THE REASONS FOR FOREIGN EXCHANGE RESERVES ACCUMULATION IN HONG KONG: A COINTEGRATION AND VECTOR ERROR CORRECTION APPROACH

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ABSTRACT

This paper empirically investigates the reasons for the large amounts of foreign exchange reserves accumulation in Hong Kong in both long run and short run. The Johansen cointegration test results show a positive long-run relationship between broad money supply and foreign exchange reserves holding, and no significant long-run relationship between exchange rate and foreign exchanges reserve holding, indicating that the increase in money supply is a reason for the rise of foreign exchange reserves holding in long run. The long-run relationships are confirmed by Granger causality test results, and are explained by Hong Kong's small open economy under fixed exchange rate regime. This paper establishes a vector error correction model to measure the short-run dynamics and the tendency to restore to its long-run equilibrium. The coefficient of error correction term implies a low speed of adjustment of foreign exchange reserves, indicating that the monetary authority of Hong Kong has to hold large amounts of foreign exchange reserves to be effective in foreign exchange reserves intervention and management. The low speed of adjustment in the short run is the second reason why Hong Kong's foreign exchange reserves holding increases rapidly.

Contribution/ Originality: This paper is one of very few studies that have investigated the reasons for the rapid growth of foreign exchange reserves holding in Hong Kong by using a vector error correction model. It helps to understand the foreign exchange reserves management of small open economy.

1. INTRODUCTION

For the past two decades, Asian countries accumulate huge amounts of foreign exchange reserves. Among these economies, Hong Kong's foreign exchange reserves holding increased dramatically. Hong Kong's foreign exchange reserves holdings were 94.3 billion U.S. dollars in early 2000. It went up to 419.2 billion U.S. dollars by November 2017. Hong Kong becomes one of the largest foreign exchange reserve holders in the world. The foreign exchange reserve holding to GDP ratio of Hong Kong is even more striking, which is the largest in the world. In addition, Hong Kong maintains currency board monetary system and is under the monetary policy of exchange rate targeting. The management of its foreign exchange reserves becomes a major issue of Hong Kong Monetary

Authority. There exists a growing debate on why the foreign exchange reserves accumulate on such a large scale in Hong Kong.

In general, central banks hold foreign exchange reserves for several reasons (see (Heller, 1966; Kelly, 1970; Edwards, 1984; Ford and Huang, 1994; Green and Torgerson, 2007; Aizenman and Lee, 2007;2008)). First, central banks hold foreign exchange reserves to self-insure against sudden shocks to the balance of payment. Hence, holding adequate foreign exchange reserves can limit external vulnerability and stabilize capital account and current account in bad scenarios. Second, central banks need foreign exchange reserves to act as a lender of last resort to commercial banks that have high foreign currency liability. Holding enough foreign exchange reserves can provide confidence to the market that the country is able to meet its external responsibilities, and attract foreign capital and investments. Third, central banks need foreign exchange reserves for intervention, such as maintaining an exchange rate target and moderating inflation.

However, based on existing literature (Landell-Mills, 1989; Aizenman and Marion, 2003; Green and Torgerson, 2007) foreign exchange reserves accumulation also generates cost. First, excessive foreign exchange reserves holding strengthens inflationary pressure and hence generates sterilization cost. Central banks conducts open market sales to issue government bonds and sterilize the inflationary impact of foreign exchange reserves accumulation. The excess of the interest rate paid to the bond buyers over the return from foreign exchange reserves induces sterilization cost. Second, holding excessive foreign exchange reserves generates opportunity cost. The resources spent on buying foreign exchange reserves can be invested in many other ways. It is quite possible that the returns from other investment opportunities are higher than the return from holding foreign exchange reserves. Third, foreign exchange reserves can lose value when foreign currency depreciates against domestic currency. Fourth, reserve accumulation may create a false sense of economic stability and security, which delays necessary adjustments and reforms.

Therefore, holding an optimal amount of foreign exchange reserves is very valuable for monetary authorities. This topic is especially important to Hong Kong, as its foreign exchange reserves holding has increased dramatically and has the highest foreign exchange reserves to GDP ratio in the world. Many questions were raised about the necessity and the reasons of the huge amounts of foreign exchange reserves accumulation in Hong Kong.

This paper is conducted to shed some light on the reasons of the huge amounts of foreign exchange reserve accumulation in Hong Kong. It contributes to the literature by investigating the long-run and short-run relationships between foreign exchange reserves and its major determinants. To the best of my knowledge, this paper is the first to investigate the reasons of Hong Kong's rapid foreign exchange reserves accumulation by using a vector error correction approach.

