CHANGES IN STRUCTURE OF DEMAND FOR MONEY IN FOUR CRISIS AFFECTED ASIAN COUNTRIES[1]

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ABSTRACT

This paper performs a comparative analysis on structures of demand for money before and after the 1997 Asian Crisis by constructing cointegration and error-correction models, utilizing monthly observations under an open-economy framework. The findings postulate the differences in the nature of long-run relationships in periods before and after the Asian crisis, as well as speed of adjustment towards equilibrium among ASIA-4: Korea, Malaysia, the Philippines and Thailand. Interest rate policy interventions have no influence on short-run relationship of demand for money function.

Introduction

During the 1980s, remarkably successful economic performance in East Asian countries[2] used to be one of the contemporaneous economic issues. Monetary development was believed to be a factor of contribution (Dekle and Pradhan, 1997). However, the evidence from the 1997 Asian Crisis (hereafter, the Crisis) has shown that some defects in financial policies could result in vulnerabilities to a financial crisis and could turn an economy into a recession. When the onset of the crisis is too sudden and severe, it may cause dramatic structural changes. Demand for money is one of the issues that policy makers should pay attention to in order to select appropriate adjustment on monetary policy actions. However, in the five most severely affected countries, namely, Indonesia, Republic of Korea, Malaysia, the Philippines, and Thailand, the changes in structure of demand for money after the crisis have not yet been clearly investigated although they already have recovered during 1999 to 2000.

There are extensive empirical studies on modeling and estimating the demand for money in the five most affected countries before the Crisis.[3] One of widely employed approaches is the error-correction model (ECM), which allows investigation on long-run relationship and short-run adjustment among cointegrated nonstationary variables. However, due to insufficient quarterly data[4] available, similar attempts have not yet been made for an analysis of the period after the crisis.

Taking into consideration the changes in the structure of the long-run relationship and short-run adjustment of demand for money in four Asian countries, comprising Korea, Malaysia, the Philippines and Thailand (hereafter, ASIA-4)[5] after the Crisis, this paper tries to develop ECMs by applying monthly data, similar to the initiative of Sriram (1999b).

Literature Review

The standard functional form of long-run demand for money illustrates the relationship between demand for money and two main determinants: scale variable[6] and opportunity costs of holding money, which, basically, comprises the own-rate of money and rate of return on alternative assets. With the assumption of unity price elasticity of nominal money balances,[7] money is usually specified in real terms.

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[1]"This article is modification of a paper on "An Empirical Analysis of the Changes in Structure of Demand for Money after the 1997 Asian Crisis: Evidence from ECM Models," presented at the 3rd Special Study Meeting of Japan Society for International Development on 29 June 2002 in Japan.

[2]They were regarded as "High Performance East Asian: by World Bank (1993).

[3]Examples are Sriram (1999b), Dekle and Pradham (1997), Fukasaku and Martineau (1996), Hataiseree (1996).

[4]Particularly the GDP which are proxy variables for real sector.

[5]The analysis has to exclude the case of Indonesia due to lack of qualified monthly proxy variable for real sector.

[6]Scale variable is a proxy variable representing economic activity.

[7]This implies demand for money balance changes proportionally to the change in price level. See Sriram (1999a), pp. 28.

M/P = f(Scale Variable, Opportunity Costs of holding money) (1)

where M/P is real demand for money. This general function of demand for money allows the integration of money demand theories that were derived to explain basic functions of money. Following the quantity theory of money demand that assumes transactions velocity of circulation and volume of transaction are constant, the money demand is discussed in real terms. The relationship with scale variable reflects the medium-of-exchange function of money as recognized in classical theory. Cambridge economists focused more on the role of wealth and implicitly introduced the opportunity cost of holding money in terms of interest rate in determining the demand for money. Keynesian theory of liquidity preference, emphasizing on the store-of-value function, states the speculative motive in holding money or bonds. Other post-Keynesian theories suggest other sources of opportunity costs.

In the simplest form when data are not available, GDP (either real or nominal) and market rate are employed, omitting the own-rate with the assumption of narrow money.[8] However, for a stable demand function, inclusion and selection of variables is necessary in model specification.

According to the quantity theory of money demand, people hold money purely for transaction purpose. Demand for money, therefore, becomes a function of income. However, the idea becomes inapplicable when one considers the case of a highly developed economy in which financial intermediaries are active in issuing several forms of financial assets with a high degree of liquidity. More flexibility allows people to maximize their return on holding financial assets. This concept complies with the idea of Asset theories. For realistic determination of demand for money, transaction, speculative, and precautionary motives should also be incorporated.

When the economy is relatively closed, rate of return on foreign assets is normally neglected. The studies on data before the late 1980s tended to exclude the role of foreign assets.[9] Post-world war II when the fixed exchange rate regime under Brettonwoods gold standard system was abolished, the floating exchange regime brought about the re-examinations on demand for money models.[10] Particularly in small open countries, the influences of foreign assets have widely been included in the model specification of demand for money.[11] The evidence from the Crisis also suggests that ASIA-4 should be considered as small open economies in which return on foreign assets plays a significant role. Both foreign interest and expected rate of depreciation should be incorporated in the demand for money functions as elements of opportunity costs of holding money.

