Capital flows and unconventional monetary policy

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Abstract

During the end of 2008, Taiwan suffered a negative economic growth as a result of global financial crisis, and yet the money supply in the same period grew substantially. A close look at the international financial account revealed a huge amount of capital inflows as investors retreated their funds from troubled international financial markets. In addition, the Central Bank of China, Taiwan, did not take measures to completely sterilize the capital inflows. This can be viewed as an unconventional monetary measure for quantitative easing, that is, increasing liquidity by not sterilizing capital inflows. Following this thought, this paper investigates the impact of capital flows on money demand. Empirical analysis using Taiwanese data confirms the conjecture that capital flows provide an additional channel to affect money demand.

1. Introduction

Stable money demand function is essential for formulation and implementation of monetary policy. With increasing openness of the domestic financial market and higher capital mobility, the impact of international financial market and capital movement on the money demand in Taiwan become stronger. In this paper, we employ portfolio balance approach to formulate the money demand function for Taiwan with special focus on the impact of capital flows.

We came to notice a special phenomenon about money supply during the 2008 subprime mortgage crisis. Table 1 reports growth rate of M2, security investment assets, security investment liability, economic growth rate, foreign exchange rate (NTD per USD), and interest rate (one-year deposit rate) from 2007Q1 to 2009Q4 in Taiwan. From the table, we find that growth rate of M2 drastically increases from 2.11% in 2008Q3 to 5.41% in 2008Q4. Yet, under the influence of the subprime mortgage crisis in the same period, Taiwan suffered an economic contraction with economic growth rate decreasing drastically from -1.23% in 2008Q3 to -7.53 % in 2008Q4. The conventional money demand theory would predict a decrease of money demand rather than a huge increase. It is worth noting that interest rate has remained stably below 2% from 2002Q4 to 2013Q3 except for the subperiod between 2006Q2 and 2008Q3. Thus, the surge of money cannot be accounted for by decreasing interest rate.

Table 1 Some key macroeconomic variables from 2007 to 2009

Date	M2 growth rate (%)	Security Investment (assets) million	Security Investment (liabilities) million	GDP growth rate (%)	Foreign exchange rate (NT per USD)	1-year deposit rate (%)
2007Q1	5.44	-10956	-771	4.45	32.92	2.23
2007Q2	4.85	-17133	10148	5.7	33.11	2.33
2007Q3	4.03	-8778	-5625	7.08	32.91	2.49
2007Q4	2.36	-8099	1152	6.51	32.43	2.57
2008Q1	1.34	-6323	9313	7.55	31.53	2.62
2008Q2	2.00	-7204	-3609	5.66	30.44	2.66
2008Q3	2.11	4194	-15227	-1.23	31.19	2.71
2008Q4	5.41	12860	-6254	-7.53	32.98	2.03
2009Q1	6.93	-818	-1017	-8.12	33.98	0.82
2009Q2	7.79	-9111	8683	-6.58	33.13	0.77
2009Q3	8.45	-10858	6953	-1.41	32.80	0.77
2009Q4	6.65	-10912	6753	8.82	32.32	0.89

Furthermore, as is clear from Table 1, New Taiwan Dollar depreciated from 2008Q2 to 2008Q4 and money demand would have decreased consequently. All of these clearly indicate that traditional money demand theory together with currency and asset substitution effects could not fully explain the drastically increase of money during 2008 and it prompts us to turn to the analysis of the role of capital in money demand. Note that net security asset in 2008Q4 was USD6.606 billion as investors withdrew their financial investment from troubled international financial markets to home country. In turn, the capital inflow stimulates money supply.

As this paper aims at investigating the relationship between capital flows and money demand, we focus on financial account, especially on security investment assets and liability in Taiwanese stock and bond markets which have high returns, high liquidity and high risk. It is reasonable to guess that the substitutability between security portfolio and money is high. Hence, we shall estimate the impact of capital

flows on money demand via the asset substitution effect and currency substitution effect as it involves different currencies effect

Empirical analysis in this paper confirms the importance of the asset substitution and currency substitution effects in the money demand function in Taiwan. Furthermore, capital flows do affect money demand and supply. This leads to the policy implication that if the central bank does not completely sterilize the capital inflows, money demand and supply will increase simultaneously. This can be viewed as an unconventional monetary policy for quantitative easing in the sense that central bank does not need to actively increase money supply through open market operation.

In addition to this introductory section, Section 2 contains literature review. Model specification and empirical results are put in Section 3. Section 4 summarizes the results of cointegration analysis. Conclusions and policy implications are put in Section 5.

