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**Do Hong Kong SAR and China Constitute An Optimal Currency Area? An Empirical
Test of the Generalized Purchasing Power Parity Hypothesis**

Prepared by Hong Liang¹

Authorized for distribution by Peter Wickham

June 1999

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Do Hong Kong SAR and China Constitute An Optimal Currency Area? An Empirical Test of the Generalized Purchasing Power Parity Hypothesis

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Abstract

The paper explores the behavior of the long-run real exchange rate (RER) of Hong Kong SAR and China by testing the generalized-purchasing power parity hypothesis (G-PPP). The hypothesis argues that if the fundamental variables determining RERs are sufficiently integrated, as in a currency area, the RERs should share common trends. The findings of this study suggest (1) at present, Hong Kong SAR and China do not satisfy the conditions necessary for forming an optimal currency area by themselves; (2) when Japan and the United States are added to the group, common trends can be found; and (3) the long-run elasticity between the RERs of Hong Kong SAR and China is negative.

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I. INTRODUCTION

On July 1, 1997, Hong Kong SAR became a Special Administrative Region (SAR) of China after more than a hundred years of British colonial rule. Following the smooth transfer of sovereignty, Hong Kong SAR has maintained its monetary independence, as well as the currency board-type arrangement for its exchange rate. Shortly after the transition, however, the sharp depreciation of Thai baht marked the beginning of the worst financial crisis in Asia's modern history. Amid the domino depreciation of most Asian currencies, the Hong Kong dollar and Chinese yuan now stand as the only remaining pegs to the U.S. dollar in the region. Despite repeated pledges by the government and monetary authorities of both China and Hong Kong SAR, there is continued debate in the media and academic circles on whether either currency will be devalued. Oftentimes, the discussion is focused on the likelihood of yuan devaluation and the subsequent impact on the Hong Kong dollar (Hu (1998), and Liu et al. (1998 a,b)).

Most of these analyses, however, have emphasized only the immediate or short-run dynamics between the Hong Kong dollar and Chinese yuan. They have ignored the interrelationship between the fundamentals of these two economies in the longer run. In particular, is there a common trend between Hong Kong SAR and China in their long-run exchange rate movements?

Figure 1a plots the monthly CPI-based real exchange rate (RER) of Hong Kong SAR and China during the period of January 1979-June 1998, using the United States as the base country.² The data are in natural logarithms and are normalized with the RER in January 1979 set equal to zero. One striking feature of Figure 1a is that the two real rates seem to move in different directions, and there is little observable comovement between them over this period. Economic theory tells us that real exchange rates should be determined by a set of real exogenous fundamental variables, such as real output growth and changes in productivity. If the fundamental variables between Hong Kong SAR and China are sufficiently interrelated, we should not expect the RERs to wander too far away from each other. The fact that such comovement is not observed casts doubt on the argument that there are common trends between the two economies in the long-run.

A theory of generalized purchasing power parity (G-PPP) was proposed by Enders and Hurn (1994) to explain exchange rate behavior across countries. The hypothesis postulates that bilateral real exchange rates are generally nonstationary, thus the purchasing power parity (PPP) does not hold, because the fundamental economic variables determining them are nonstationary. However, if the fundamentals are highly interrelated among a group of countries, the real rates might contain common stochastic trends, that is, they will be cointegrated in the long run. Hence, there may exist at least one linear combination of the RERs that is stationary.

² The United States is chosen to be the base country because the nominal exchange rates of both China (*de facto*) and Hong Kong SAR (*de jure*) have been pegged to the U.S. dollar during most of the sample period this study covers.

It is possible to interpret the G-PPP hypothesis in terms of a potential optimal currency area. Mundell (1961) argues that, if factor mobility is low between regions within a nation, the existing national boundaries do not necessarily coincide with the domain of an optimal currency area. Assuming short run rigidities in wages and prices, Mundell postulates that without factor mobility, regions (or nations) constitute the domain of an optimal currency area if they experience the same types of real disturbances. When considering which countries should form a currency union, most economists agree that one necessary condition for a currency union to make most sense is that the shocks hitting the system be symmetric rather than idiosyncratic. A positive finding of G-PPP among a group of countries' RERs indicates that there are common trends in their real macroeconomic "forcing" variables. Thus, these regions/nations can be viewed as potentially constituting an optimal currency area.³

So, do Hong Kong SAR and China satisfy this necessary criterion for constituting a potential optimal currency area? If they do not, do they jointly form a potential currency area with other countries such as Japan and the United States? What is the implied relationship between the two real exchange rates in the long run?