The long-run demand for money function can be changed, rather than stable as claimed by Ericsson (1998) that financial innovation and deregulation were the sources of changes in opportunity costs. Simmons (1992) also stated that policy shocks such as shift in exchange rate regimes possibly affected the structure of demand for money function in industrial countries.

3. Model Framework

Most of studies applied log-linear form to the standard function of the demand for money by introducing log operations to real money aggregate, scale variable and inflation rates, and maintaining interest rates as levels. The evidence of the Crisis implies the nature of small-open economy in which return on foreign assets has a significant influence on demand for real money. Therefore, the standard function of demand for money in open-economy to be applied to all sets of data will include proxies for return on foreign assets. The long-run demand for money is specified as follows:

$$M = \alpha_0 + {}_1SCALE + {}_2OWNR + {}_3YDA + {}_4INF + {}_5YFA + {}_6DPR + \epsilon \quad (2)$$

where M = ln(money aggregate/CPI), where CPI is consumer price index;
SCALE = ln (industrial production index or manufacturing index);
OWNR = interest rate representing own-rate;
YDA = annual yield on alternative domestic assets;
INF = annualized inflation rate;
YFA = annual yield on foreign alternative assets;
DPR = annualized rate of exchange rate depreciation; and
ϵ = error-term.

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[8]This is justified when the demand deposit does not provide interest, unavailable data or low variation in the long term.

[9]See Chow (1996), Friedman (1959), Judd and Scaddling (1982), Gupta and Moazzami (1989) and Miller (1991).

[10]See Arize (1994).

[4]Particularly the GDP which are proxy variables for real sector.

[11]See Arize (1991), Leventakis (1993), Darrat (1986), and Simmons (1992).

SCALE represents a scale variable, of which coefficient is expected to be positive to reflect the conventional theories concerning demand for money. Under open-economy framework, three types of assets are considered: domestic money, domestic assets, and foreign assets. Since OWNR is the own-rate, its sign of coefficient is expected to be positive. On the other hand, a movement of YDA, INF and YFA should be in an opposite direction with the demand for real money. The expected negative signs of their coefficients will reflect the substitution effects in portfolio of assets that may comprise choices of money, other domestic financial assets, domestic real assets, and foreign financial assets.

Dealing with nonstationary time series, cointegration technique is necessary. For multivariable analysis, the cointegration vector method developed by Johansen (1988), applying Vector Autoregressive (VAR) model is widely employed because it enables the analysis on the error structure of system, which regression estimates cannot.[12] However, since our study covers four countries with the main aim of comparing the overview of their structural changes, the depth of the analysis has to be curtailed. For such tradeoff, two-stage Engle and Granger (1987) (EG) approach[13] is selected.

Before performing the two-stage EG approach, stationarity property of individual time series is investigated. The Dickey-Fuller (DF) tests and Augmented Dickey-Fuller (ADF) tests on autoregressive (AR) models with constant and trend components are conducted. The first stage of the EG approach is to estimate long-run regression by Ordinary Least Square (OLS) technique. With such a static regression, long-run coefficients of explanatory variables in demand for money function are derived. The next stage is to test the stationarity of the error terms of the cointegration regressions to assure the long-run relationship among nonstationary time series. Both DF and ADF tests on AR models of the error time without constant and trend components are conducted.

After confirming long-run static relationship by the cointegration regression analysis, the nature of short-run dynamic adjustment can be investigated by constructing ECM models. As summarized by Miller (1991), the process is to regress the first difference of proxy variable of demand for money, M, onto lagged values of the first-difference of all the remaining variables plus the lagged value of the error-correction terms (or the error term from the cointegration regression) and include dummy variables. The standard ECM models to be applied to all sets of time series is:

$$\Delta M_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1i}\Delta M_{t-i} + \sum_{i=0}^{n2} \beta_{2i}\Delta SCALE_{t-i} + \sum_{i=0}^{n3} \beta_{3i}\Delta OWNR_{t-i} + \sum_{i=0}^{n4} \beta_{4i}\Delta YDA_{t-i} + \sum_{i=0}^{n5} \beta_{5i}\Delta INF_{t-i} + \sum_{i=0}^{n6} \beta_{6i}\Delta YFA_{t-i} + \sum_{i=0}^{n7} \beta_{7i}\Delta DPR_{t-i} + \beta_8 EC_{t-1} + \beta_9 DLIB_t + \beta_{10} DINT_t + \beta_{11} DEX_t + \mu_t \quad (3)$$

where EC refers to error-correction term or in equation (2), D refers to first difference value and refers to stochastic term. Policy intervention dummy variables are classified into DLIB, indicating financial liberalization policy; DINT, indicating interest rate policy; and DEX, indicating exchange rate policy. The other variables are defined previously. The coefficients of the lagged value of the error-correction terms reveal the speed of adjustment towards equilibrium.