2. Literature review

Previous literatures on money demand are voluminous but can be roughly classified into two categories: variable specification of money demand function and estimation methods. The first category of literatures include, among others, Chaisrisawatsuk, Sharma & Chowdhury (2004), Bahmiani-Oskooee(1996)、Bahmiani-Oskooee & Techaratanschai (2001), Bahmiani-Oskooee & Karacal (2006), Hsieha & Hsing (2009) , Hossain(2010) , Muscatelli & Spinelli(1996), Lutkepohl, Teräsvirta, & Wolter(1999), Tang(2007), Arize & Nam (2012), Teräsvirta & Eliasson (2001), Escribano(2004), Bashier & Dahlan (2011), Wu(2009) and Wu & Hu(2007).

Variables frequently included in these papers are income, consumer price index (or inflation rate), opportunity cost of holding money (or interest rates) and currency substitution proxy (or exchange rate). As the medium of exchange, money demand naturally depends positively upon income. Consumer price index or inflation rate affects real money demand via money illusion or other channel. Interest rate or proxy for opportunity cost of holding money is viewed as an important determinant of money demand. When loan rate is low, investors could borrow money from the bank and then invest in high return financial assets that is the so called asset substitution effect. Also, investors could convert domestic currency into foreign currency in order to purchase foreign financial assets for the higher return rate that is termed as currency substitution effect. Many literatures discussed this issue such as McNown & Wallace (1992) who found that adding exchange rate could make the money demand for M2 become more stable and substitution effect were significant. Cuddington(1983), Akcay, Alper & Karasulu (1997), Chaisrisawatsuk et al.(2004) and Hsieha & Hsing (2009) also confirm significant currency substitution effect as investors could explore the interest spread between two countries by converting currencies. As a result, money demand is also affected by foreign exchange market. Arize & Nam (2012) confirmed the effect of exchange rate on money demand and supply in both short and long run using data from seven Asian countries. As for other variables, Wu, Lin, Tiao & Cho (2005) found a significant relationship between money and stock market.

As for the impact of capital inflows on domestic economy, Sie & Li(2001) show that long-term investment could stimulate economic growth while short-term investment could increase the efficiency of securities markets. To one's surprise, capital outflow could also have positive impact on the domestic economy. Wang &

Chen(2008) showed that capital outflows will help relieve domestic excess liquidity and to ease inflation pressure. Also, capital outflows could lessen the pressure of exchange rate appreciation.

On the other hands, several papers emphasize on the negative impacts of capital flows on domestic economy. Cheng & Huang (2009) find that after the 2008 subprime mortgage crisis, many multinational corporations withdrew investments in foreign countries to pose a strong negative impact on the emerging economies. From this viewpoint, large volume of capital infows or outflows could hurt local economy and monitoring the capital flows is recommended. For example, Chow, Lee & Shiu (2011) compare six emerging countries and conclude that appropriate volume of capital flows could benefit the domestic economy and the domestic security market. De Santis, Favero & Roffia (2013) show that domestic and foreign asset prices influence money holdings and then fluctuations in international financial markets are among the key determinants of the observed path of euro area money growth. Evans & Hnatkovska (2014) find that international capital flows have increased dramatically with much of the increase being due to trade in equity and bond markets.

As for the estimation methods, a considerable large number of literatures use the portfolio balance approach. Girton & Henderson (1976), mentioned earlier in this paper, classify wealth in three parts, namely, currency, domestic bonds and foreign bonds. With given wealth, when two markets are in equilibrium, so is the third one. By taking advantage of this feature, money demand and supply can be derived from the two bond markets in each country. Several papers extend this model by adding other variables. Yet other methods, Akcay et al (1997) use the EGARCH and VAR models to investigate the currency substitution effects. McNown & Wallace(1992)、Chaisrisawatsuk et al.(2004) and Arize & Nam (2012) employ cointegration model

while Hossain(2010) uses error correction model. Muscatelli & Spinelli(1996), Teräsvirta & Eliasson(2001) and Escribano(2004) adopt nonlinear error correction model to estimate currency demand for the UK. Also, Lutkepohl et al (1999) use smooth transition regression to estimate German money demand (M1). Smooth transition autoregressive model is used by Teräsvirta & Anderson (1992). Teräsvirta(1994) turns to the logistic Smooth transition autoregressive and exponential smooth transition autoregressive model. Tang(2007) uses autoregressive distribution lag model to study the money demand of five countries in Southeast Asia.

3. Model specification and empirical results

For model specification, this study employed portfolio balance approach which is commonly used in the literature. Explanatory variables are income, opportunity cost of holding money, consumer price index, foreign exchange rates, as well as asset and liability of security investment[1] which latter are proxies for capital flows. It is worth noting that for both security investment asset and security investment liability accounts, positive value means capital inflow that could increase money supply while negative value means capital outflow that could decrease money supply.