Empirical time series approaches such as unit root test, cointegration test, Granger causality test, and vector error correction model are applied in the paper. The cointegration test finds a positive long-run relationship between broad money supply and foreign exchange reserves, and finds no significant long-run relationship between exchange rate and foreign exchange reserves, indicating that the increase in money supply is one reason for the large foreign exchange reserves accumulation. These results are also confirmed by the Granger causality tests. This paper also establishes a vector error correction model, whose result shows that the foreign exchange reserves has a low speed of adjustment of its departure from the long-run equilibrium, providing a second reason for the large amount of foreign exchange reserves holding.

The remainder of this paper is structured as follows. In the second section, related literatures are reviewed. This paper provides variable and data description in the third section. In the fourth section, the empirical methodology is illustrated. In the fifth section, this paper shows the empirical results and the analysis. This paper concludes in the sixth section.

2. LITERATURE REVIEW

Holding an optimal amount of foreign exchange reserves has received a lot of attention. There is a growing body of literature in the field of optimal level of foreign exchange reserves holding and its determinants. These literatures can be classified into two main categories: univariate ratio analysis and multivariate regression analysis.

For the univariate ratio analysis of optimal foreign exchange reserves holding, there are three conventional ratios that are foreign exchange reserves to short-term external debt ratio (Jeanne and Ranciere, 2011) foreign exchange reserves to broad money supply ratio (Frenkel, 1974; Wijnholds and Kapteyn, 2001) and foreign exchange reserves to imports ratio (Pineau *et al.*, 2006). These benchmarks are all measured against a single variable. Previous studies argue that the foreign exchange reserves are held as a fixed portion of each variable. However, these univariate ratio analyses have received a lot of criticism recently. For example, Green and Torgerson (2007) investigate each of the above mentioned ratio benchmarks by using the data of foreign exchange reserves holding of emerging markets in 2005. The results conclude that all the top foreign exchange reserves holders held much more reserves than those benchmarks suggested and state that these ratio benchmarks against a single variable were no longer appropriate criterion for central banks nowadays. The authors also examine the beneficial motivations and the cost of foreign exchange reserves accumulation among the emerging economies.

Besides the above ratio benchmarks against a single variable, multivariate approach is also widely used to study the determinants of foreign exchange reserves. Some studies are conducted by using multivariate regression analysis (Lane and Burke, 2001; Aizenman and Marion, 2003). The explanatory variables used in these studies can be classified into several groups: current account vulnerability measured by imports or exports, monetary policy indicated by broad money supply and interest rate changes, economic size measured by GDP and population, and exchange rate. They argue that the reasons why these variables determine the level of foreign exchange reserves accumulation can be explained by the purposes of holding foreign exchange reserves. Since one important purpose for reserve holding is to stabilize its capital account and current account in face of a sudden shock, measures of the vulnerability of capital account and current account should be considered as explanatory variables. Factors in current account, such as international trade, are correlated with economic size and exchange rate. A more flexible exchange rate regime should reduce the demand for foreign exchange reserves for cushion purpose.

Some studies apply time series approach to investigate the foreign exchange accumulation in Asia. Ford and Huang (1994) employ the error correction model to investigate the foreign exchange reserves accumulation in China from 1950s to 1990s. They show that reserve holdings in China have a stable relationship with its determinants. Narayan and Smyth (2004) study the relationship between China's foreign exchange reserves holding and exchange rate. They use cointegration method and Granger causality test to find that foreign exchange reserves holding causes the exchange rate to change in the long run. Gosselin and Parent (2005) use data ranging from 1980 to 2003 over eight Asian emerging market economies to analyze their foreign exchange reverses holdings. The results of panel error correction model suggest that the speed of foreign exchange reserves accumulation in these countries would slow down. Prabheesh *et al.* (2007) use cointegration and vector error correction approach to analyze India's demand for foreign exchange reserves from 1983 to 2005. The results imply that India' reserve accumulation is highly related to capital account vulnerability and less related to its opportunity cost.

3. VARIABLES AND DATA

This paper uses broad money supply M2 and exchange rate as the explanatory variables. Broad money supply M2 measures the magnitude of overall domestic banking system and the financial depth of economy of the country, which in turn affect capital account vulnerability, leading to precautionary self-insuring foreign exchange reserves accumulation. Obstfeld *et al.* (2010) empirically prove that it is broad money supply M2 rather than other monetary aggregates that drives the foreign exchange reserves accumulation.