Data Issues and Variable Selection

To capture the changes in characteristics of demand for money before and after the crisis, monthly data is selected to allow enough number of observations. The time-series of each variable from January 1991 to the most currently available monthly data are divided into two periods, pre- and post-crisis. The beginning period of 1991 is chosen due to unavailability of data prior to that. The pre-crisis period is defined as the period from January 1991 to the month prior to the last month of authorities' intervention. It is widely recognized that the Crisis started from foreign exchange market. In case of non-free-floating exchange rate regimes, when the authority discontinued defending its domestic currency from severe speculations or capital flights, normally because of the depletion of international reserves, the deep depreciation caused severe impacts to an economy. Therefore, it is justified to define the month of abolition of currency defense as the beginning of the Crisis. The abolition happened in November 1997 for Korea, and in July 1997 for Malaysia, the Philippines and Thailand (Berg 1999)

For post-crisis period, since it is mutually accepted that from 1999 all ASIA-4 have already recovered, January 1999 is chosen as the beginning month of the

[12]See Johnansen (1988).

[13]See comparative analysis on the forecast accuracy between two-step and multi-step estimation in Engle and Yoo (1987).

post crisis.[14] The period of the onset of the Crisis is excluded from the analysis.

Money aggregate

Broad definition of money aggregate, M2,[15] is chosen in this analysis as a reflection of the financial innovation in ASIA-4 during the 1990s. All sets of time-series data, except for a case of Korea, are obtained from the summation of "Money" and "Quasi Money", line 34 and 35, in several issues of the *International Financial Statistics (IFS)*, IMF. The M2 of Korea is taken from the website of Bank of Korea.

Scale variable

Choices of scale variable are limited due to the unavailability of monthly-recorded data. In the case of Korea, Malaysia and Thailand, the only proxy variable for real sector available on a monthly basis is the industrial production index. For the Philippines, it is the manufacturing production index. All of the time-series, except for Thai industrial production index, are obtained from the *IFS* CD-ROM, IMF, together with several issues of its monthly review bulletins. The time-series of Thai industrial production index is obtained from the Bank of Thailand's website. The year1995 is the base year for all series.

Opportunity costs

Based on the *IFS*, the ratio of quasi-money to M2 in1995 ranged from 68% to 88% among ASIA-4 (Korea: 75%, Malaysia: 68%, the Philippines: 80%, and Thailand: 88%). This postulates the significance of deposits rate to be a proxy for own-rate of holding money.

As for the rate of return on alternative domestic assets, YDA, Treasury bill is usually selected as a proxy in specifying demand for money because of its high degree of liquidity and risk-free characteristics. However, the variable is not applicable in the cases of Korea and Thailand. In Korea, there is no issuance of Treasury bill. Between interest rate on commercial paper and the yield on Treasury bond, the former is preferable when degree of liquidity is the main concern. Moreover, since the Treasury bond was first issued in middle of the 1990s, the data is not applicable for the full analysis. Similar problem also exists in the case of Thailand. Due to consecutive budget surplus, Treasury bills and bonds had not been issued frequently. The trading volume had been small and resulted in stagnant yields.[16] Therefore, the yields on Treasure security become an unqualified proxy. Candidates for Thai YDA are interest rate on promissory notes issued by finance companies, and the market rate of return on stocks. The former is inappropriate, due to the fact that during the Crisis, 56 finance companies have collapsed. This drastically affected the share of its financial assets in the market. The market rate of return of stocks, therefore, becomes preferable. Its proxy is stock index at the end of each month announced by the Stock Exchange of Thailand (SET). The annualized rate of return on stocks is calculated by:

$$TYDA = [\ln(SETIND_t) - \ln(SETIND_{t-1})] \times 12 \quad (4)$$

where TYDA refers to the annualized yield on domestic alternative assets in Thailand, and SETIND refers to end-of-month stock index announced by SET.

Next, similarly implied rate of inflation is calculated by:

$$INF = [\ln(CPI_t) - \ln(CPI_{t-1})] \times 12 \quad (5)$$

where INF refers to annualized rate of inflation, and CPI refers to Consumer Price Index.

For a closed-economy, the proxy variables mentioned above may be sufficient for demand for money specification. However, for ASIA-4, an open-economy framework seems to be more appropriate when we consider the degree of international trade involvement and capital control. Residents are permitted to hold foreign deposits as well as to hold foreign currencies without approval. Their decision may be sensitive to the changes in deposit rates in industrial countries that are main trading partners. The proxy variable of yield on alternative foreign assets, YFA, therefore, is the weighted average of deposit rates in Canada, Germany, Japan; rate

[14]There are different definitions for the recovery but none of them clearly stated the exact month of recovery. See more discussion in Hermandez and Montiel (2001), and Park and Lee (2001).