In order to analyze the effects of capital flows on money demand, we estimate two groups of models, one with only domestic explanatory variables, and the other with three additional variables, foreign exchange rate, security investment asset and security investment liability. Group A model is mainly in accordance with money demand with domestic determinants whereas group B Model includes variables important for a small open economy. Specifically, Model I is specified as:

$$m_t = \beta_0 + \beta_1 m_{t-1} + \beta_2 y_t + \beta_3 r_t + \beta_4 cpi_t + \varepsilon_t \qquad (1)$$

[1] For exact definition of these two variables, see http://www.cbc.gov.tw/public/data/economic/statistics/bop/cappendix.pdf (in Chinese)

where m_t is logarithm transformed real money supply (M2). y_t is logarithm transformed real GDP. r_t is opportunity cost, measured as the difference between 30-day commercial paper rate and averaged one-year deposit rate of five major banks, and cpi_t is the consumer price index.

Model B includes three additional variables, foreign exchange rates, security investment asset and security investment liabilities to capture the effect of capital flows.

$$m_t = \beta_0 + \beta_1 m_{t-1} + \beta_2 y_t + \beta_3 r_t + \beta_4 cpi_t + \beta_5 e_t + \beta_6 pi_t^a + \beta_7 pi_t^d + \varepsilon_t \quad (2)$$

where e_t is foreign exchange rate expressed in term of New Taiwan Dollar per US dollar, pi_t^a and pi_t^d are respectively the security investment assets and security investment liability. The details of these variables are summarized in Table 2.

Table 2 Descriptions of variables used in the money demand function in Taiwan

Variable Coding Name	Original type	Conversion type
M2 ln_M2	Monthly mean data	The average per quarter data represents 1-4 quarterly data
M2 growth rate	Monthly mean data	The average per quarter data represents 1-4 quarterly data
Real GDP ln_GDP	Quarterly data	Original type
Real GDP growth rate	Taiwan's annual growth rate of real GDP 2006=100- Quarterly (%)	Original type
1-30 day second market rate (%)	Monthly data	The average per quarter data represents 1-4 quarterly data
1-year deposit rates (%)	Monthly data	The average per quarter data represents 1-4 quarterly data
Consumer prices index dlnCPI	3,6,9,12 month data represents 1-4 quarterly data 2011=100(index)	Logarithmic of raw data and take first differential
Exchange rate ln_exchange	Monthly mean data	The average per quarter data represents 1-4 quarterly data

Portfolio investment of assets MD2401	Quarterly data	Original type
Portfolio investment of liabilities MD2701	Quarterly data	original type

Taking into account of previous empirical analysis of money demand in Taiwan, we consider two sets of seasonal dummies in this paper, one with only D1, D3 (first and third quarter) and the other with D1, D2, D3 (all first three quarters). Different specification of seasonal dummy variables sometimes leads to different estimation results though the gap is usually not large. As a result, there are four models in the paper. All variables are quarterly from 1983Q1 to 2013Q3 and simple least squares estimation is employed.

Estimation results are reported in Table 3. Before discussing the empirical results, we perform the diagnostic checking of the residuals. Time series plots of original series, as well as ACF and PACF for residuals from models 1 to 4 are reported in Figures 1 to 5 respectively. These figures seem to indicate clean residuals of all four models but Ljung Box test as in Table 3 show that the residuals of models 1 and 2 have significant autocorrelation, while models 3 and 4 do not.

From Table 3, we make the following observations. Firstly, the adjusted R squares are all up to 0.999, indicating a very high explanatory power for all models. Secondly, the coefficient of m_{t-1} is close one and the signs for y_t in models 1 and 2 are negative that is inconsistent with theoretical expectation. Yet, adding foreign exchange rate and two capital flow variables have corrected the mistake so that y_t becomes insignificantly positive in model 3 and significantly positive in model 4 respectively. Thirdly, both security investment asset and liability are positively

significant as is expected from the theory. It is worth mentioning again that for both asset and liability, positive number means capital inflow and negative means capital outflow.

To further examine the difference among four models, we perform the recursive in-sample and out-of-sample forecast precision comparison. For in-sample forecast performance evaluation, we first estimate the model using data from 1983Q1 to 2000Q1, and the compute the predicted value of m_t at 2000Q1, we then add one observation, 2000Q2 to the dataset, re-estimate and then forecast m_t at 2000Q2. Repeat the process until all data span 1983Q1 to 2013Q3 are used for estimation and then to predict m_t at 2013Q3. Finally, the forecast root mean squared error is computed. As for the out-of-sample forecast RMSE, we first estimate the model with data from 1983Q1 to 2000Q1 and then predict m_t at 2000Q2. Again, we add one more observation to the dataset, estimate the model with data from 1983Q1 to 2000Q2 and then predict m_t at 2000Q3. Repeat the process until when data 1983Q1 to 2013Q2 are used for estimation and then used to predict m_t at 2013Q3. Finally, the forecast RMSE is computed. The computation results are summarized in Table 4. From the table, we find that models 3 and 4 are all better than models 1 and 2 while model 3 is marginally better than model 4 in term of in-sample forecast performance. As for out-of-sample forecast comparison, the precision order is almost reversed. Model 3 is slightly inferior to models 1 and 2 while model 4 is better than model 2 and 3. Yet, judging from the Diebold-Mariano test as is reported in the parenthesis, the null hypothesis of equal forecast RMSE cannot be rejected for all pairs of models.

