	1.06	The cointegration tests provide mixed results. The Johansen and Juselius (1990) shows that there is more than one cointegration vector while the results of the Gregory and Hansen (1996) reveal that the null hypothesis of no cointegration can not be rejected. The results of the conventional stability tests are consistent with the results of Gregory and Hansen (1996) and indicate that the money demand M3 is unstable during 1978-1980. However, the author believes that the instability of the M3 demand is temporary since it is caused by the structural breaks which occurred during 1978-1980.

Table A.1 Continued

Author	Country	Frequency of the data	Measures of money	Determinants	Unit root tests	Cointegration approaches	Stability tests	Income elasticity	Main findings
Austin et al. (2007)	China	1987-2004 quarterly data	log real M0	log real GDP; inflation rate	PP; KPSS	J (1991); the STR model estimated by conditional maximum likelihood.	Classical F-test	The estimated elasticities from the linear ECM and non-linear STR model are 0.0104 and 0.176 respectively	The results from both the cointegration and stability tests indicate that the real M0 demand is stable in China.
Lee & Chien (2008)	China	1977-2002 annual data	log real M1; log real M2	log real GNP; 1-year time deposits rate	ADF; ZA	J (1988); GH (1996)	None	1.013; 1.110 respectively	Mixed results are found. The results of J (1988) suggest that there is one cointegrating vector.Thus the long relationship exists between M1 and M2 demand and their determinants.The results of GH show evidence of cointegration between M2 and its determinants but not for M1 demand. The authors conclude that the M1 demand is unstable in the long run.
Baharumshah et al. (2009)	China	1990Q4-2007Q2 quarterly data	log real M2	log (real GDP); short term domestic and foreign interest rates (inflation rate; the US money rate; the Korean one-year lending rate; Japanese one-year lending year); stock prices	None	The ARDL cointegration procedure which is proposed by Pesaran et al. (2001)	Hansen (1992); CUSUM and CUSUMSQ	1.06	The results of both the cointegration and the parameter constancy tests are consistent with each other. The results show that the long run relationship exists between M2 demand and its determinants, real GDP, inflation rate, foreign interest rates, and the stock prices.
Zuo & Park (2011)	China	1996Q1-2009Q1 quarterly data	log real M2	log real GDP (scale variable 1); log real industrial value added, scale variable 2); stock prices; real interest rate; inflation rate	ADF; KPSS; ZA; LP	Canonoical cointegrating regression (Time-varying cointegration approach)	None	between 0.60 and 0.75	There is evidence of a long run time-varying stable relationship between the M2 demand and its determinants.

Table A.1 Continued

Author	Country	Frequency of the data	Measures of money	Determinants	Unit root tests	Cointegration approaches	Stability tests	Income elasticity	Main findings
James (2005)	Indonesia	1983Q1-2000Q4 quarterly data	log real M2	log real GDP; nominal domestic interest rates (the money market rates); nominal foreign interest rates (the 3 month US T-bill rate); the time trend to capture the financial liberalization; two impulse dummy variables were added to capture the structural breaks which occurred in 90Q4 and 98Q2	ADF	Bound test developed in Pesaran el al. (2001)	CUSUM and CUSUMSQ	1.526	The results indicate that the existence of the long run money demand equation can only be found when the proxy for financial liberalization is included in the model. Both the parameter instability tests show stability of the M2 demand.
Narayan (2007)	Indonesia	1970-2005 annual data	log real M1; log real M2	log real GDP; log nominal short-term interest rates; log nominal short-term foreign interest rates; log real exchange rate	ADF	J (1988); ARDL; FMOLS	Hansen (1992)	1.1190; 1.1345 for M1; 2.0254; 1.8054 for M2. The reported elasticities are from ARDL and FMOLS respectively	Mixed results are found. The J (1988) reveals that there is a long run relationship between M1 and M2 demand and their determinants. However, the results of Hansen (1992) shows that both the M1 and M2 demand are unstable.
Sriram (2002)	Malaysia	1973:08-1995:12 monthly data	log real M2	log industrial production index; own rate (interest on 3-month time deposits at the commercial banks); rate of return on alternative assets to money (discount rate on 3-month treasury bill); inflation rate is added as an additional opportunity cost variable; two dummy variables are added to capture the structural changes.	DF; ADF	J (1988); Johansen and Juselius (1990); OLS; ECM	Chow tests; one step residuals; residual sum of squares	1.0358	The results of the cointegration tests and ECM indicate that the demand for M2 is stable in the long run and the short run. However, the results of the parameter constancy tests reveal that the M2 demand is unstable in both the long run and the short run due to the structural breaks.
Nair et al. (2008)	Malaysia	1970-2004 annual data	log real M1;M2;M3	log real GDP; domestic interest rate	ADF	ARDL (UECM, Bounds tests); GH (1996)	None	1.733; 2.784; 3.244 respectively	The results of GH indicate that there is no long run relationship between the money demand M1, M2, M3 and their determinants. However, this result might be unreliable since the authors pre-selected the structural break as 1997 which refers to the Asian financial crisis. the results of ARDL suggest that there is a long run relationship between M1, M2, and M3 demand and their determinants.