Moreover, Hong Kong is under the currency board monetary system and applies exchange rate targeting monetary policy. Exchange rate targeting can be an essential purpose of foreign exchange reserves accumulation, so the exchange rate should be considered as another factor that affects the foreign exchange reserves holding in Hong Kong. Changes in exchange rate also affect import and export, which have an impact on capital account vulnerability, resulting in a precautionary self-insuring foreign exchange reserves accumulation. Greater exchange rate flexibility may reduce the demand for foreign exchange reserves for cushion purpose.

This paper eliminates potential explanatory variables such as interest rate, population, short-term external debt, GDP, imports and exports. Hong Kong is a small open economy, which has perfect access to the world capital market. The interest rate in the small open economy is determined by the world interest rate. Hong Kong's monetary authority has no control on its domestic interest rate. According to the study results of Obstfeld *et al.* (2010) variables such as population and short-term external debt are insignificant in explaining foreign exchange reserves holding. GDP is significant in the regression without M2 but becomes insignificant in the regression with M2. It is because GDP is positively correlated with broad money supply M2, and acts as the proxy for M2 when M2 is omitted. The inclusion of the true driver M2 will make GDP insignificant in explaining the demand for foreign exchange reserves. Variables measuring current account such as imports and exports tend to be less significant with the existence of exchange rate. Theoretically, net export, measured by the difference between export and import, is a function of exchange rate for an open economy. Green and Torgerson (2007) confirm that the import and export measurements are only useful in low-income countries that have limited access to international capital market. Rodrik (2006) also indicate that the foreign exchange reserves accumulation is driven by the size of their domestic financial sector rather than the magnitude of international trade. Lane and Burke (2001) find that the financial openness is insignificant under their cross-country empirical study. Therefore, for my empirical study for Hong Kong's foreign exchange reserves accumulation, interest rate, population, short-term external debt, GDP, imports and exports are excluded.

Data used in this paper is obtained from the website of International Financial Statistics of IMF and Hong Kong Monetary Authority. The monthly data range from January 2000 to November 2007, which make the sample size large enough to enable the time series econometric study. Many empirical studies (Aizenman and Marion, 2003; Mendoza, 2004; Aizenman *et al.*, 2007) demonstrate that the Asian financial crisis occurred in 1997 produced great effects on the demand for foreign exchange reserves accumulation in Asian countries. It strengthened the self-insurance incentive and hence increased the foreign exchange reserves holding. The effects of Asian financial crisis have faded away since 1999. Moreover, according the business cycle date announced by U.S. National Bureau of Economic Research, an economic recession started from December 2007. In order to investigate the true effect of foreign exchange reserves' determinants, this paper chooses the period ranging from January 2000 to November 2007 to avoid the disturbance of financial crisis.

The foreign exchange reserves held by the Hong Kong Monetary Authority is measured in the unit of millions of U.S. dollar. It eliminates the gold reserve, because gold is not used by the country as an intervention asset. This paper uses M2 to measure the money supply. The M2 data is originally measured in the unit of millions of Hong Kong dollar, and is transformed into million U.S. dollars. All the variables are studied in the form of logarithm. Hong Kong Monetary Authority follows the fixed exchange rate regime, which targets a fixed exchange rate with respect to U.S. dollar. It only allows for a limited fluctuation within a very small interval. Hence, this paper uses the real effective exchange rate (REER) to measure the exchange rate of Hong Kong dollar. Real effective exchange rate is the weighted average of the currency's exchange rate with respect to a basket of major foreign currencies adjusted for the effect of inflation, with the weight determined by the balance of international trade. A drop in the value of exchange rate indicates a depreciation of the value of domestic currency.

4. EMPIRICAL METHODOLOGIES

This paper empirically studies the relationship among exchange rate, broad money supply, and foreign exchange reserves in Hong Kong by using time series approaches such as unit root test, cointegration test, Granger causality test and vector error correction model.

It first conducts the stationarity check for all the three variables by using Augmented Dickey-Fuller unit root test (Dickey and Fuller, 1979;1981) and Phillips-Perron unit root test (Phillips and Perron, 1988). The unit root properties of the variables are important for the estimation of relationship among them. If the variables are not stationary, the ordinary regression will lead to a spurious regression and reach an incorrect conclusion. Even if the two integrated variables are uncorrelated, the spurious regression could produce a significant regression coefficient. The Augmented Dickey-Fuller unit root test with a drift for a variable has the format as shown in equation (1).

$$\Delta y_t = \alpha + \theta y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon_t \tag{1}$$

where Δy_t is the change in the logarithm of the time series variable, such as foreign exchange reserves holding, exchange rate, and broad money supply. The number of lags p is determined by Bayesian information criterion (BIC) (Schwarz, 1978) instead of Akaike information criterion (AIC) (Akaike, 1973). As documented by Bickel and Zhang (1992) BIC identifies the true model and consistent while in contrast AIC is not.