To sum up, judging from the estimation result and forecasting comparison, we consider model 4 as the best model. Also, the significance of two flow variables seem to support the existence of both asset substitution and currency substitution effects in the money demand function in Taiwan.

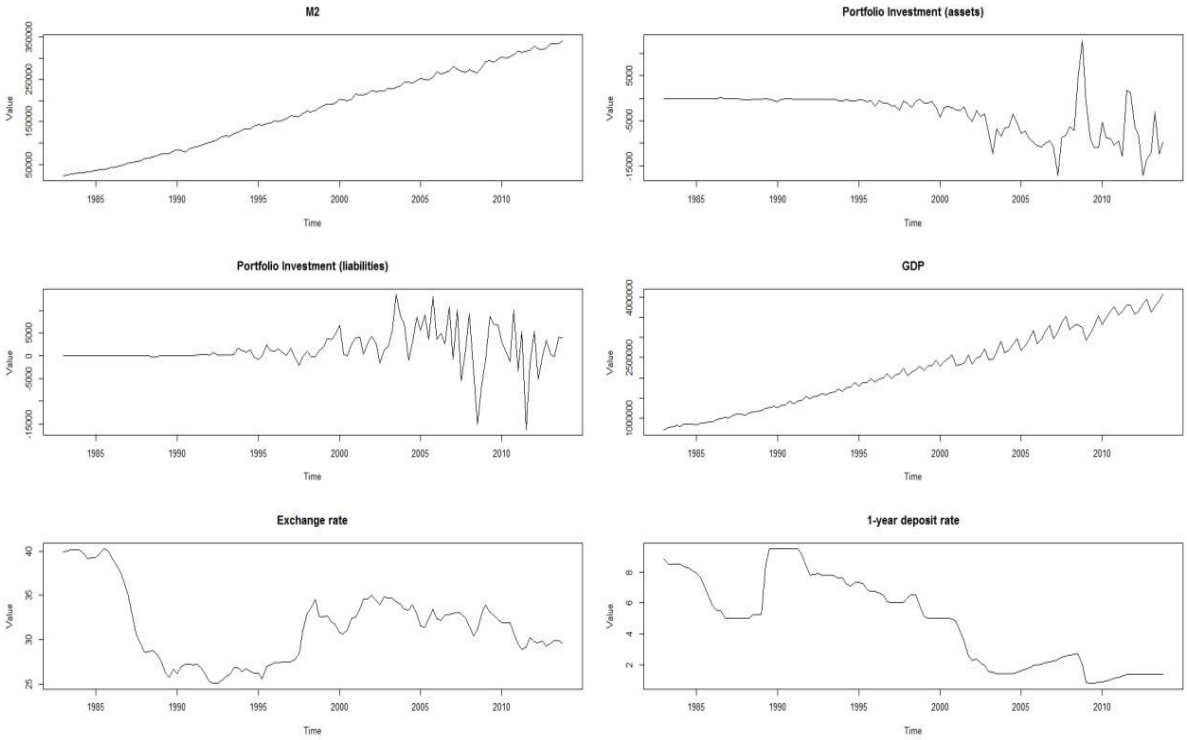

Figure 1 Time series plot of some macroeconomic variables

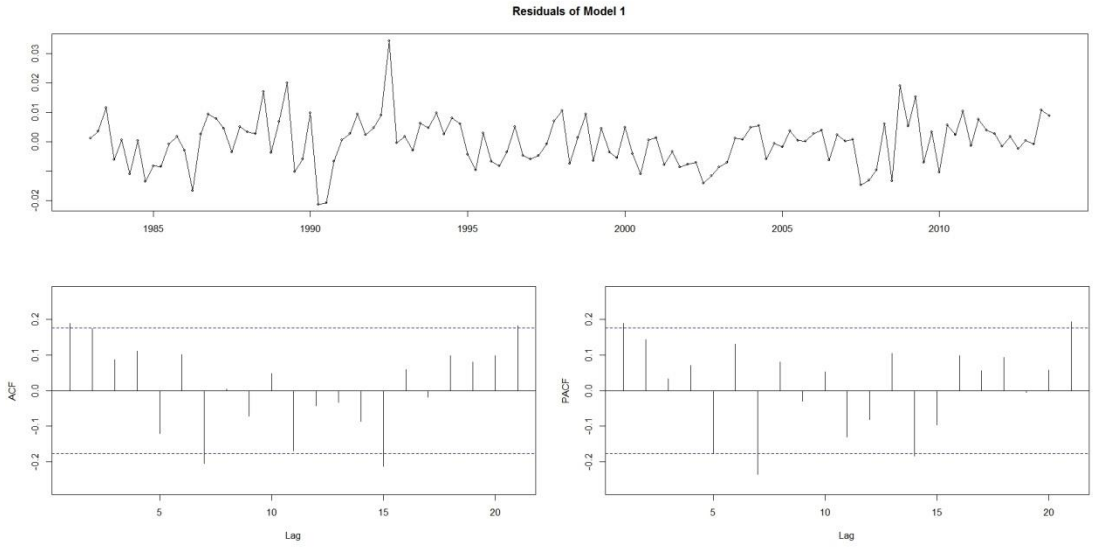

Figure 2 Residual plot, ACF and PACF for model 1

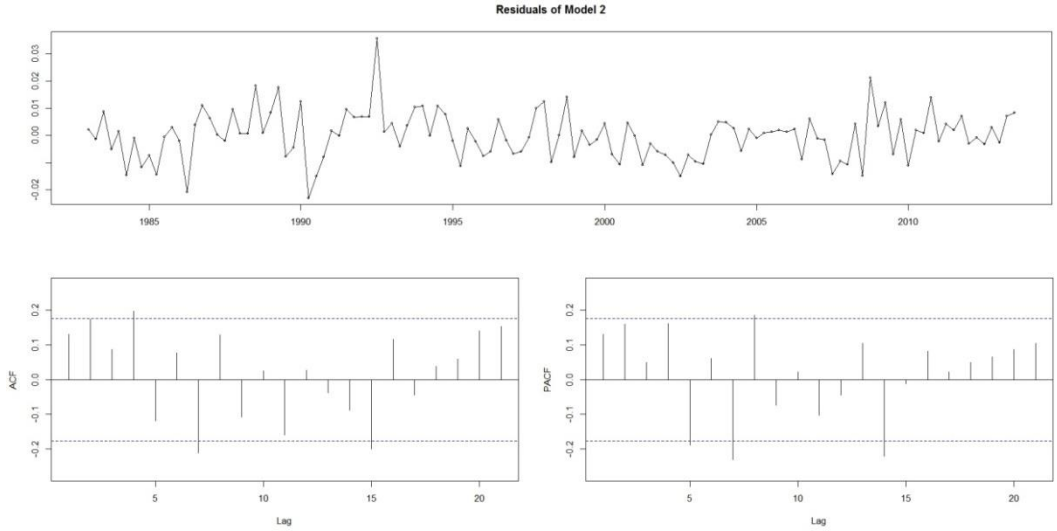

Figure 3 Residual plot, ACF and PACF for model 2

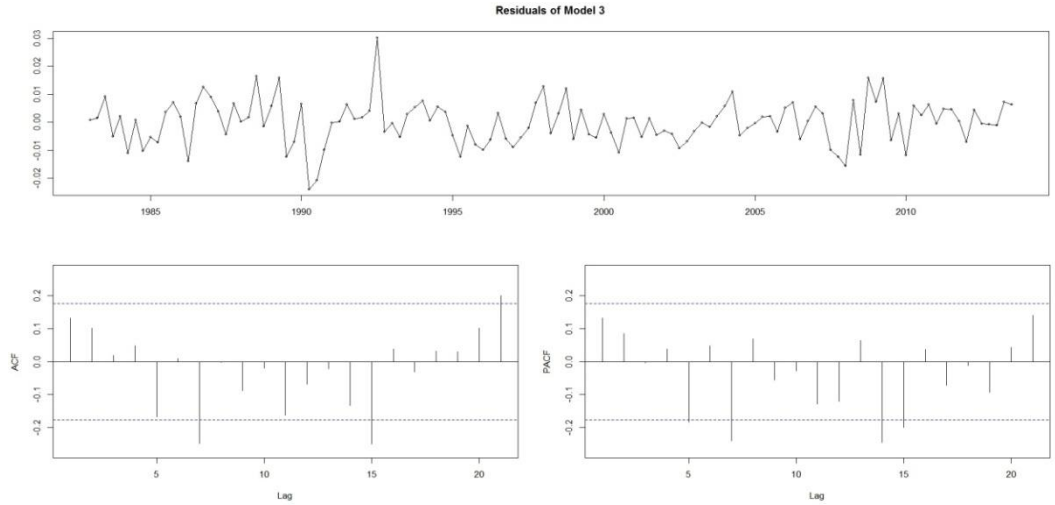

Figure 4 Residual plot, ACF and PACF for model 3

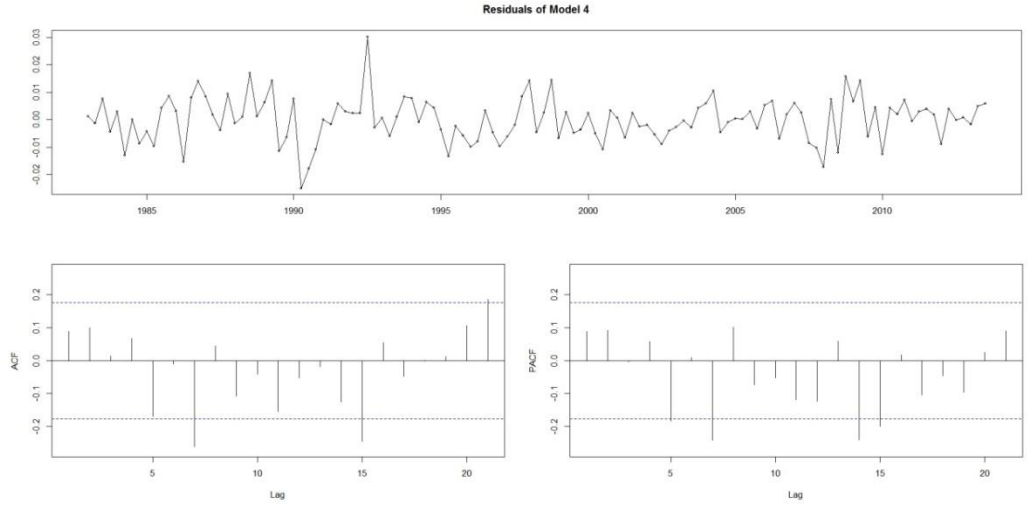

Figure 5 Residual plot, ACF and PACF for model 4

Table 3 Model coefficients

	Model 1		Model 2		Model 3		Model 4		Model 4 (1983Q1-2013Q4)	