Table A.1 Continued

Author	Country	Frequency of the data	Measures of money	Determinants	Unit root tests	Cointegration approaches	Stability tests	Income elasticity	Main findings
Manap (2009)	Malaysia	1977-2009 quarterly data	log real M1; log real M2	log real GDP; nominal short term interest rates (3-month treasury bill rate)	ADF;PP; KPSS;ZA	J (1988); JJ (1992); FMOLS;DOLS	Hansen (1992)	1.25; 1.52 respectively	The results of both J (1988) and JJ (1992) show that there are at least one cointegration vector in the M1 and M2 demand. However, the results of Hansen (1992) reveal that only M1 is stable while M2 demand is not.
Hwang (2002)	South Korea	1973Q1-1997Q2 quarterly data	log real M1; M2	log real GDP; short-term interest rates (money market rates); long-term interest rates (the yield on national housing bond)	ADF	J (1988); JJ (1990); ECM	CUSUM	-19.35; 0.69 respectively	When the short-term interest rate was used as a proxy for the opportunity cost, the results show that both M1 and M2 demand are unstable in the long run. But, when the long term interest rate was used as a proxy for the opportunity cost, the results show that both M1 and M2 demand are stable in the long run. However, the results of the ECM show that only M2 is stable in the short run.
Cheong (2003)	South Korea	1972Q3 – 1997Q4 quarterly data	log real M2	log real GDP; a one - year time deposit rate; a 3 - year corporate bond rate; inflation rate; two dummies to account for structural breaks	ADF	J (1988); ADL; ECM	Recursive Chow test; classical Chow test; one step residuals	1.28	The results of the J (1988) show that there is only one cointegrating vector in the system. The parameter constansy tests and ECM confirm the results of J (1988) and indicate that the M2 demand is stable in the long run and the short run.
Cho & Miles (2007)	South Korea	1976Q4 – 1998Q3 quarterly data	log real M2	log real GDP; long term nominal interest rate (the rate of government housing bonds); a linear trend to capture the effect of the financial innovation	ADF	J (1988)	None	1.77	The results indicate that the M2 demand is stable in the long run.
Anoruo (2002)	Nigeria	1986Q2 – 2000Q1 quarterly data	log real M2	log real industrial production; real discount rate	KPSS; HEGY	JJ (1990); FMOLS	Hansen (1992); CUSUM and CUSUMSQ ; Hansen (1991)	5.7	There is one cointegrating vector in the system. The stability tests support the results from the cointegration test and indicate that the M2 demand in Nigeria is stable.
Chukwu et al. (2010)	Nigeria	1986Q1-2006Q4 quarterly data	log real M2	log real economic activity; interest rates swap spread (the spread between interest rates on lending and deposit; inflation rate	Ng-Perron (2001)	GH; ECM	None	1.321;-1.362'0.222 ;-2.428 for GH1 ,GH2,GH3, GH4 respectively before the break	A long run relationship exists. Thus, the M2 demand is stable in the long run.

Table A.1 Continued

Author	Country	Frequency of the data	Measures of money	Determinants	Unit root tests	Cointegration approaches	Stability tests	Income elasticity	Main findings
Shu Wu et al. (2005)	Taiwan	1978Q1-1999Q4 quarterly data	log real M1B (MIB is the average of three end of the month monthly money supply)	log real GDP; log nominal interest rate (1-month time deposit rate); log stock market transactions; first lag of the M1B; first lag of the error term	ADF	Statistic oriented approach (ARMAX); J (1995)	None	around 0.8 - .86; 0.295	There is evidence of a stable money demand function in Taiwan.
Narayan et al. (2008)	South Asian countries: Bangladesh, India, Pakistan, Sri Lanka, Nepal	1974-2002 annual data	log real M2	log real GDP; nominal short term domestic interest rates (3 - 6 month deposit rate; the bank rate; call money rate; 3 month deposit rate; and 3 - 12 month time rate); nominal short term foreign interest rate (the US commercial paper interest rate); real exchange rate	ADF ; Breitung t - test; LLC t - test; IPS	Westerlund (2006); dynamic SUR; panel dynamic OLS	Hansen (1992)	The estimated elasticities by dynamic SUR and POLS are 1.314 and 1.300 respectively	Find evidence for a long run relationship between M2 demand and its determinants for individual countries and the panel. The results of Hansen (1992) show that the money demand functions in all countries are stable except Nepal.
Darrat & Al-Sowadi (2009)	Bahrain; United Arab Emirates; Qatar	1973-2005 annual data	log real M1; M2	log real GDP; expected inflation rate; foreign interest rates; dummy variables to capture the financial developments	ADF; PP; WS	JJ (1990)	HJ (1993)		There is evidence of a long run relationship between the M1 and M2 demand and their determinants when the JJ (1990) approach is used for all of the three countries. The results of JH (1993) show that both the M1 and M2 demand are stable in Bahrain. But, for the UAE and Qatar, only M2 and M1 demand are stable respectively.
Hossain (2010)	Bangladesh	1973-2008 annual data	log of real broad money balances (stock of broad money BM + millions of taka)	log real GDP; log domestic interest rates; log foreign interest rates; log nominal effective exchange rate of the taka	ADF; KPSS	JJ (1990)	HJ (1993)	2.26	The result of the JJ (1990) shows that the money demand function is stable over the whole sample. However, the result of HJ (1993) reveals mixed results. This result shows that the money demand function is unstable during the early 1990s while it is stable during the early 2000s.