However, if the non-stationary variables are cointegrated (Granger and Newbold, 1974) which means variables move together in the long run and have a common unit root factor, then the regressions among these non-stationary variables are valid. Therefore, the long-run relationship among foreign exchange reserves holding, broad money supply and exchange rate can be explored through the conintegration equation.

There are two main methods for cointegration test. The first one is introduced by Engle and Granger (1987) and is based on unit root tests. If the residual of the regression is stationary or the combination of the variables is stationary, the variables are cointegrated. The second method is introduced by Johansen (1988) which has advantages over the first method when testing cointegration with more than two variables. Johansen' method is also a joint procedure that contains the estimation of the vector error correction model and long run equilibrium relations. Since this paper studies the long-run relationship among three variables, it uses Johansen's method in equation (2) to test cointegration among foreign exchange reserves, money supply, and exchange rate.

$$\Delta Y_t = C + A_0 Y_{t-1} + \sum_{i=1}^{p} A_i \Delta Y_{t-i} + \varepsilon_t \tag{2}$$

where Y_t is a 3×1 vector which contains variables of foreign exchange reserves holding, broad money supply, and exchange rate. The number of lags p is determined by Bayesian information criterion (BIC) (Schwarz, 1978).

If the variables are cointegrated, we can investigate the short-run dynamics through the vector error correction model by adding the error correcting term into the regression (see Pesaran *et al.* (2000)). The variables changes in response to the deviation from the long-run equilibrium of the previous period. The coefficient A_0 in the vector error correction model is the product of adjustment speed parameter B and cointegrating vector D, i.e.

$A_0 X_{t-1} = -BD'X_{t-1} = -BZ_{t-1}$. The cointegration guarantees that the added error correction term is also stationary, and hence the stationary equation can hold. The error correction term represents the potential effect of departure from long-run equilibrium that is gradually corrected through short-run adjustments. In other words, the

error correction term can measure the speed and tendency of each variable to restore from short-run dynamics back to its own long-run equilibrium.

5. EMPIRICAL RESULTS

Table 1 shows the results of Augmented Dickey-Fuller (ADF) unit root tests and Phillips-Perron unit root tests (PP) for all the three variables. The null hypothesis is that the variable is non-stationary. The results of both unit root tests show that all three variables are I(1), indicating that they are all non-stationary at their original level, but become stationary after the first difference.

Table-1. ADF and PP Unit Root Test Results

Variables		ADF Test statistics	PP Test statistics
R_t	Level	-0.683 (0.845)	-0.583 (0.868)
	first difference	-5.744*** (0.000)	-5.714*** (0.000)
E_t	Level	0.292 (0.977)	0.607 (0.989)
	first difference	-6.880*** (0.000)	-6.852*** (0.000)
M_t	Level	2.569 (1.000)	3.358 (1.000)
	first difference	-9.382*** (0.000)	-9.377*** (0.000)

Note: The above table shows the t-statistic results of Augmented Dickey-Fuller (ADF) unit root test and Phillips-Perron unit root test (PP) for all the three variables at their level and first difference. E denotes the logarithm of exchange rate, M denotes the logarithm of money supply M2, and R denotes the logarithm of foreign exchange reserves holding. P-values are listed in the parenthesis (* denotes 10% significance level, ** denotes 5% significance level, and *** denotes 1% significance level).

Since there are three variables, this paper uses Johansen cointegration test to explore the long-run relationship among these variables. Johansen cointegration test also involves the estimation of vector error correction model. We determine the number of lags of vector error correction model using Bayesian information criterion (BIC). As shown in Table 2, the lowest value of BIC indicates that the number of lag is one.

Table-2. BIC Lag Selection Results

Lag number	BIC Statistics
1	-16.921*
2	-16.871
3	-16.773
4	-16.477
5	-16.184
6	-15.816
7	-15.522
8	-15.180

Note: The above table shows the lag selection results of cointegration test based on Bayesian information criterion (* indicates the lag number selected by BIC criterion).