[15]Varying the definition of money aggregate may help improve the result of model specification. However, due to space limitation, the scope of the analysis covers only M 2.

[16]As suggested by Simmons (1992), including time-series of a stable interest rate will not improve the quality of model specification.

of 3-month certificate of deposit in the United States; and yield on Treasury bill in the United Kingdom.[17] The process starts from setting a base year, in this case 1995, then calculating weights w_j. Following the concept of Arize (1994), nominal GDP in terms of US dollar at 1995 of an individual country is divided by the summation of the figures of all countries as follows:

$$w_j = \frac{\text{GDP at 1995 of country j}}{\text{Sum of 5 industrial countries}} \quad (6)$$

Then,

$$YFA_t = w_j i_{j,t} \quad (7)$$

where $i_{j,t}$ represents deposit rate in each country at time t.

One more important item in an open-economy framework is the expected rate of depreciation of exchange rate. Its proxy is calculated by:

$$DPR = [\ln(e_t)-\ln(e_{t-1})]x12 \quad (8)$$

where e refers to exchange rate of domestic currency per US dollar.

Dummy Variables

In order to improve the result of model specification, three types of policy intervention dummy variables are deliberately constructed.[18] First, DLIB denotes dummy variable for policy regarding financial liberalization, covering all aspects except for interest rate and exchange rate regime. The examples are the Acceptance of obligations of Article 8 of the IMF, promulgation of any acts that encourage financial deepening, deregulation on financial institutions, liberalization on capital movement and liberalization of capital market. Starting from the month that the policy is announced, value of one is assigned in the time series of the dummy variable DLIB. On the other hand, any significant imposition of guideline, regulation or restriction in the opposite direction implies an interruption in the liberalization process. Examples are the imposition of ceiling on capital transfer, a rise in minimum risk-weighted capital ratio requirement and a request to commercial banks to stop selling domestic currency to nonresidents. Value of zero is assigned in the time series of DLIB when there is such an interruption. The figure remains the same unless countering policy emerges. Generally policies implemented in a particular period should comply with one another, announcement of a countering policy implies change in direction of intervention. Therefore, it is justified to treat all liberalization-oriented policies equally in constructing dummy variable. This is also to avoid redundant dummy variables in the models.

The second policy intervention dummy variable is DINT. It depicts the changes in the policy on interest rate. Assignment of figures in the time series is based on the same concept as that of DLIB. For instance, when there is an abolition of ceiling on interest rate, the value of one is assigned in the time series continuously until an interest-rate- oriented restriction is announced and the value becomes zero.

The last one is DEX, which represents a dummy variable for exchange rate regime. The value of one is assigned in the period of floating exchange rate regime (regardless of specific type of flotation), and zero otherwise.

It is worth noting that if there is no interruption in the time series of any dummy variable in a certain period of concern, the dummy is dropped out to avoid the zero-matrix error in the model estimation. For instance, DEX disappears from the models of pre-crisis and post-crisis periods because there is no change in the exchange rate regime in each period although the regimes are different in each period.

Empirical Analysis

The general framework towards obtaining the error-correction models involves three main steps. Firstly, the orders of integration for each of the variables has to be investigated in order to ascertain the stationary property. If variables are integrated at different levels, the next step is to apply two-stage EG cointegration technique to examine the characteristics of long-run relationship among variables. The last step is to construct the error-correction models that enable the analysis on the short-run dynamic adjustment behaviors of variable. Through the procedures towards obtaining ECMs, EViews program, version 3.0, is utilized.

Unit Root Tests

In this paper, both Dickey-Fuller and Augmented Dickey-Fuller (ADF) tests are conducted to examine the stationarity of individual time series. Seasonally adjusted data are used with the purpose of minimizing the number

[17]There is no deposit rate in the United States and the United Kingdom.

[18]However, due to limited space, the details cannot be presented here, but are available upon request.

of explanatory variables. In the ADF tests, the number of lags imposed in the test follows the Schwert's rule, which suggested that a longer lag was preferable to ensure white noise residuals in the fitted equation (Patterson, 2000), as follows

$$\text{Lag} = \text{Int}\,[(12/100^{1/4})T^{1/4}] \qquad (9)$$

where Lag refers to lag length suggested, Int refers to integer part of the product in the parenthesis without rounding, and T refers to numbers of months in the time series.

Tests for stationarity for the period from 1991:1 to 2001:10 were performed separately.[19] The DF tests show that all time series are either level stationary or trend stationary. However the ADF tests for proxy of scale variable of Malaysia and that of demand for money, M, of the Philippines and of Thailand do not suggest the same conclusion. The first difference probably induces stationarity if lag length is already appropriate. Over-differencing is detected when we perform the DF and ADF tests on second-differences of those variables. It is found that adjusting lag length by one period (i.e. plus or minus one month) can yield a compatible conclusion, except for the M of the Philippines. A further analysis is carried by changing the proxy of the demand for money in the Philippines to be M1. However, M1 was not found as a better variable in terms of stationarity and degree of coefficient of determination, R^2. Therefore we do not change or drop the variable from the model.

