Currency Substitution between Hong Kong Dollar and Renminbi in South China

Kenneth S. Chan
Department of Economics, McMaster University
and
Hong Kong Institute for Monetary Research

March 2001

Abstract

This paper estimates the demand for the Hong Kong currency circulating in the Guangdong Province of China and Macau. The amount of Hong Kong Dollar circulating in the Guangdong (Macau) region is reckoned to be 7.4 (3.2) per cent of the total amount issued in Hong Kong. The estimated coefficients in the currency demand equation suggest that the Hong Kong currency in Guangdong is used mainly for transactions. Therefore, in spite of strong evidence of currency substitution of the renminbi with the Hong Kong dollar, its impact on the exchange rate and on the international reserves of Hong Kong during currency crisis should be minimal.

The author is indebted to Yin-Wong Cheung, Yue Ma, Steve Ching, Chander Kant, Simon Kwan, Cynthia Leung, Guy Meredith and Matthew Yiu, for comments on an earlier draft. He is thankful to Desmond Hou for excellent research assistance. This paper was written while he was visiting the Hong Kong Institute for Monetary Research in 2000. The views presented in this paper are those of the author and do not necessarily reflect those of the Hong Kong Institute for Monetary Research, its Council of Advisors, or Board of Directors.

1. Introduction

This paper estimates the demand for the Hong Kong currency ("HKD") circulating in the South China region, mainly in the Guangdong Province of China and Macau. There is a large literature on the policy implications and estimations of key currencies, such as the US, German, Swiss and Japanese currencies, held outside the currency issuing countries (Doyle (2000), Latter (2000), Porter and Judson (1996), Rogoff (1998), Sprenkle (1993), among others). For other currencies such as HKD, Greenwood (1990) and Hawkins and Leung (1997) have calculated the amount of HKD co-circulating with the renminbi ("RMB") in the Guangdong Province of China. The goal of this paper is to provide an alternative methodology to the existing work and an updated estimate on the foreign circulation of HKD.

In the empirical literature (see the survey by Krueger and Ha (1995)), a rough measure of home currency circulating outside the issuing country is from the currency-per-capita balances of a "control" country that has no foreign circulation of its own currency. Currency issued in excess of the currency-per-capita of the "control" country is reckoned as currency circulating outside the issuing country. Another simple method is to examine the amplitude of seasonal fluctuations, assuming currency circulating abroad does not easily flow back to the home country with seasonal patterns. In this method, the seasonal pattern of a "control" country is first identified. For example, in estimating the US dollars abroad, the Canadian seasonal pattern is used as a benchmark. The difference in the seasonal patterns can be used to compute the US dollars circulating abroad.

Recently, Doyle (2000) makes an impressive attempt to reckon the foreign circulation of the US dollar. He chooses Canada as the benchmark country from which the per capita currency demand of Canadians can be estimated. Using the estimated coefficients from the Canadian currency demand function as a benchmark, the "true" US currency demand can be calculated. The discrepancy between currency issued and the "true" currency demand is the US currency abroad. Similar to other approaches, Doyle also chooses a country as control.

Elsewhere in the literature, Hawkins and Leung (1997) have estimated the foreign circulation of HKD. They assume that the surge of HKD circulating in Guangdong is triggered by Guangdong's economic growth. This growth started in 1984 as the result of China's open door policy and economic reforms. They introduce a China Dummy, a "dummy" time trend started at 1984, in a currency demand equation for HKD. The estimated coefficient of this dummy variable is used to calculate HKD circulating in Guangdong. This technique echoes the earlier work by Greenwood (1990) who computes the currency/GDP ratio of Hong Kong up to 1983. Then this value is used to predict, using a downward time trend for this ratio, the "true" currency demand in Hong Kong in 1989. The excess between the amount extrapolated and the total amount issued in Hong Kong is foreign circulation. Both Greenwood and, Hawkins and Leung find that the foreign circulation of HKD is approximately 19 billion HKD or 20 per cent of the total issued currency. The present analysis puts the macroeconomic variables of China and Hong Kong into the regression model instead of approximating some of these variables by a time trend as in Greenwood and, Hawkins and Leung.