Table A.1 Continued

Author	Country	Frequency of the data	Measures of money	Determinants	Unit root tests	Cointegration approaches	Stability tests	Income elasticity	Main findings
Dagher & Kovanen (2011)	Ghana	1990Q1-2009Q4 quarterly data	log real M2	log real GDP; nominal effective exchange rate	ADF	Pesaran et al. (2001) (a bound testing approach)	CUSUM and CUSUMSQ	1.75	The money demand M2 is stable in both the long run and the short run.
Kumar (2011)	20 of the developing countries: South Africa; Cameroon; Jamaica; Rwanda; Kenya; Ethiopia; Egypt; Nigeria; India; Indonesia; Thailand; China; Philippines; South Korea; Taiwan; Bangladesh; Sir Lanka; Nepal; Malaysia; Singapore	Sub samples: 1975 - 1988; 1989 - 2005; 1975 - 1994; 1995 - 2005; (The selection of the break dates 1989 and 1995 are arbitrary) annual data	log real M1	log real GDP; nominal short term time deposits	ADF	A single equation time series approach (GETS)	CUSUM and CUSUMSQ	The income elasticities are almost around unity for all the 20 countries for the 4 sub samples	The study finds evidence of stable long and short run money demand M1 in all countries.

Note: ADF; J ; ARDL; ECM; JJ ; CCR; KPSS; LP; ZA; GH; GETS; UECM; PSS; PP; WS; HJ; STR; DF; FMOLS mean Augmented Dickey-Fuller; Johansen; Autoregressive Distributed Lag; Error Correction Model; Johansen & Juselius; Canonical Cointegrating Regression; Kwiatkowskis, Phillips, and Shin; Lumsdaine and Papell; Zavit & Andrews; Gregory & Hansen; General to Specific Approach; Unrestricted Error Correction Model; Pesaran, Shin, and Smith; Phillips & Perron; Weighted Symmetric; Hansen & Johansen; Smooth Transition Regression; Dickey-Fuller; Fully Modified Ordinary Least Square.

Appendix B - Supplemental Data for Chapter 2

Table B.1 Summary of Literature Review on the Stability of the Money Demand Function in South Korea and Malaysia

Author	Country	Frequency of the data	Measures of money	Cointegration approach	Stability tests	Main findings
Hwang (2002)	South Korea	1973Q1-1997Q2 quarterly data	log real M1;M2	J (1988);JJ (1990); ECM	CUSUM	The results of J (1988) and JJ (1990) depend on the measure of the opportunity cost. The author finds no long run cointegrating relationship when the short term interest rate was used as a proxy for the opportunity cost. However, when the long term interest rate was used as a proxy for the opportunity cost, the results show that M1 and M2 demand are stable in the long run. The CUSUM test shows that M1 and M2 demand are stable.
Bahmani-Oskooee (2002)	South Korea	1973Q1-1997Q3 quarterly data	log M1, M2, M3	JJ (1990); ECM	CUSUMSQ	All the monetary aggregates are unstable.
Cheong (2003)	South Korea	1972Q2-1997Q4 quarterly data	log real M2	J (1988);ARDL; ECM	Recursive Chow test; Classical Chow test; One step residuals	Both cointegration and parameter constancy tests reveal that M2 demand is stable in both the long run and the short run.
Cho & Miles (2007)	South Korea	1976Q4-1998Q3 quarterly data	log real M2	J (1988)	None	There is evidence of a long run relationship between the M2 demand and its determinants: real GDP, long term interest rate, and time trend. The author adds the time trend to account for the financial innovation.
Miteza (2009)	South Korea	1976Q4-2006Q4 quarterly data	log real M2	Salkkouen and Lutkepohl (2000a,b,c); the STR model	CUSUM and CUSUMSQ on the ECM; Classical F-test on non-linear model (the STR)	Could not find a stable relationship between M2 demand and its determinants without nominal exchange rate.
Kumar (2011)	20 of the developing countries: South Korea; Malaysia; South Africa; Cameroon; Jamaica; Rwanda; Kenya; Ethiopia; Egypt; Nigeria; India; Indonesia; Thailand; China; Philippines; Taiwan; Bangladesh; Sir Lanka; Nepal; Singapore.	4 Sub-Samples: 1975-1988; 1989-2005; 1975-1994; 1995-2005 annual data	log real M1	A single equation time series approach (GETS)	CUSUM and CUSUMSQ	The result from this paper contradicts the results from Hwang (2002). This paper uses the short term interest rate as a proxy for the opportunity cost which is not suggested as an adequate measure for the opportunity cost by Hwang (2002) in the case of South Korea. However, the results of this paper suggest that there is a stable relationship between the M1 demand and its determinants in both the long run and the short run in all countries after considering the structural breaks.