Cointegration Regressions

Since all variables are not I(0), cointegration technique should be conducted if the long-run relationship is to be investigated. As explained earlier, this study applies two-stage EG approach. Table 1 reports the results of cointegration regression estimation. At the end of the table, Adjusted R^2, Durbin-Watson (D-W), DF and ADF test statistics are also presented.

Although D-W statistics are low in some regression, the results of DF tests indicate that all cointegration regressions for periods are stationary in every country. However, the ADF tests fail to reject the null hypothesis in cases of Malaysia in post-crisis and the Philippines in both pre- and post-crisis periods. Even so, it is too pessimistic to deny the possibility of truly cointegrated relationships. Appropriate lag length is an assumption behind the power of the ADF test against DF test when serial correlation is suspected. The true lag length is actually unknown. Leaning on Schwert's rule, a uniform lag length is set for cases of the same period because the number of adjusted observations is not greatly different. It is worth noting that on case-by-case basis, varying the lag length for one period (plus and minus one lag) can result in a change in conclusion. The verification is carried on the nonstationary-by-ADF tests time series. The cointegration regression of Malaysia in post-crisis becomes stationary at the lag length of 7 and at the lag length of 9 for the Philippines in pre-crisis period. However, despite the adjustment of lag length, ADF tests on full period still fail to reject the null hypothesis of nonstationarity. This implies a high potential of spurious relationships among the variables.

The contradicting stationarity characteristics among the three periods of the same country and among the countries at particular periods are worth investigating. One purpose of presenting the full period in which the data during the onset of the Crisis is incorporated is to describe how seriously the impacts of the crisis cause a change in stationarity of the long-run demand for money function of each country. Moreover, it helps describe the compatibility of stage of macro economy and the demand for money. If the stage of the stationarity for the full period resembles that of the pre-crisis period, i.e. both are stationary, this means the shocks do not cause a breakdown in the time series of error term as severely as the case of contradict stages.

On the other hand, there may be a contradicting stage of stationarity in which stationarity is found in the time series of error time in the pre-crisis period, but not in the full period. This implies that the shocks may be so severe that it causes a structural break in the long run relationship.

For the scenario in which stationary cointegration regressions are found in full period and pre-crisis period, it may cause some doubts when post-crisis cointegration regression is nonstationary. Since the period of the onset of the crisis is already excluded from the post-crisis period, the stationarity is expected. The nonstationarity may arise from the change in nature of relationship among the variables due to abrupt policy changes, affecting the signs and coefficients of each independent variable, and the specification of the equation, as well as on the error term. The other possible reason is the inappropriateness of the beginning point of the post crisis period. If it is true, it implies that the perception of an economic

[19]The results are available upon request.

recovery in general cannot be a source of reference to determine the appropriate starting point of post-crisis period that allows that nature of the error correction term to resemble that of the full period. From Table 1, if the results of ADF tests are chosen as the source of reference and the lag lengths as well as the beginning point of post-crisis period are appropriate, the differences in the long-run relationship of demand for money in each country may be sources of policy implication. Focusing on post-crisis period, in Korea and Thailand, where the authorities adopted the flotation of their domestic currencies as the main strategy to cope with the Crisis, their adjustment in post-crisis period seems to attain an equilibrium. On the other hand in Malaysia, where fixed exchange rate regime was strictly adopted to stabilize domestic exchange rate since the Crisis, the adjustment in the post-period seems to be later, if not unreachable. However, the cointegration regressions of the full periods in these three countries are stationary. It supports the possibility that there exists the stationary long-run demand for money and it is interesting to note that while Malaysia pursued different extreme of adjustment policy after the Crisis, its long-run demand for money is still consistently stationary for the full period.