Section 2 of this paper discusses the empirical framework for the demand of HKD. It is difficult to identify which components of the estimated demand coefficients belong to Guangdong and which belong to Hong Kong. To overcome such difficulty, a specific functional form is used which gives additional restrictions among the estimated coefficients. Section 3 discusses the data and the regressions. The present paper finds that the demand for HKD in Guangdong is mainly for transaction purposes and amounts to 7.4 per cent of the total currency issued in Hong Kong. Macau also uses HKD extensively. The amount of HKD in Macau is around 3.2 per cent of the total HKD issued. Section 4 concludes, highlighting the main results.

2. The Framework

Let the money market equilibrium equation in Hong Kong be represented by the following simple form:

(1) $$M^c/P = m(I)\,Y; \qquad m' < 0;$$

In equation (1) above, M^c is the amount of Hong Kong currency circulating in Hong Kong alone; P is the price index, which is set to unity in the base year; I is the interest rate in Hong Kong; Y is the GDP of Hong Kong in base year price; and the currency-output ratio, $m(.)$, is negatively related to I.

Let the GDP in Guangdong, in the base year price, be Y^p. There is a currency demand equation corresponding to this level of output; but, a fraction, g, of this economy, gY^p, can hold money either in RMB (B^p) or in HKD (M^p), that is

(2) $$(M^p + E^p B^p)/P = m^p(R)\,(gY^pE^p); \qquad m^{p\prime} < 0;$$

where E^p is the exchange rate of HKD (the amount of HKD per unit of RMB); R is the opportunity cost of holding currency, which is a composite function of the two interest rates, the Hong Kong interest rate and the Chinese interest rate:

(3) $$R = R(I, I^p + \Delta E^p/E^p); \qquad R_1 < 0 ; R_2 < 0;$$

Interest yielded from Chinese assets, which is in RMB, will have a capital gain if HKD depreciates. This is captured in the second component of equation (3). Out of these currency holdings, $M^p + E^pB^p$, a fraction of it, k, is held in HKD. This fraction will depend on the expected rate of depreciation of HKD, $\Delta E^p/E^p$, that is:

(4) $$M^p/P = k(\Delta E^p/E^p)\, m^p(R)\,(gY^pE^p); \qquad k' < 0;$$

Equation (4) is broadly consistent with the portfolio balance models and with the money-in-the-utility inter-temporal models that have a strong microeconomic foundation (see Cuddington (1983), Zervoyianni (1992), Obstfeld and Rogoff (1999; chapter 8) among others). Let the total money supply of HKD be M^t ($M^t = M^c + M^p$). The following (first order Taylor series) linear approximation for $Ln\,(M^t)$ is employed[1]:

(5) $$Ln(M^c/P + M^p/P) = L_0 + (1 - \gamma)Ln(M^c/P) + \gamma Ln(M^p/P);$$

where,

1 To derive equation (5), one should also apply a first order Taylor series approximation for the terms $Ln(M^c/P)$ and $Ln(M^p/P)$.

(5a) $$\gamma = M^p_0 / (M^c_0 + M^p_0);$$

(5b) $$L_0 = Ln(M^t_0/P_0) - (1 - \gamma)Ln(M^c_0/P_0) - \gamma Ln(M^p_0/P_0);$$

where M^c_0 and M^p_0, in the γ-parameter equation above, are the sample means (or alternatively, the long-run values) of M^c and M^p respectively. L_0 is the constant term that captures the other terms in the Taylor series expansion. The following log-linear "structural" equation can be derived:

(6) $$Ln(M^t/P) = L_0 + (1 - \gamma)[a_0 - a_1 I + a_2 Ln(Y)] + \gamma[a_4 - a_5 I - a_6 I^p - a_7 \Delta E^p/E^p + a_8 Ln(gY^p E^p)];$$

Let the *estimation* of the above "structural" equation be of the following form:

(7) $$Ln(M^t/P) = b_0 - b_1 I + b_2 Ln(Y) - b_3 I^p - b_4 \Delta E^p/E^p + b_5 Ln(Y^p E^p) + \varepsilon;$$

where ε is the error term and the b_i's are the estimated coefficients. In what follows, two methods of estimation will be introduced, each representing an extreme form of specification.

Suppose the R function in (3) takes a CES-functional form. Depending on the substitution parameter in the CES function, R takes on the extreme case of a linear form to a Leontief form when the substitution parameter changes from infinity to zero. These two extreme cases correspond to estimation methods A and B below. Both methods provide useful benchmarks.

2.1 Method A

The first method assumes that the R function takes a linear form. The functional form $m(.)$ and $m^p(.)$ are also assumed to be identical. Consider the case when $I = I^p + \Delta E^p/E^p$. The two assumptions imply:

(8) $$I = R(I , I) = r_1 I + r_2 I$$

where r_1 and r_2 above are the constant terms in the linear R-function. In terms of the "structural" coefficients in equation (6), equation (8) implies

$$(1 - \gamma)a_1 = \gamma(a_5 + a_6);$$

with $r_1 = \gamma a_5/(1 - \gamma)a_1$, and $r_2 = \gamma a_6/(1 - \gamma)a_1$;

And:

(9)
$$\begin{aligned}
a_1 &= (b_1 + b_3)/2(1 - \gamma); \\
a_2 &= b_2/(1 - \gamma); \\
a_5 &= (b_1 - b_3)/2\gamma; \\
a_6 &= b_3/\gamma; \\
a_7 &= b_4/\gamma; \\
a_8 &= b_5/\gamma;
\end{aligned}$$

2.2 Method B

Suppose the R function takes a Leontief form. At an "interior" equilibrium of the economy, I and $I^p + \Delta E^p/E^p$ must be in fixed proportion, that is:

(10) $$r_3 I = r_4 (I^p + \Delta E^p/E^p) = R;$$

where r_3 and r_4 above are constants. Using the relationship in (10), the variable I can be eliminated from (6). We now arrive at the following specification:

(11) $$Ln(M^t/P) = L_0 + (1 - \gamma)[a_0 - a_1 I + a_2 Ln(Y)] + \gamma[a_4 - a_9 I^p - a_7 \Delta E^p/E^p + a_8 Ln(gY^p E^p)];$$

where $a_9 = a_5(r_4/r_3) + a_6$;

In the above specification, it is not necessary to assume that m^p and m have identical functional forms.

By specifying a functional form for $R(.)$, which gives additional restrictions among the coefficients, the demand coefficients for HKD from Guangdong can be identified. Moreover, Method A and B provide informative upper and lower boundaries for the "family" of R-functions.

3. The Empirical Results

The sample period in the present analysis starts at 1987 because of the unavailability of the Chinese data before that. As for the I^p variable, China's lending rate is chosen for this variable. The sampling period of China's lending rate (Central Bank Base Interest Rate, less than 20 days) starts at 1987, while China's three-month savings deposit rate and time deposit rate series start at 1988 and 1989 respectively.