Table B.1 Continued

Author	Country	Frequency of the data	Measures of money	Cointegration approach	Stability tests	Main findings
Sriram (2002)	Malaysia	1973:08-1995:12 monthly data	log real M2	J (1988); JJ (1990); OLS; ECM	Chow tests; One step residuals; Residual sum of squares	Mixed results are found. The results of the cointegration tests and ECM indicate that the demand for M2 is stable in the long run and the short run. However, the results of the parameter constancy tests reveal that the M2 demand is unstable in both the long run and the short run due to the structural breaks.
Tang (2007)	Malaysia; Indonesia; Thailand; Philippines; Singapore	Malaysia: 1961-2004; Indonesia: 1967-2005; Thailand: 1961-2005; Philippines: 1961-2005; Singapore: 1972-2005 annual data	log real M2	ARDL	CUSUM and CUSUMSQ	The cointegration test results indicate that M2 demand is cointegrated with its determinants only for Malaysia, Philippines and Singapore. However, the results of CUSUM and CUSUMSQ reveal that M2 demand is stable in all the countries except for Indonesia. The parameter instability tests results are based on the short run specification of the money demand.
Nair et al. (2008)	Malaysia	1970-2004 annual data	log real M1;M2; M3	ARDL; GH (1996)	None	The GH result indicates that there is no long run relationship between the M1, M2, and M3 demand and their determinants. However, this result might be unreliable since the authors pre-selected the date of the structural break as 1997 rather than estimate it endogenously. The results of the ARDL suggest that there is a long run relationship between M1, M2, and M3 demand and their determinants.
Tang (2009)	Malaysia	1971Q1-2007Q3 quarterly data	log real M2	JJ (1990)	Rolling regression procedure	Mixed results are found: the Johansen cointegration results document the existence of a long-run relationship between the M2 demand and its determinants: real income, inflation rate, and exchange rate. However, the results of the rolling regression procedure indicate that M2 demand is unstable due to structural breaks.
Manap (2009)	Malaysia	1977-2009 quarterly data	log real M1; M2	J (1988); JJ (1992); FMOLS; DOLS	Hansen (1992)	The cointegration tests results document the existence of a long run cointegrating relationship between M1 and M2 demand and their determinants: real GDP, nominal short term interest rates. However, the results of the Hansen (1992) reveal that only M1 demand is stable while M2 demand is not.

Note: J; JJ; ECM; ARDL; STR; GH; FMOLS; DOLS; GETS mean Johansen; Johansen & Juselius; Error Correction Model; Autoregressive Distributed Lag; Smooth Transition Regression; Gregory & Hansen; Fully Modified Ordinary Least Square; Dynamic Ordinary Least Square; General to Specific Approach.

Appendix C - Supplemental Data for Chapter 3

Regime Shifts with ADF* for South Korea:

Figure 3.1 GH1 for the Money Demand M1 in South Korea

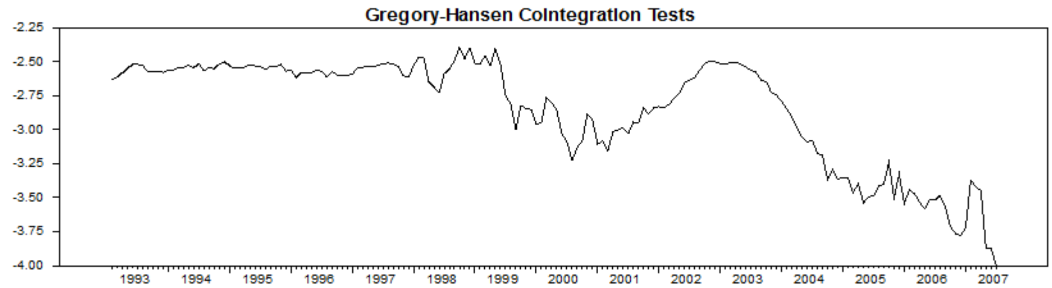


Figure 3.2 GH2 for the Money Demand M1 in South Korea

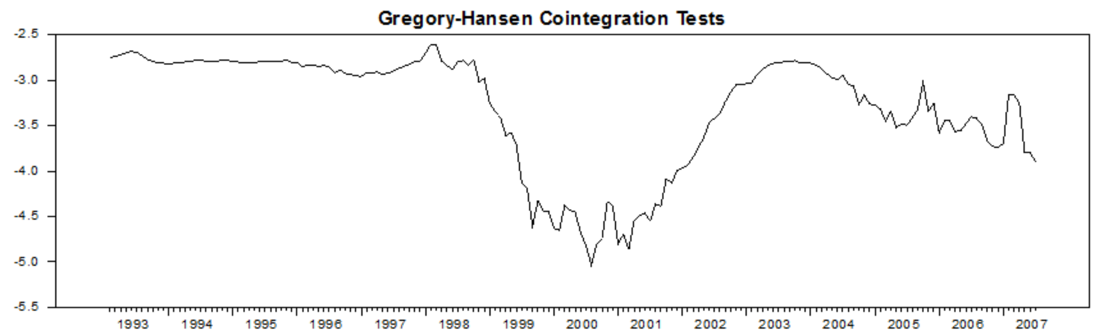


Figure 3.3 GH3 for the Money Demand M1 in South Korea

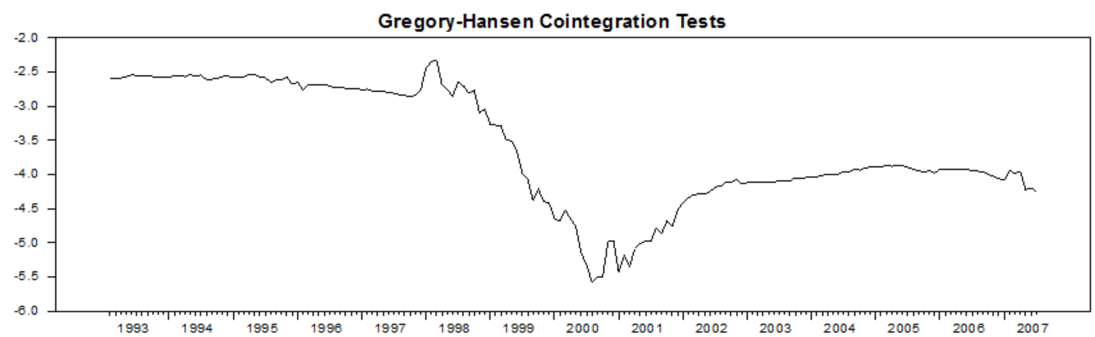


Figure 3.4 GH1 for the Money Demand M2 in South Korea

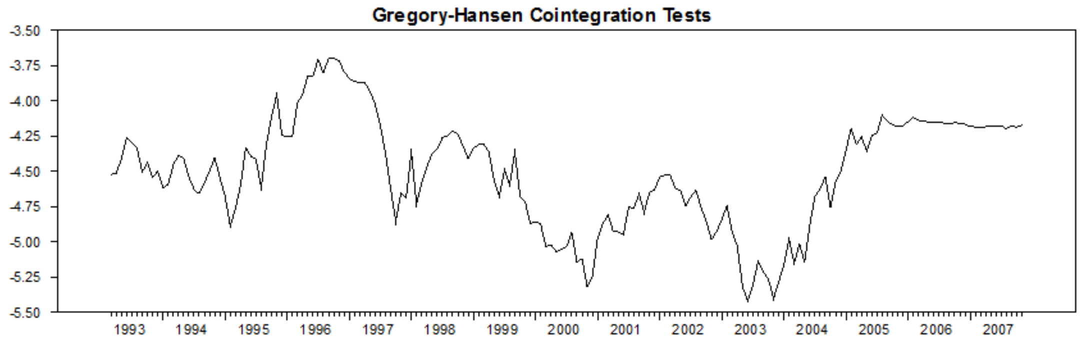


Figure 3.5 GH2 for the Money Demand M2 in South Korea