Table 1: ***Cointegration Regressions***

	Korea			Malaysia			Philippines			Thailand		
	1991:1	**1991:1**	**1991:1**	**1991:1**	**1991:1**	**1991:1**	**1991:1**	**1991:1**	**1991:1**	**1991:1**	**1991:1**	**1991:1**
Variable	-2001:10	-1997:11	-2001:10	-2001:10	-1997:6	-2001:10	-2001:10	-1997:6	-2001:6	-2001:10	-1997:6	-2001:10
Constnt	0.617	2.679	2.260	1.961	2.332	4.342	-2.800	-3.524	0.977	-2.356	-1.543	2.841
	(2.191)**	(15.202)***	(2.107)**	(11.901)***	(12.737)***	(5.467)***	(11.851)***	(10.801)***	(2.451)**	(-5.316)***	(-5.172)***	(7.751)***
SCALE	1.485	1.017	1.215	1.247	1.167	0.777	1.085	1.205	0.326	1.313	1.098	0.198
	(29.192)***	(29.427)***	(5.896)***	(42.130)***	(35.445)***	(5.189)***	(26.087)***	(18.971)***	(3.782)***	(15.011)***	(17.960)***	(2.589)**
OWNR	2.124	1.166	-2.034	1.335	0.252	0.005	1.351	2.658	0.738	-0902	0.251	-1.623
	(3.227)***	(2.302)***	(-0.641)***	(1.852)*	(0.228)	(0.001)	(1.800)*	(3.663)***	(0.720)	(-30.702)***	(0.681)	(-4.469)
YDA	-1.818	0.007	-2.321	-1.260	-1.215	-1.612	-0.062	-1.165	-0.759	-0.003	-0.005	-0.001
	(-3.165)***	(0.021)	(-1.553)	(1.572)***	(-1.304)	(-0.384)	(-0.092)	(-1.853)*	(-0.723)	(-0.483)	(-0.996)*	(-0.582)
INF	-0.222	-0.183	-0.064	0.131	-0.047	0.292	-0.070	-0.082	-0.164	-0.027	-0.057	-0.034
	(-1.178)	(-1.513)	(-0.325)	(0.878)	(-0.348)	(0.981)	(-0.431)	(-0.531)	(-0.845)	(-0.281)	(-0.594)	(-1727)*
DPR	-2.114	-5.721	0.735	-5923	-4.793	-5.916	-3.570	0.923	0.477	-3.118	-3435	0.278
	(-1.680)*	(-7.774)***	(0.190)	(-7.087)***	(-5.588)***	(-4.015)***	(-1.973)*	(0.520)	(0.182)	(-2.073)**	(-2.683)***	(0.573)
	0.017	0.055	0.039	-0.010	0.020		-0.004	0.156	-0.061	-0.005	0.094	-0.036
	(0.803)	(2.062)**	(0.975)	(-0.657)	(-0.623)		(-0.120)	(2.689)***	(-1.181)	(-0.227)	(-1.010)***	(-2.512)**
Observations	129	82	34	129	77	34	125	77	30	129	77	34
Adjusted R^2	0.954	0.97	0.889	0.978	0.98	0.739	0.916	0.903	0.345	0.864	0.953	0.69
D-W Stat.	0.388	1.411	0.661	0.982	1.452	2.109	0.601	0.955	1.565	0.224	1.153	0.81
DF test stat.	(-3.609)	(-6.657)***	(-2.574)**	(-6.714)***	(-6.781)***	(-6.322)***	(-4.538)***	(-4.822)***	(-4.246)***	(-2.706)***	(-5.918)***	(-2.850)***
ADF test stat.	(-2.036)**	(-2.000)**	(-3.234)***	(-2.069)**	(-2.318)**	(-1.363)	(-1.461)	(-1.121)	(-2.261)**	(-2.273)**	(-1.847)*	(-2.074)**
Lag length	12	10	8	12	10	8	12	10	8	12	10	8

Note: Values in the first line represents coeflicient, while in the second line represents t-value
This augmented Dickey-Fuller (ADF) test applies lag length calculated by Schwert's rule.
***, ** and * refer to rejection of Ho at I percent, 5 percent and 10 percent levels of significance, respectively

A controversy is found in the case of the Philippines. While the full and pre-crisis periods' cointegration regression are nonstationary, that of post-crisis period is stationary. If it is not because of spurious relationship between the proxy for demand for money and the set of explanatory variables, it is skeptical that the financial liberalization may contribute greatly to the long-run stationarity of the demand for money in the Philippines in the post-crisis period. Due to the fact that the Philippines just accepted the obligations of the Article 8, section 2, 3 and 4 of the International Monetary Fund in September 1995,[20] the openness of the economy truly began after that. The pattern of the demand for money could be greatly different in the prior period.

The next aspect of investigation on the long-run demand for money is the significance and the direction of independent variables. First, the constant terms are statistically significant in all sets of regression which implies the intrinsic function of money as a means to carry out transaction. Second, the industrial index or manufacturing index selected as scale variable, SCALE, shows strong relationships with the implied demand for money in the ASIA-4 in all periods. This effectiveness of the variable allows the possibility for future investigation in other aspects of scale and monetary relationship on a monthly basis. Third, own-rate, OWNR, is statistically significant in the full-period demand functions of ASIA-4. However, there are some controversies in sub periods. It is not significant in any post-crisis cointegration regression, except in the case of Thailand.[21] Possibly, after the Crisis, the demand for money become insensitive to change in saving rates. If it is true, it is advisable that policy makers not rely on the own-rate as a main tool to direct the demand for money when the economy has just recovered from a crisis.

Fourth, the yield on alternative domestic assets, YDA, in all cases is statistically insignificant, except for the case of Korea in full period and the Philippines in pre-crisis period. However, it is too soon to conclude that the demand for money in these countries is insensitive to the change in yield on alternative domestic assets, unless all types of the applicable yields are investigated.[22]

Fifth, the implied inflation rate, INF, is statistically significant only in the case of post-crisis period of Thailand. If the models are already well specified, it leads to a critical question on the appropriateness of adoption of inflation targeting of monetary policy framework. Korea and Thailand have already officially adopted, while the Philippines and Malaysia are in the preparatory stage.