As for the Y^p variable, the output of Guangdong province in China, the Gross Industrial Output (GIO) quarterly series from the CEIC Data Company is chosen instead of the Guangdong annual GDP series. From 1991 to 1999, this GIO series is in 1990 prices and, from 1987 to 1990, it is in 1980 prices. The quarterly GIO volume index, extracted from Statistical Yearbook of Guangdong, is used to adjust the GIO series to 1990 prices. The GDP series from the Guangdong Statistical Yearbook records only annually, but could provide a useful cross check nonetheless. In 1990 (especially in the third and fourth quarters), the quarterly GIO series from the CEIC shows an obvious error as the gross industrial output drops enormously by two-thirds while the annual GDP series and the quarterly GIO volume index series in the Guangdong Statistical Yearbook show a smooth positive growth. The GIO series is then re-adjusted with some guide provided by the Guangdong Statistical Yearbook. Since January 1998, the coverage of the industrial output statistics in China broadens. A dummy variable is used, when the GIO series is seasonally adjusted, to account for the change in the assessment method. As the GIO (or the Y^p) series is in 1990 prices and in millions of RMB, the series is converted by E^p, as shown from equation (2) to equation (7).

The variable Y, the GDP in Hong Kong, is in millions of HKD and in 1990 prices. The Implicit Price Deflator of Hong Kong is chosen for the variable P, the value of which is set to unity in 1990.

The dependent variable M^t in the regression is the amount of currency, in millions of HKD, issued in Hong Kong (or the total amount of M_0). The three-month time deposit rate is chosen for the variable I, because it is easily comparable to other related works (see Huynh (2000), Hawkins and Leung (1997)). Other interest rates (HIBOR, one-month time deposit, the savings rate, etc.) have been tried in the regression and have produced very little difference in the results. Because of the Y2K problem, the money supply in the last quarter of 1999 is excessively high. Instead of using a dummy variable for the Y2K problem, the last quarter of 1999 (the last sample period) is deleted. We are left with a sample size of 51. The series M^t/P, Y and Y^p have been seasonally adjusted.[2]

As for the expected rate of depreciation variable, $\Delta E^p/E^p$, there is no satisfactory way to deal with this in the empirical literature, especially in small sample regressions. There is only a small, incomplete set of forward exchange rates for the renminbi. A useful candidate to measure the expected rate of depreciation is by the long-run inflation differential between China and Hong Kong. By increasing the cost of production relative to its trading partners, the exchange rates will be increasingly overvalued. With a deteriorating current account, the likelihood of devaluation will increase.[3] In the regressions, the variable $InfD$ is the difference between China's CPI inflation rate and Hong Kong CPI inflation rate (see the estimation technique by Frankel (1979) in a related literature).

Table 1 summarises the unit root test for all the variables. The time series M^t/P, Y, Y^p, I, and I^p are $I(1)$, while the series $InfD$ is $I(0)$. The cointegrating regressions and cointegrating parameters of equation (7) are reported in Table 2. From the augmented Dickey-Fuller test statistics (see Cheung and Lai (1995), Hamilton (1994)), reported as equations A and B in Table 2, all the variables specified in (7) are cointegrated. That means there is a long-term equilibrium relationship between these variables. The short-run adjustments, or the error-correction model, of equation (7) is reported as equations (A1, A2) and (B1, B2) in Table 2. The significant *t*-statistics in the error-correction term (Error (-1) in Table 2) suggests that a stable short-run property of the data exists. The error in each time period converges to its long-run relationship.

To check the robustness of the estimation, equation A in Table 2 considers the whole array of variables specified in equation (7). Equation B drops the statistically insignificant variables, I^p and the constant term (except I), from equation A. Equations A2 and B2 drop the statistically insignificant variables from the error-correction models of equations A1 and B1. The estimated coefficients and the test statistics hardly change at all.

In the cointegrating regressions, the estimated coefficients have the predicted signs except for I^p, the coefficient of which is statistically insignificant and has the wrong sign. The variable I^p is therefore dropped in equation B. As for the variable I, the estimated coefficient has the predicted sign but is statistically insignificant, which is contrary to other findings in the literature. This is a problem caused by small samples. When the same money demand equation with only the Hong Kong variables in it is run

2 The other series I, I^p and $InfD$ (see later) are not seasonally adjusted in the regressions because seasonal patterns have not been identified empirically in those series.