From the result of Table 3, it can be seen that the null hypothesis of no cointegrating vector is rejected at the 1% significant level, and the alternative hypothesis that there is at most one cointegrating vector is not rejected. Hence, the results of Johansen's cointegration test demonstrate that there is one cointegrating vector among three variables.

Table-3. Johansen Cointegration Test Results

Cointegrating Vectors Number	Trace Statistics	Critical Value	P-value
No Cointegrating Vector	36.433	29.797	0.007***
At most one	9.704	15.494	0.304
At most two	0.005	3.841	0.945

Note: The above table demonstrates the Jonhansen Cointegration test results (* denotes 10% significance level, ** denotes 5% significance level, and *** denotes 1% significance level).

In order to investigate the speed of adjustment of departure from long-run equilibrium to analyze the reason of large foreign exchange reserves accumulation in Hong Kong, the paper also builds up a vector error correction

model. Since this paper follows the BIC as the information criterion to choose the optimal lag number of one, the vector error correction model with one lag is established as equation (3).

$$\Delta Y_t = C + A_0 Y_{t-1} + A_1 \Delta Y_{t-1} + \varepsilon_t \tag{3}$$

where Y_t is a 3×1 vector containing three variables of $R_t, M_t,$ and E_t.

Table-4. Cointegrating Equation and Vector Error Correction Model Results

Cointegrating Equation			
R_{t-1}	1.00		
E_{t-1}	0.03 (0.11)		
M_{t-1}	-0.66*** (0.11)		
c	-3.07		
Error Correction	ΔR_t	ΔE_t	ΔM_t
Adjustment	-0.10*** (0.03)	-0.04 (0.03)	-0.06 (0.05)
ΔR_{t-1}	0.32*** (0.10)	-0.05 (0.10)	-0.31*** (0.01)
ΔE_{t-1}	0.01 (0.11)	0.21 (0.11)	0.20 (0.12)
ΔM_{t-1}	0.03 (0.44)	-0.16* (0.07)	-0.07 (0.12)
c	0.003*** (0.001)	-0.002** (0.001)	0.007*** (0.002)

Note: The above table demonstrates the cointegration equation and vector error correction model estimation results. Standard errors are reported in the parenthesis (* denotes 10% significance level, ** denotes 5% significance level, and *** denotes 1% significance level).

Transforming the cointegration results from Table 4 into an equation, the equation (4) illustrates the long-run relationship among the three variables.

$$R_t = -0.03E_t + 0.66M_t - 3.07 \tag{4}$$

$$(0.11) \qquad (0.11)$$

Based on the standard errors listed in the parenthesis, the coefficient of exchange rate is insignificant, indicating that the long-run relationship between exchange rate and foreign exchange reserves holding is nil. Moreover, the broad money supply M2 has significantly positive long-run relationship with foreign exchange reserves holding. These results indicate that the money supply increase can explain the large scale of foreign exchange reserves accumulation in Hong Kong. The above relationships among foreign exchange reserves holding, money supply and exchange rate can be explained by Hong Kong's small open economy under fixed exchange rate regime. "Small" means that Hong Kong has negligible impacts on the world economy. "Open" means that Hong Kong has perfect access to the world capital market, and capital is able to flow in and flow out freely. The money demand is growing together with income, and the money supply is exogenously controlled by Hong Kong Monetary Authority. If the demand of Hong Kong dollar is greater than its supply, then the exchange rate of Hong Kong dollar is about to increase. Under the currency board monetary system and the exchange rate targeting monetary policy, Hong Kong Monetary Authority needs to moderate the appreciation to make the exchange rate stable. To balance the extra demand of Hong Kong dollar, Hong Kong Monetary Authority needs to increase the supply of Hong Kong dollar by selling Hong Kong dollar and buying foreign currency, resulting in an increase in foreign exchange reserves holding. Therefore, the money supply and foreign exchange reserves holding have a positive relationship. The increase of domestic money supply will reduce the exchange rate back to its original level, and maintain the exchange rate constant. Therefore, the relationship between exchange rate and foreign exchange reserves holding should be nil in the long run. The long-run relationships among foreign exchange reserves holding, money supply and exchange rate are also confirmed by the results of Granger causality tests (Granger,

1969;1986) that are shown in Table 5. The Granger causality test demonstrates whether the past information of one variable is useful in predicting the future value of another variable. Only the null hypothesis that broad money supply M2 does not Granger cause foreign exchange reserves is rejected. The results imply that only the broad money supply M2 Granger causes foreign exchange reserves holding. Therefore, it reinforces the idea that the increase in broad money supply is the reason for the large foreign exchange reserves accumulation in the long run.