Next is yield on foreign assets, YFA. The proxy variable is statistically significant for all countries in the full period. This clearly depicts the nature of an open economy. The signs of the coefficient in each country's equation are also correctly specified, ascertaining a negative relationship with the demand for money. When focusing on the pre-crisis period, the Philippines is the only country in which the variable is insignificant. Again, the relatively close stage of the economy in that period may be a reason for that. Apart from the stage of the economy, exchange rate regime might influence the decision to hold foreign assets. When exchange rate is relatively stable, it is less risky to hold foreign assets. After an abrupt change to floating exchange rate regime, the investor may become less willing to hold foreign assets. This can be a source of the difference in the significance of the YFA in pre- and post-periods in Korea and Thailand.

The last variable is depreciation rate, DPR. It is significant in the pre-crisis periods of Korea and of the Philippines, and post-crisis period of Thailand.

Error Correction Model

The OLS method is applied with the starting lag length of 2 to estimate equation (3). Insignificant variables are excluded and the model is reestimated. Table 2 reports the final selected ECM models, which minimizes Akaike's criteria. It should be noted that the values of adjusted R^2 are still low in many results of regression. This mirrors the possibility that the adjustment process may be influenced by past value of many periods earlier. Despite such possibility, the selected models are still useful in confirming the changes in the structure of dynamic demand for money function after the crisis, as well as the difference in such structures among the ASIA-4.

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[20]In the other countries, the event happened before the period of disscussion.

[21]the wrong signs in cointegration regression of full and post-crisis of Thailand may be a result of truly spurious relationship as can be noted from the relatively low D-W statistic.

[22]Due to limited access to the sources of data, this paper does not try to perform a test on other proxy variables. Morever, it is worth noting that the differences in types of the proxy vaiable for the YDA across countries makes it difficult for comparitive analysis due to different degree of risk premiums.

The lagged values of error correction terms, lagged ECs, are significant in the full and pre-crisis periods of Korea, Malaysia and the Philippines. In post-periods, lagged ECs are significant in cases of Malaysia, the Philippines and Thailand. For all cases of significant lagged ECs, their signs of coefficients, or so called error correction coefficients, are negative. This implies the reduction towards the equilibrium of the lagged ECs. Its absolute value represents the speed of such dynamic adjustments towards equilibrium.

	Korea			Malaysia			Philippines			Thailand		
Variable	1991:1 -2001:10	1991:1 -1997:11	1999:1 -2001:10	1991:1 -2001:10	1991:1 -1997:6	1999:1 -2001:10	1991:1 -2001:6	1991:1 -1997:6	1999:1 -2001:6	1991:1 -2001:10	1991:1 -1997:6	1999:1 -2001:10
C	0.008	0.010	0.011	0.013	0.010		0.176			0.006	0.005	
	(4.384)***	(6.825)***	(2.922)***	(5.618)***	(6.085)***		(2.469)**			(5.297)***	(4.091)***	
M(-1)			0.345	-0.504				0.219	0.257	0.325	0.403	0.653
			(2.078)**	(-6.439)***				(1.948)*	(1.374)	(3.912)***	(3.662)***	(5.056)***
M(-2)				-0.166		0.030	-1.927	0.201	0.124			
				(-2.166)**		(0.241)	(-2.051)**	(1.708)*	(0.667)			
SCALE				0.130	0.127	0.148		0.219	-0.077			
				(2.146)**	(2.395)**	(0.796)		(2.113)**	(-0.766)			
SCALE(-1)												
SCALE(-2)												
OWNR	-1.265	-0.929	2.307									
	(-4.242)***	(-2.417)**	(2.026)*									
OWNR(-1)												
OWNR(-2)												
YDA				-1.378	-0.740					0.001	0.002	
				(-2.836)***	(-1.514)					(3.021)***	(2.697)***	
YDA(-1)	0.291	0.789		-0.719						0.001		
	(2.107)**	(3.068)***		(-1.409)						(2.112)**		
YDA(-2)					-1.159							
					(-2.405)**							
INF	-0.064		-0.085							-0.071	-0.080	-0.070
	(-2.741)***		(-2.043)*							(-10.503)***	(-5.915)***	(-8.320)***
INF(-1)				-0.114				0.119		-0.043	-0.038	-0.216
				(-2.321)**				(1.762)*		(-5.655)***	(-2.915)***	(-2.754)**
INF(-2)				-0.105						-0.015		
				(-2.131)**						(-2.169)**		
YFA						-7.457						
						(-1.966)*						
YFA(-1)		2.152										
		(1.941)*										
YFA(-2)												
DPR			0.022	0.007						0.003		
			(2.589)**	(1.278)						92.092**		
DPR(-1)										0.003		
										(2.073)**		
DPR(-2)												
EC(-1)	-0.037	-0.136		-0.263	-0.211	-1.120	-1.075	-0.247	-0.624			-0.207
	(-2.106)**	(-3.314)***		(-6.269)***	(-3.752)***	(-6.643)***	(-2.527)**	(-3.325)***	(-3.486)***			(-2.096)**
DLIB							-0.170					
							(-1.918)*					
DINT												
DEX	0.007									-0.004		
	(2.175)**									(-2.777)***		
Observations	128	81	32	126	75	31	124	75	27	126	75	32
Adjusted R^2	0.153	0.217	0.334	0.421	0.192	0.578	0.089	0.132	0.361	0.554	0.355	0.721
D-W Statistic	1.996	2.152	2.056	2.125	2.236	2.342	1.071	2.069	1.620	2.193	2.186	2.321
Akaike info criterion	-5.519	-5.878	-5.639	-4.659	-5.652	-3.781	1.253	-3.514	-3.627	-6.989	-7.039	-6.867
F-Statistic	(5.584)***	(6.532)***	(4.895)***	(11.118)***	(5.388)***	(14.687)***	(4.981)**	(3.819)***	(5.892)**	(18.228)***	(11.167)***	(27.691)***