3 A common practice by investment companies to gauge the overvaluation of exchange rates (and hence the expected depreciation) is to measure the gap between the real exchange rate and unity. This common practice is also captured by the long-run inflation differential.

independently with a longer time series, the estimated coefficient from the Hong Kong three-month time deposit rate will be (slightly) larger but statistically much more significant. In the error-correction models, the coefficient of ΔI is found to be statistically significant, but not for ΔI^p. Therefore, deleting the variable I^p, but not I, in equation B seems reasonable.

From the regressions, the inflation differential variable is significant in the long-run but not in the short run. This, together with the statistically insignificant I^p, suggests the presence of currency substitution between HKD and RMB in the Guangdong area. Moreover, the statistically significant Y^p variable and the statistically insignificant I^p variable confirm the dominance of the transaction motive of holding HKD in Guangdong.

After estimating the coefficients from the $Ln(M^t/P)$ equation, the two demand for currency equations, M^c and M^p, can be individually identified from either Method A or B. There are three variables (M^c, M^p and γ) and three equations, the two constructed money demand equations and equation (5a). Note that in equation (5a), reproduced in (12) below, both M^c and M^p equations contain γ. Rather than solving out the entire three equations for the three unknowns, a convenient method is to assume an initial trial value for γ, then derive fully the money demand equations for M^c and M^p, and recalculate the value of γ from (12) below. After that, iterate until the calculated value of γ converges to its trial value.[4]

(12) $$\gamma = M^p(\gamma) / [M^c(\gamma) + M^p(\gamma)];$$

The computed value γ for every year is reported in Table 3. This ratio rises steadily, peaked at 1989 and at 1994, and then falls steadily thereafter.

From Table 3, the values of γ, calculated from either Method A or B, are very similar. The average of the two methods over the sample period is about 7.4369 per cent.

To have an idea of a 95 per cent confidence interval for the estimated value of γ, take the log on equation (12), and substitute the equation for $Ln(M^p/P)$ into the right-hand-side of (12). With some re-arrangement, we have the following:

(13) $$\gamma[Ln(\gamma) + Ln(\underline{M^t/P})] + (b_1/4)\underline{I} + b_4\underline{(InfD)} - b_5\, Ln\underline{(Y^p\, E^p)} = 0;$$

The variables underlined in equation (13) are the sample averages; b_1 is divided by four to average out the estimations from Methods A and B. Hence, for an estimated value of γ (i.e., $\gamma = 0.074369$), equation (13) represents a "restriction" on the estimated coefficients of equation (7). A Wald test can be employed for the hypothesis that the given set of coefficients are jointly equal to the value on the right-hand-side. The standard error of this equality test (the left hand side of equation (13) equals zero) is 0.253747, with

4 There is some discrepancy between the calculated M^t ($= M^c(\gamma) + M^p(\gamma)$) and the actual/sample M^t. This discrepancy could come from the constant term of the regression, the L_0 term (or the term b_0), as indicated in (5b). To see this, move the constant term to the left hand side of the equation and use that constant term to adjust the M^t variable. The constant term is dropped in the estimation because, statistically, it is not significantly different from zero. Therefore, calculating γ, the ratio of money demands, rather the level of money demands, will have an advantage as the discrepancy on the level variables, in a ratio form, cancels off.

a mean of 0.024314 and a *t*-statistic of 0.095820. Therefore, one cannot reject the null hypothesis that the equation equals zero. Using a 95 per cent confidence interval for the right-hand-side of (13), the confidence interval for γ can be reconstructed. It is found to be [0.00035, 0.127916].

Summing up, there is around 7.4 per cent of Hong Kong currency circulating in Guangdong Province of China. Most of this currency is for transactions purpose. This is affirmed by the statistically significant coefficient of the Y^p variable in the long-run cointegrating regressions. The short-run impact of the Hong Kong interest rates on currency demand is statistically significant but very small especially after the estimated coefficient is decomposed into that for Hong Kong and that for Guangdong. Exchange rate expectation does affect currency substitution between HKD and RMB, but this substitution is important only in the long run.