	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	0.3909	0.0475 ****	0.3647	0.0486 ****	0.3406	0.0606 ****	0.3115	0.0589 ****	0.3089	0.0583 ****
ln_M2_1	0.9899	0.0067 ****	0.9868	0.0069 ****	0.9689	0.0087 ****	0.9635	0.0082 ****	0.9630	0.0080 ****
ln_GDP	-0.0141	0.0106	-0.0090	0.0109	0.0190	0.0138	0.0278	0.0130 **	0.0287	0.0127 **
OC	-0.0141	0.0041 ****	-0.0152	0.0042 ****	-0.0121	0.0040 ***	-0.0125	0.0040 ***	-0.0124	0.0040 ***
dln_CPI	-0.9305	0.0664 ****	-1.0406	0.0593 ****	-0.9866	0.0663 ****	-1.0470	0.0573 ****	-1.0490	0.0570 ****
ln_exchange					-0.0245	0.0076 ***	-0.0281	0.0074 ****	-0.0285	0.0073 ****
MD2401					4.8E-07	2.7E-07 *	6.1E-07	2.7E-07 **	6.1E-07	2.6E-07 **
MD2701					5.7E-07	2.5E-07 **	7.0E-07	2.4E-07 ***	7.0E-07	2.4E-07 ***
D1	0.0176	0.0024 ****	0.0220	0.0021 ****	0.0210	0.0025 ****	0.0238	0.0020 ****	0.0238	0.0020 ****