Note. Values in the first line represents coefficient, while in the second line represents t-value.

***, ** and * refers to rejection of Ho at 1percent, 5 percent and 10 percent level of significance, respective respectively.

refers to value of first difference and (-1) refers to first lagged value

In the full period of Korea, the dynamic adjustment towards equilibrium of the demand for money also depends on the changes in OWNR, first lagged value of change in YDA, change in INF, and first lagged value of EC, as well as exchange rate policy intervention. In the pre-crisis period, the change in INF and the dummy variables are not significant. However the first lagged value of change in YFA seems to have significant influence. After the Crisis, the first lagged value of change in M, change in OWNR, change in INF, and change in DPR, are the significant explanatory variables.

In Malaysia, for the full period, first and second lagged values of change in M, change in SCALE and its first lagged value, change in YDA and its first lagged value, first and second lagged values of INF, and change in DPR are statistically significant in adjustment process, in addition to lagged EC. In the pre-crisis period, apart from the lagged EC, changes in SCALE, change in YDA and its second lagged value are statistically significant for the adjustment. In post-crisis period, although second lagged value of change in M and change in SCALE improve the model specification; they are not statistically significant. Only change in YFA and lagged EC are main factors.

For the Philippines, in full period, the significant variables are second lagged value of M and liberalization policy intervention dummy variable in addition to the lagged EC. The ECMs of its pre-crisis period contains the first and second lagged values of M, change in SCALE and its first lagged value, first lagged value of INF and the lagged EC. The post-crisis ECM also has similar structure although it excludes the first lagged value of change in INF and only lagged EC is statistically significant. It should be noted that since the available data series for the Philippines is relatively insufficient, compared to that of the other countries, the validity of the model might be inferior.

While significant variables in ECM of the all countries differ greatly in each period, Thailand is a case in which there is some consistency in the set of significant variables. Another unique characteristic is the insignificance of the lagged ECs in full and pre-crisis periods. The main contributors for the adjustment towards the equilibrium in all periods are first lagged value of M, INF and its lagged values. More specifically, in the full period, the other significant variables are change in YDA and its first lagged value, change in DPR and its first lagged value, and exchange rate policy intervention dummy variable. In the pre-crisis period, the additional significant variable is the change in YDA. In the post-crisis period, the lagged EC is the only additional variable.

Conclusion

This analysis applies two-stage EG approach and ECM to investigate the changes in the structure of demand for money in ASIA-4: Korea, Malaysia, the Philippines and Thailand after the Crisis. Time series of monthly industry production index or manufacturing index are employed to enable comparison analysis between pre-crisis and post-crisis periods. The standard cointegration models and the error-correction models mirror the nature of an open economy, in which rate of return on foreign assets and expected depreciation rates play significant roles. Policy intervention dummy variables are included in error-correction models.

The results of the augmented Dickey-Fuller test for cointegration show that despite severe impacts on the demand for money during of the Crisis, there exists long-run relationships between the demand for money and the set of explanatory variables in the full-period context of all ASIA-4, except for the Philippines. Similar conclusion can be drawn in the pre-crisis periods. However, when the analysis is conducted on the post-crisis periods, some controversies arise in the cases of Malaysia and the Philippines.

Focusing on dynamic adjustment in the demand for money function, the results of the ECMs postulate the differences among the structures of demand for money of ASIA-4 in terms of both agents and speed of adjustments towards equilibrium. This raises the question on whether they could apply the identical monetary policy framework while their monetary economies are quite unique. Regarding the inclusion of deliberately constructed policy intervention dummy variables, the results indicate that policy on interest rate liberalization is not significant in explaining the structure of short-run demand for money in any country.

Finally, the monthly industrial index/manufacturing index proves to be an efficient variable that allows a comparative analysis on a monthly basis.

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