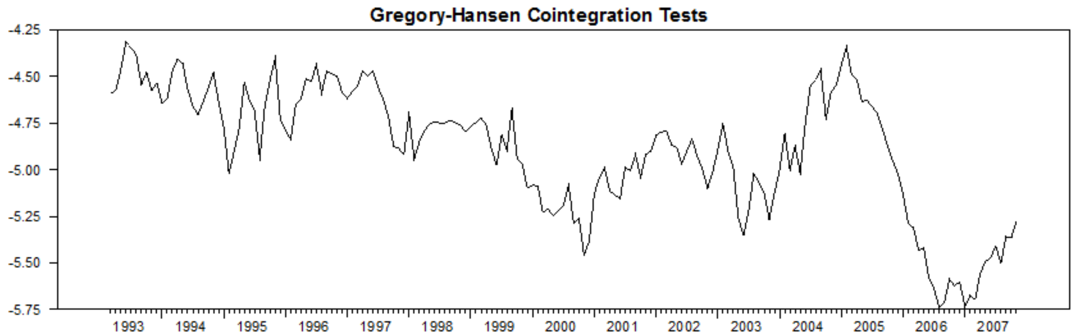


Figure 3.6 GH3 for the Money Demand M2 in South Korea

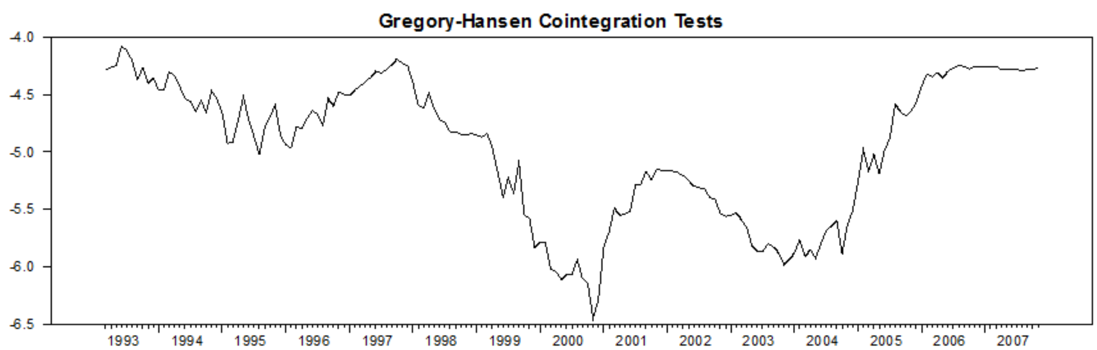


Figure 3.7 GH1 for the Money Demand LF in South Korea

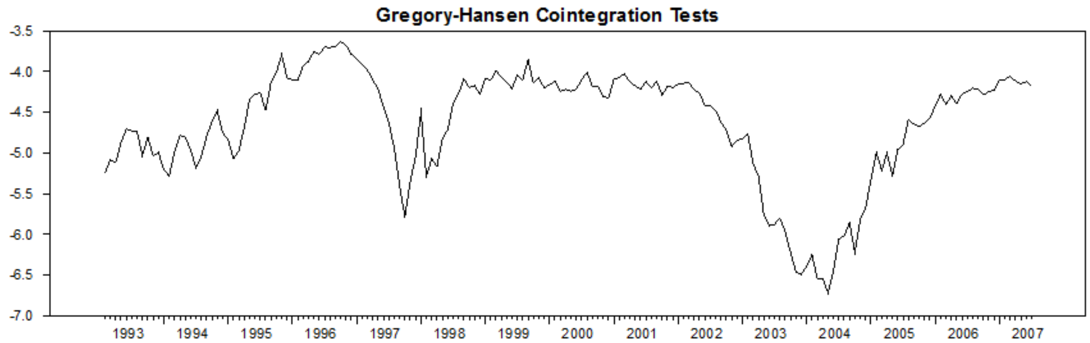


Figure 3.8 GH2 for the Money Demand LF in South Korea

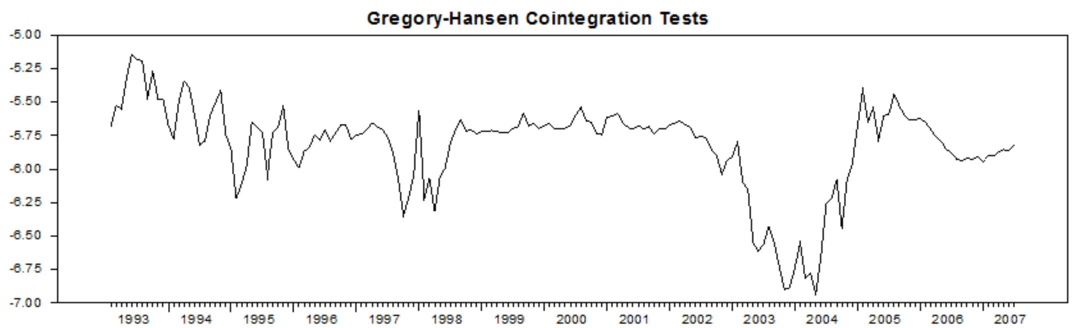
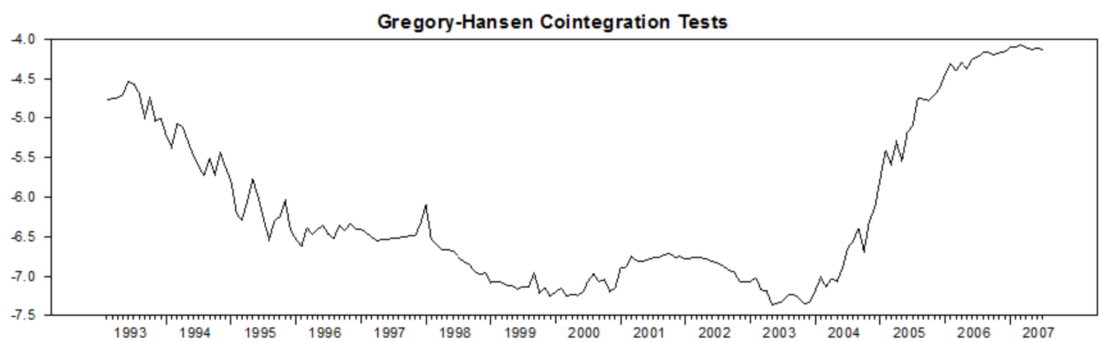


Figure 3.9 GH3 for the Money Demand LF in South Korea



Regime Shifts with ADF* for Malaysia:

Figure 3.10 GH1 for the Money Demand M1 in Malaysia

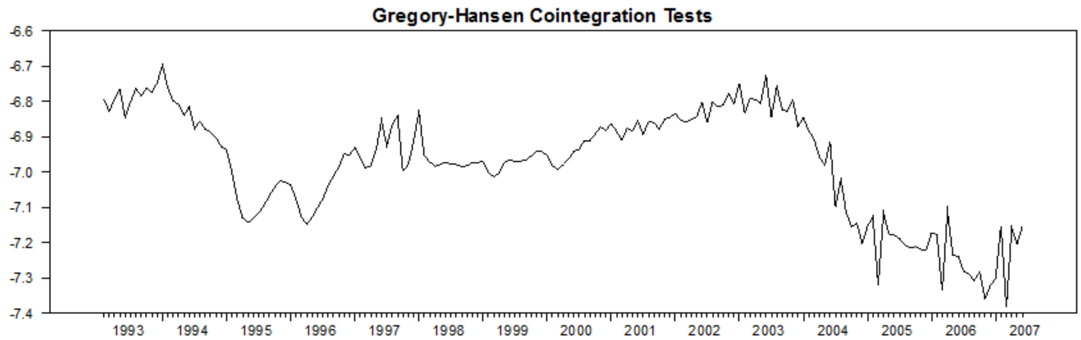


Figure 3.11 GH2 for the Money Demand M1 in Malaysia

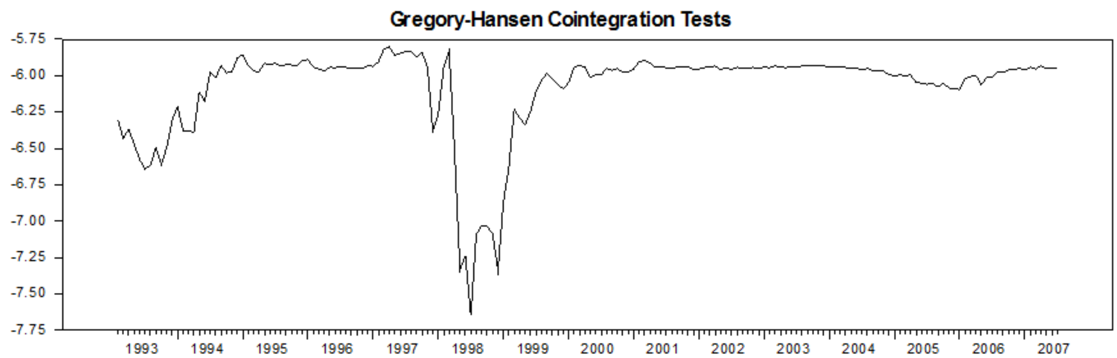


Figure 3.12 GH3 for the Money Demand M1 in Malaysia

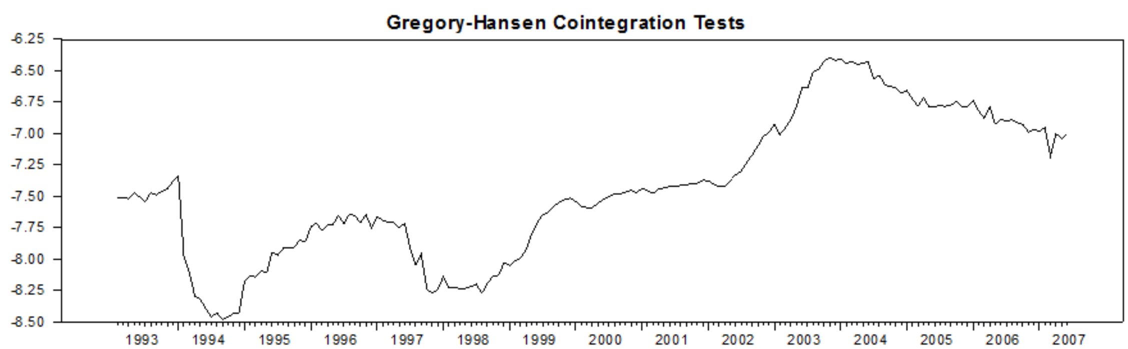


Figure 3.13 GH1 for the Money Demand M2 in Malaysia

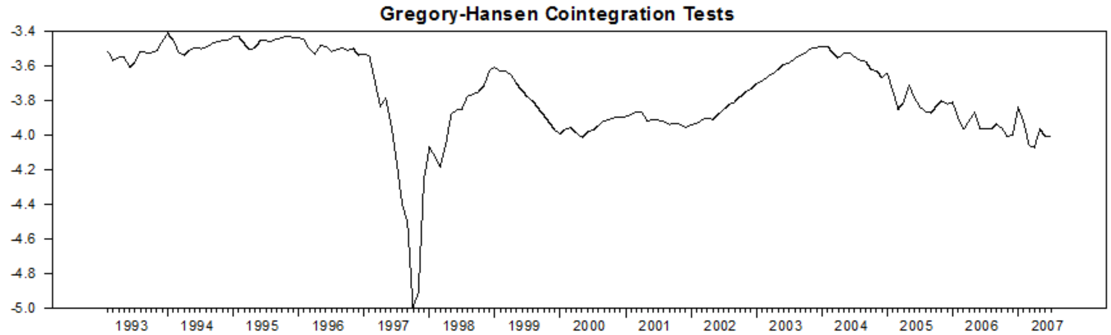