D2	-0.0087	0.0027 ***			-0.0049	0.0028 *				
D3	0.0001	0.0026	0.0055	0.0020 ***	0.0036	0.0027	0.0069	0.0019 ****	0.0068	0.0019 ****
Ljung Box(5)	statistic	p-value	statistic	p-value	statistic	p-value	statistic	p-value	statistic	p-value
	12.8326	0.0250 **	13.8661	0.0165 **	7.5178	0.1849	6.5741	0.2543	6.7217	0.2422
Adj R^2	0.999		0.999		0.999		0.999		0.999	

Signif. codes: 0 ‘****’ 0.001 ‘***’ 0.01 ‘**’ 0.05 ‘*’ 0.1 ‘ ’ 1

Table 4 In-sample and out-of-sample forecast performance

	In-sample performance	Out-of-sample performance
Model 3 - Model 1	-4.89E-04 (0.94)	3.82E-04 (0.95)
Model 3 - Model 2	-9.75E-04 (0.87)	8.49E-05 (0.99)
Model 4 - Model 1	-2.78E-04 (0.96)	2.16E-04 (0.97)
Model 4 - Model 2	-7.63E-04 (0.90)	-8.05E-05 (0.99)
Model 4 - Model 3	2.12E-04 (0.97)	-1.65E-04 (0.98)

The parentheses are p-value of Diebold-Mariano test.