HKD in Macau

So far, the present estimation has been on the Hong Kong currency circulating in Gaungdong. There is also a substantial amount of HKD in neighbouring Macau, where the local currency, the Patacas, and HKD co-circulate and exchange with each other close to par (at an exchange rate of 1.003 Patacas per HKD). The Monetary Authority of Macau collects statistics on HKD demand, time, and savings deposits in Macau (that is, the M_1 and M_2 of the Hong Kong dollar minus HKD currency in circulation). Using the ratios of Patacas M_1/M_0 and M_2/M_0 as a guide, the circulation of Hong Kong currency (M_0) in Macau can be computed. That amounts to 3.2 per cent of the total currency issued in Hong Kong (see Table 4).

4. Conclusion and Discussion of Results

The present paper has provided an empirical framework from which HKD circulating outside Hong Kong can be estimated. Further research is needed to check the robustness of the present findings. Based on the present findings, there is about 11 per cent (7.4 per cent in Guangdong and 3.2 per cent in Macau) of Hong Kong currency circulating outside Hong Kong. The empirical result supports the hypothesis that the demand for HKD in Guangdong is mainly for transaction purpose. Therefore, its short-run impact on the exchange rate and on the volatility of international reserves of Hong Kong during currency crisis should be minimal. This claim is also supported by the estimated coefficients in the short-run model (or the error-correction model). Moreover, there is evidence of currency substitution between HKD and RMB in the long run.

In estimating equation (6), many small variations of specification have been tried. They do not yield substantially different results from the present. One variable that may be of concern is the output series from Guangdong Province. If the current output series is replaced by a simulated output series with *faster* growth rates than the actual series, it will give a substantially larger estimate for HKD circulating in Guangdong.[5] This is because the transaction demand has been increased. This simulation could explain the anomaly between the findings by Hawkins and Leung and the present. Hawkins and Leung use a

5 For example, if the output series (Y^pE^p) is replaced by a simulated series of Y^p (i.e., without the E^p). This simulated series must have a faster growth rate than the one replaced as the value of RMB has steadily depreciated (E^p falls) over the years. The computed value of γ rises to 24 per cent.

linear time trend to approximate the income effect on the demand for HKD in Guangdong. Since there was faster growth in the earlier years of liberalisation, their linear time trend may have picked up the earlier faster output growth of Guangdong, leading to a larger estimate of HKD circulating in Guangdong. Another variable of interest is the Hong Kong GDP, or the Y series. If this series is replaced by a simulated Y series with a *slower* growth rate than the actual series, it will also give a larger estimate for HKD circulating in Guangdong.[6] The latter simulation could explain the anomaly with Greenwood's, who uses a downward time trend to extrapolate the currency/GDP ratio beyond 1984. This downward time trend may have depressed the Hong Kong GDP series, and hence giving a higher estimate. Further research in this direction will be fruitful.

6 Let the actual $Ln(Y)$ series be replaced by a simulated series of $Ln(Y) - 0.002t$ (t is time, starting from zero), which has a slower growth rate than the actual series. This will give γ a computed value of 14 per cent.

References

Cheung Y.W. and Lai K.S. (1995), "Lag Order and Critical Values of the Augmented Dickey-Fuller Test," *Oxford Bulletin of Economics and Statistics* 57, 411-9.

Cuddington, J.T. (1983), "Currency Substitutability, Capital Mobility and Money Demand," *Journal of International Money and Finance* 2, 111-33.

Doyle, B.M. (2000), "Here, Dollars, Dollars. Estimating Currency Demand and World Wide Currency Substitution," Discussion Paper No. 65. Board of Governors of the Federal Reserves System, Washington, D.C.

Frankel, J. (1979), "On the Mark: A Theory of Floating Exchange Rates Based On Real Interest Differences," *American Economic Review* 69, 610-22.