Table-5. Granger Causality Test Results

Null Hypothesis	F-Statistic	Probability
Ex does not Granger Cause Reserve	1.638	0.204
Reserve does not Granger Cause Ex	1.403	0.239
M2 does not Granger Cause Reserve***	19.367	0.00003
Reserve does not Granger Cause M2	0.348	0.557
M2 does not Granger Cause Ex	0.008	0.927
Ex does not Granger Cause M2	0.647	0.423

Note: The above table demonstrates the Granger causality test results. (* denotes 10% significance level, ** denotes 5% significance level, and *** denotes 1% significance level).

The short-run relationships among foreign exchange reserves holding, money supply and exchange rate are demonstrated by the vector error correction model. The first column of vector error correction model in Table 4 is transformed into equation (5), and reveal another reason for the large foreign exchange reserves accumulation.

$$\Delta R_t = -0.1\,(R_{t-1} + 0.03E_{t-1} - 0.66M_{t-1}) + 0.32\,\Delta R_{t-1} + 0.01\Delta E_{t-1} + 0.03\Delta M_{t-1} + 0.003 \quad (5)$$

$$(0.03) \qquad (0.11) \qquad (0.11) \qquad (0.10) \qquad (0.11) \qquad (0.44) \qquad (0.001)$$

Based on the standard errors listed in the parenthesis in equation (5), we can see ΔR_t is significantly affected

by $(R_{t-1} + 0.03E_{t-1} - 0.66M_{t-1})$ and ΔR_{t-1}. This tells that foreign exchange reserves holding changes in response to both its deviation from long-run equilibrium in the past period and its past fluctuation. The previous changes in exchange rate and money supply does not have a significant impact on foreign exchange reserves accumulation in the short-run. The coefficient of error correction term indicates the speed of adjustment of each variable to restore to its long-run equilibrium. From the results of Table 4, it can be seen that the coefficient of

adjustment of error correction term of ΔR_t is -0.1, and it is significant at 1% level. It implies that about 10% of the

departure from long-run equilibrium is removed each month. The speed of adjustment is relatively low, which indicates that the past error in the foreign exchange reserves holdings could be corrected in a slow pace. The recovery of long-run equilibrium would take a relatively long time. According to Clark (1970) a low speed of adjustment of departure to long-run equilibrium generates a large foreign exchange reserves holding, because the monetary authority needs a huge amount of foreign exchange reserves in hand to promote the recovery of long-run equilibrium. The low speed of adjustment of departure to long-run equilibrium also suggests that the Hong Kong Monetary Authority needs to hold considerable amount of foreign exchange reserves in order to actively intervene to maintain the fixed exchange rate and the balance of its current account and capital account. This provide a short-run reason why Hong Kong's foreign exchange reserves holding is so huge. The sign of the coefficient of error correction term of foreign exchange reserves is negative, which means the foreign exchange reserves holdings of Hong Kong is excessive, and they need be reduced to restore the long-run equilibrium.

6. CONCLUSION

During the past two decades, Hong Kong's foreign exchange reserves holding increases dramatically and becomes one of the largest foreign exchange reserves holders in the world. To the best of my knowledge, this paper

is the first to examine the reason why Hong Kong's foreign exchange reserves holding increases at such a large scale in both long and short run with a vector error correction approach. This paper reviews the determinants of foreign exchange reserves accumulation in the existing literature, and analyzes the long-run and short-run relationships among foreign exchange reserves holding, broad money supply, and exchange rate in Hong Kong. The Johansen's cointegration test results demonstrate that there exists a positive long-run relationship between broad money supply and foreign exchange reserves holding, and no relationship between exchange rate and foreign exchange reserves holding in the long run. The Granger causality test results also confirm these relationships. The increase in money supply in Hong Kong is one reason why it accumulates a large amount of foreign exchange reserves. This paper builds up a vector error correction model to measure the short-run dynamics and the tendency of each variable to restore to its long-run equilibrium. The coefficient of error correction term implies a relatively low speed of adjustment of foreign exchange reserves. Only 10% of the departure from long-run equilibrium is eliminated each month. The low speed of adjustment indicates that the monetary authority of Hong Kong has to hold a large amount of foreign exchange reserves to be active in foreign exchange reserve intervention and management. The low speed of adjustment is the second reason why Hong Kong Monetary Authority's foreign exchange reserves holding increases rapidly.

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