4. Cointegration analysis

As we are dealing with macroeconomic time series, the issue of unit root and cointegration must be addressed. Yet, since cointegration analysis is mainly concerned with the long-run equilibrium relationship among variables, it is not expected to be informative in this study. The conjecture is made based upon the observation that capital flows are very volatile and their relationship with money can hardly be stable in the long run.

Even so, to avoid the risk of spurious regression, we perform the standard unit root and cointegration analysis. Though there exist a bundle of unit root tests, we decide to use the traditional Augmented Dickey-Fuller test and summarize the p-values of test results in Table 5. From the table, we conclude that two capital flow variables and opportunity cost are I(0) while the others are I(1). We then proceed with Johansen's cointegration analysis. It is worth noting that mixing I(1) with I(0) variables within Johansen (1988、1995) framework is allowed statistically but interpreting the cointegration rank and cointegration vector need to be very careful. The VAR and vector error correction model (VECM) model are:

$$X_t = \sum_{j=1}^{k} \Pi_j X_{t-j} + \Phi D_t + \varepsilon_t,\ t = 1, \dots, T \qquad (3)$$

And the vector error correction model (VECM) will become

$$\Delta X_t = \sum_{j=1}^{k-1} \Gamma_j \Delta X_{t-j} + \Pi X_{t-1} + \Phi D_t + \varepsilon_t,\ t = 1, \dots, T \tag{4}$$

where $\Gamma_j = -(\Pi_{i+1} + \cdots + \Pi_k)$ and $\Pi = -(\mathrm{I} - \Pi_1 - \cdots - \Pi_k) = \alpha\beta'$

α is loading weights, β is the cointegration vector, I is Identity matrix; D_t denote deterministic term and seasonal dummies, and ε_t is disturbance vector with mean 0 and variance Λ.

Table 5 ADF test

	ln_M2	ln_GDP	OC	dln_CPI	ln_exchange	MD2401	MD2701
level	0.1333	0.7590	0.0216	0.0197	0.4697	0.0119	0.0219
diff_1	0.0355	0.01	0.01	0.01	0.0164	0.01	0.01
diff_2	0.01	0	0	0	0.01	0	0

The values in table are p-values.

We use AIC (Akaike information criterion), HQ (Hannan-Quinn), SC (Schwarz) and FPE (Forecast Prediction Error) to choose the order in VAR model. The formula of AIC, HQ, SC and FPE are in following

$$\mathrm{AIC} = \ln det\left(\tilde{\Sigma}_u(n)\right) + \frac{2}{T} nK^2 \tag{6}$$

$$\mathrm{HQ} = \ln det\left(\tilde{\Sigma}_u(n)\right) + \frac{2\ln(\ln(T))}{T} nK^2 \tag{7}$$

$$\mathrm{SC} = \ln det\left(\tilde{\Sigma}_u(n)\right) + \frac{\ln(T)}{T} nK^2 \tag{8}$$

$$\mathrm{FPE} = \left(\frac{T+n^*}{T-n^*}\right)^K det\left(\tilde{\Sigma}_u(n)\right) \tag{9}$$

where $\tilde{\Sigma}_u(n) = T^{-1} \sum_{t=1}^{T} \hat{u}_t \hat{u}'_t$ and u_t is residuals of model. T, K, n^* and n are sample periods, the number of exogenous variables, the number of parameters and lag

order, respectively. Table 6 shows the maximum order are three for two group models then this article sets VAR (3) model to analyze the cointegration.

Table 6 VAR order selection

	Model with MD2401 and MD2701			
Order	AIC(n)	HQ(n)	SC(n)	FPE(n)
1	-4.4720	-3.8082	-2.8372	0.0115
2	-4.5455	-3.4170	-1.7664	0.0108
3	-4.7352	-3.1421	-0.8118	0.0091
4	-4.4006	-2.3427	0.6672	0.0134

As can be seen from Table 7, the maximum eigenvalue test and trace test indicate that at the 5% critical value model 4 has 5 cointegration vectors, suggesting the existence of long run equilibrium relationship among all variables.

Table 7 Cointegration test

	Max. eigenvalue test		Trace test	
H0	Test	5pct	Test	5pct
r<= 6	2.91	8.18	2.91	8.18
r<= 5	7.68	14.90	10.58	17.95
r<= 4	24.57	21.07	35.15	31.52
r<= 3	31.72	27.14	66.88	48.28
r<= 2	36.40	33.32	103.28	70.60
r<= 1	51.79	39.43	155.07	90.39
r= 0	62.72	44.91	225.7	124.25

Test means test value. 5pct is 5% is critical value of statistic；If Test >=5pct then reject H0

Table 8 reports the parameter estimates of ECM. As the cointegration rank is greater than one and the model involves I(0) variables, we do not attempt to interpret the estimation result economically.