Greenwood, J. (1990), "China: An Estimation of Hong Kong Dollar Currency Circulating in Guangdong Province," Asian Monetary Monitor, July-August, 37-44.

Hamilton, J. D. (1994), <u>Time Series Analysis</u>, Princeton University Press, Princeton, N.J.

Hawkins, J. and C. Leung (1997), "The Demand for Hong Kong Dollar," Quarterly Bulletin, HKMA, May, 2-13.

Huynh, D. (2000), " Money Demand Equation for Hong Kong," Manuscript, HKIMR, Hong Kong.

Krueger, R. and J. Ha (1995), "Measurement of Co-circulation of Currencies," IMF Working Paper, WP/95/34, IMF.

Latter, T. (2000), "Internationalisation of Currencies," Quarterly Bulletin, HKMA, 02, 46-52.

Obsfeld, M. and K. Rogoff, (1999), <u>Foundations of International Macroeconomics</u>, MIT Press.

Porter, R.D. and R. A. Judson, (1996), "The Location of U.S. Currency: How Much is Abroad?" Federal Reserve Bulletin, Vol. 82, No.10, October.

Rogoff, K. (1998), "Foreign and Underground Demand for Euro Notes: Blessing or Curse?" *Economic Policy* 26, April, 236-303.

Sprenkle, C.M. (1993), "The Case of the Missing Currency," *Journal of Economic Perspectives* 7, 175-84.

Zervoyianni, A. (1992), "International Macroeconomic Interdependent, Currency Substitution and Price Stickiness," *Journal of Macroeconomics* 14, 59-86.

Table 1: Order of Integration of Individual Variables

	ADF	Number of Lags
$Ln(M^t/P)$	-2.257 (with trend)	5
$\Delta Ln(M^t/P)$	-5.876**	0
$Ln(Y)$	-2.779 (with trend)	5
$\Delta Ln(Y)$	-2.819*	4
$Ln(Y^p)$	-2.943 (with trend)	0
$\Delta Ln(Y^p)$	-3.962**	8
$Ln(E^p)$	-1.599 (with trend)	0
$\Delta Ln(E^p)$	-7.354**	0
I	-2.491	1
ΔI	-4.936**	0
I^p	-1.13	1
ΔI^p	-4.06**	0
InfD	-3.923**	6

Notes: Sampling period quarterly from 1987Q1 to 1999Q4.

M^t/P: Money supply in millions of HKD, divided by the implicit price deflator P, at 1990 prices. This series is seasonally adjusted.

Y^p: Seasonally adjusted Gross Industrial Output of Guangdong, China, at 1990 prices (RMB) and in millions of RMB.

Y: Seasonally adjusted GDP of Hong Kong, at 1990 prices (HKD).

I^p: The lending rate (less than 20 days) in China, period average, percentage p.a.

I: The 3-month time deposit interest rate in Hong Kong, period average, percentage p.a.

InfD: Inflation Differential; China's CPI inflation rate (Source: IFS; IMF) minus Hong Kong CPI inflation rate.

Data Source: CEIC data Co., unless specified otherwise.

Table 2: Cointegration Tests
Dependent Variable: $Ln(M^t/P)$ or $\Delta Ln(M^t/P)$