Figure 3.14 GH2 for the Money Demand M2 in Malaysia

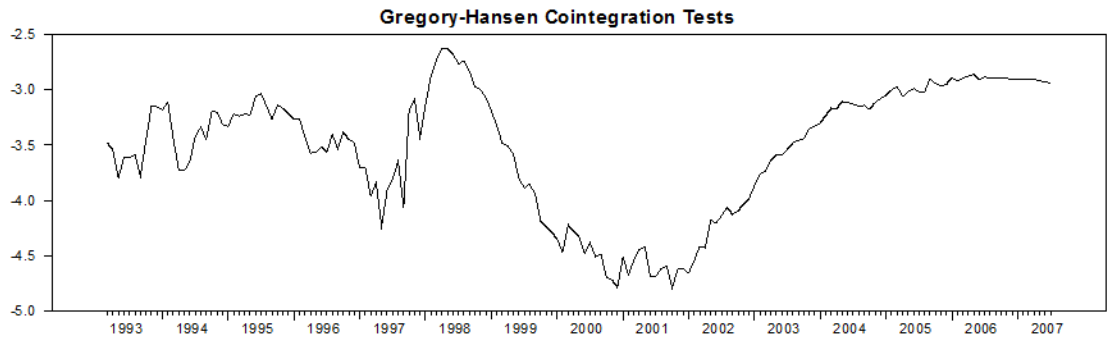


Figure 3.15 GH3 for the Money Demand M2 in Malaysia

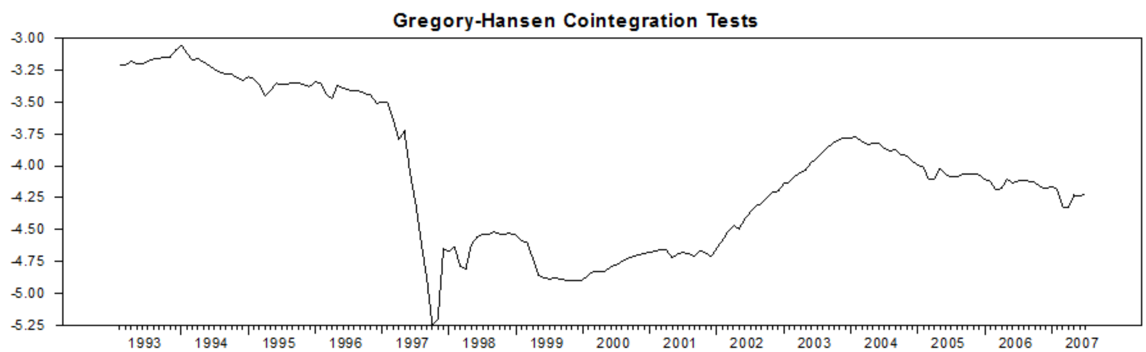


Figure 3.16 GH1 for the Money Demand M3 in Malaysia

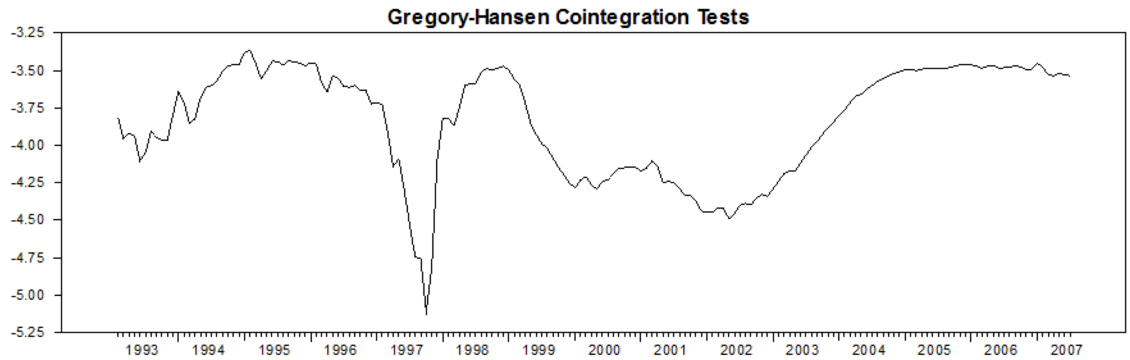


Figure 3.17 GH2 for the Money Demand M3 in Malaysia

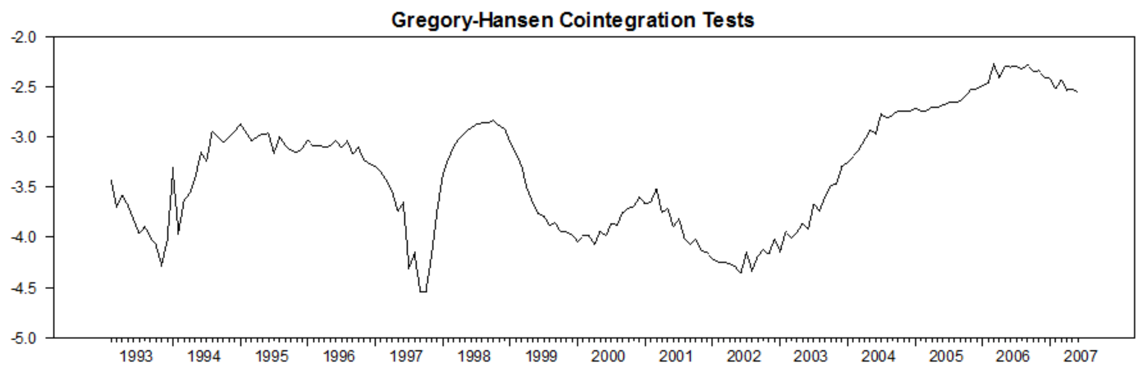


Figure 3.18 GH3 for the Money Demand M3 in Malaysia