Table 8 Parameter estimates for loading weights and cointegration vectors

		ln_M2.l1	ln_GDP.l1	OC.l1	dln_CPI.l1	ln_exchange.l1	MD2401.l1	MD2701.l1
Cointegration relations (Beta)	ln_M2.l1	1	1	1	1	1	1	1
	ln_GDP.l1	-2.3940	-1.2151	-1.3903	-2.1924	3.3830	-1.5583	-1.5335
	OC.l1	-3.6541	-0.5696	0.3852	-1.0972	-2.5746	0.0740	0.0768
	dln_CPI.l1	-363.0539	21.8522	9.0178	-6.0933	149.9397	0.6506	-1.5083
	ln_exchange.l1	-6.9516	1.4887	0.4070	0.1120	2.5772	-0.8721	0.9516
	MD2401.l1	0	0	0	-0.0001	0.0002	0	0
	MD2701.l1	-0.0001	-0.0001	0	0	0.0003	0	0
Weights (Alpha)	ln_M2.d	-0.0046	0.0252	-0.0384	0.0090	-0.0023	0.0017	0.0004
	ln_GDP.d	-0.0007	-0.0286	0.0392	0.0282	0.0018	0.0079	0.0141
	OC.d	0.0441	0.1313	-0.1998	0.1809	0.0366	0.0563	-0.0921
	dln_CPI.d	0.0048	-0.0181	0.0133	0.0002	0.0001	-0.0035	0.0020
	ln_exchange.d	-0.0011	-0.0377	-0.0214	-0.0155	-0.0026	0.0153	-0.0086
	MD2401.d	-406.5076	-4967.8837	4839.1734	3238.4812	-329.5136	-876.3608	-2132.5521
	MD2701.d	686.1025	11876.8495	6322.8717	-1513.3527	-380.8713	1474.7342	1453.3366

Table 9 reports the parameter estimates for the short-run coefficients. Note that "variable.dl1" denote first difference of variable and "variable.l1" is lag 1 of variable and so on. sd1, sd2 and sd3 are seasonal dummy variables of the first quarter, second quarter and third quarter, respectively. As is suggested by Zhou, Bonham, & Gangnes (2004), since cointegration rank is greater than 1, α and β cannot be uniquely determined unless there exist enough restrictions. This belongs to the domain of structural cointegration and is beyond the scope of this study.

Table 9 Coefficient of EVCM

	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
constant	-0.0564	0.1601				
sd1	0.0214	0.0055 ****				
sd2	-0.0307	0.0069 ****				
sd3	-0.0105	0.0083				
	variable.dl1		variable.dl2		variable.l1	
ln_M2	0.3544	0.1685 **	0.0156	0.1699	-0.0091	0.0212
ln_GDP	-0.1056	0.0548 *	-0.0192	0.0552	0.0034	0.0323
OC	0.0105	0.0097	-0.0037	0.0081	-0.016	0.0114
dln_CPI	-0.5597	0.3358 *	-0.0937	0.1375	1.495	0.4408 ***
ln_exchange	0.0662	0.0661	-0.0552	0.0667	0.0482	0.0188 **
MD2401	-2.00E-07	6.50E-07	-7.70E-08	5.70E-07	5.80E-07	7.30E-07
MD2701	3.90E-07	6.40E-07	1.30E-07	4.40E-07	-2.30E-07	7.80E-07

Signif. codes: 0 '****' 0.001 '***' 0.01 '**' 0.05 '*' 0.1 ' ' 1

5. Conclusion and policy implication

It is the observation of the close relationship between money demand and capital flow variables in the end of 2008 that has prompted us to investigate the relationship between capital flows and money demand in Taiwan. The asset substitution effect and currency substitution effect can be used to justify the inclusion of the capital flow variables and foreign exchange rate. Empirical analysis using data from 1983Q1 to 2013Q3 supports our conjecture that capital flows do have significant impact on money demand. It also supports the existence of the currency substitution effect and the assets substitution effect.

The empirical results of this study have one policy implication. When the international financial markets fluctuate and induce capital to flow in or out of one country, the money demand will adjust accordingly. If the central bank does not take measures to completely sterilize the capital inflows or outflows, monetary aggregates will increase or decrease accordingly. For example, during the end of 2008, the global

financial market turmoil has induced huge capital inflows to Taiwan as investors withdrew their funds to home country to minimize risk. Provided central bank does not fully sterilize, money supply would increase drastically. This can be viewed as an unconventional monetary measure for quantitative easing, that is, increasing liquidity by not sterilizing capital inflows.

As Dr. Kuo-Yuan Liang pointed out, the international capital movement is not necessarily equal to the inflow (or outflow) of capital. When capital does flow in, how the central bank in Taiwan perceives the degree of speculation (hot money) will strongly affect her policy choices that in turn would have different effect on money supply. A complete analysis of the central bank's policy reaction function and its transmission is an important issue with high priority for future research agenda.

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