	Equation A: Long-Run $Ln(M^t/P)$	Equation A1: Short-Run $\Delta Ln(M^t/P)$	Equation A2: Short-Run $\Delta Ln(M^t/P)$	Equation B: Long-Run $Ln(M^t/P)$	Equation B1: Short-Run $\Delta Ln(M^t/P)$	Equation B2: Short-Run $\Delta Ln(M^t/P)$
Constant	0.992006	0.009889	0.014807		0.010339	0.014913
	(1.18847)	(1.87142)*	(3.57256)**		(2.00322)**	(3.45171)**
$Ln(Y)$	0.722179			0.847049		
	(6.63566)**			(39.9421)**		
$Ln(Y^p)$	0.097887			0.054627		
	(2.24880)**			(2.48603)**		
I	-0.001210			-0.001845		
	(0.294673)			(0.457325)		
I^p	0.000929					
	(0.209736)					
InfD	0.002031			0.002138		
	(2.16215)**			(2.44897)**		
$\Delta Ln(Y(-1))$		0.117302			0.023323	
		(0.375911)			(0.079452)	
$\Delta Ln(Y^p(-1))$		0.037038			0.058521	
		(0.837635)			(1.43524)	
$\Delta I(-1)$		-0.015366	-0.015647		-0.015824	-0.015831
		(3.21614)**	(3.21669)**		(3.30328)**	(3.11177)**
$\Delta I^p(-1)$		-0.001039				
		(0.13205)				
$\Delta(InfD(-2))$		0.001738			0.002075	
		(1.23951)			(1.53055)	
Error(-1)		-0.379454	-0.473511		-0.292058	-0.412421
		(2.29911)**	(3.76004)**		(1.88235)*	(3.08786)**
ADF	-6.96690**			-7.26648**		
R-square (Adjusted)	0.934486	0.320105	0.290906	0.935725	0.308484	0.232133

Notes: Sample Size: 51; ADF is the Engle-Granger test-statistics (one lag); Statistical significant at 5 (10) per cent level is distinguished by ** (*); See also the Notes in Table 1. InfD is the inflation differential (China's inflation rate minus Hong Kong's).

Table 3: The computed value of γ

	Method A	Method B
1987	7.07%	7.10%
1888	7.33%	7.35%
1989	7.66%	7.73%
1990	7.10%	7.16%
1991	7.01%	7.07%
1992	7.46%	7.51%
1993	7.64%	7.66%
1994	7.69%	7.72%
1995	7.63%	7.69%
1996	7.45%	7.49%
1997	7.40%	7.45%
1998	7.38%	7.56%
1999	7.56%	7.61%
Average(1987-1999):	7.41%	7.46%

Table 4. Estimation of Hong Kong Currency Co-circulates in Macau

Fourth Quarter	M_0 in PATACAS (1)	M_1 in PATACAS (2)	M_1 in HKD (3)	M_2 in PATACAS (4)	M_2 in HKD (5)	Estimation Of HK Currency: In units of HKD (6)	Percentage of HK Currency Co-circulates In Macau (7)
88Q4	530.1	2407.2	3013.2	3829.1	11272.7	1292.375	3.791403
89Q4	626.7	2907.5	3563.1	5090.5	13459.3	1392.56	3.51036
90Q4	698.9	3213.1	4242.6	6946.6	14989.6	1386.493	3.20495
91Q4	822.8	4475.9	9612.8	9543.7	21404.9	2031.376	4.130744
92Q4	968.5	6045.4	12032.3	12042.7	25578.4	2200.158	3.597558
93Q4	1080.8	6491.8	10966.8	14136.5	27466.4	2167.133	3.015184
94Q4	1197.8	6734.8	9978.3	16563.4	33848.8	2328.737	2.980097
95Q4	1280.3	7323.2	9750.8	20126.1	38985.8	2288.548	2.802292
96Q4	1426.8	8691	9719.5	22834.4	41046.0	2254.729	2.588281
97Q4	1518.3	8278.5	8576.6	24179.8	41595.2	2287.909	2.468985
Average	998.973	5525.624	8273.05	13382.45	27030.02	1973.918	3.226066

Notes: In Millions. Column (6) equals Col. (1) x [Col. (5)/(Col. (4) - Col. (1)) + Col. (3)/(Col. (2) - Col. (1)]/2. The M_1 and M_2 in HKD do not include M_0 (or Hong Kong currency in circulation).

Source: Authoridade Monetaria e Cambial de Macau. Annual Report, various issues.