This paper exploits the idea of G-PPP in the context of Hong Kong SAR and China, which may eventually form a national currency area. The focus of the study is not at all on the question of whether Hong Kong SAR or China should devalue their currencies at the present time, nor what the consequences of unilateral devaluation by one economy are likely to be on the other economy in the short run. Rather, the main question this study tries to shed light on is the long-run relationship between these two economies as suggested by the data generating process, in particular, whether a common currency area for them might be appropriate.

The paper is organized as follows. Section II presents an overview of the data and the G-PPP hypothesis. Section III is devoted to the key empirical issues: the properties of the data, the cointegration results and tests, and the implied long-run relationship between the RERs of Hong Kong SAR and China. Section IV concludes.

³ The Mundell model of optimal currency area has been described as "single criterion case" (Ishiyama (1975)), and as such may be regarded as rather restrictive in scope. Hence, positive findings of common trend in a group of countries' RERs should only be viewed as evidence that it satisfies one of the necessary (not sufficient) conditions for forming the domain of an optimal currency area.

II. DATA AND THEORETICAL UNDERPINNINGS

A. Description of Data

In this study, the real exchange rate series are constructed using the United States as the base country unless indicated otherwise, and are defined as:

$$q_t = s_t + p_t^* - p_t \quad (1)$$

where s_t is the natural logarithm of national currency price of the U.S. dollar,⁴ p_t^* and p_t are the natural logarithm of the United States and domestic price levels, respectively. Hence, an observed upward movement of the RER indicates real depreciation of the domestic currency.

Monthly consumer price indices and exchange rate series (January 1979-June 1998) are obtained from the IMF's IFS for the following economic entities: Hong Kong SAR, China, Japan and the United States.⁵ The constructed RER series are then normalized by setting the observation in January 1979 equal to zero. The time paths of the three RERs against the U.S. dollar are plotted in Figures 1a and 1b. Visual examination of the figures suggest that all three RERs are nonstationary, and there does not appear to be any convergence toward a long-run mean of zero. Formal tests for a unit root in the next section will confirm this visual impression.

The theory of G-PPP suggests that, although the individual RER series are nonstationary, certain groupings of them may be stationary if the macro forcing variables behind these rates are sufficiently interrelated.

B. The Model

There is a rich literature on the determinants of real exchange rate. One important strand of this research is associated with Edwards (1994) who investigates the equilibrium real rates by looking at the reduced forms linking the RER to a set of exogenous fundamental

⁴ In this study, the real exchange rate for China is constructed by using the official nominal exchange rate. For the period of 1988:01-1993:12, there was also an implicit market rate in the official swap market alongside the official exchange rate. However, no qualitative result of this study is altered by using the weighted average exchange rate. These results are not reported here, but are available upon request from the author.

⁵ Price and exchange rate series are also obtained from the same source for Taiwan Province of China. Similar empirical methodology is also applied to the three exchange rates of Hong Kong, China and Taiwan, and to see whether these three regions form the domain of a potential optimal currency area. The G-PPP hypothesis does not hold for these three economies, nor does it hold at the 5 percent significance level when Japan and/or the United States is added to the group. These results are available upon request from the author.

variables identified from a theoretical model. Using multivariable cointegration methods, recent empirical studies find strong evidence that there is significant long-run relationship between real exchange rate and a set of fundamental macro variables (Feyzioglu (1997), MacDonald (1997)).

For each country j , the long run relationship between its RER against the base country 1 and the fundamentals is defined as follows:

$$q_{1jt} = x_{jt}' \beta_j + \varepsilon_{jt} \quad j = 1, \dots, n \quad (2)$$

where x_{jt} is the vector of fundamentals, β_j is the vector of coefficients, and ε_{jt} is the stationary error term. There are n independent real exchange rates among $n+1$ countries within the potential currency area under consideration.

Elements in x_{jt} denote a host of macroeconomic variables, such as productivity shocks and the real interest rate. If all of them are stationary, the real exchange rate will be stationary and PPP will hold; if one data generating process in x_{jt} is nonstationary, PPP will no longer hold. In the latter case, a long-run relationship between the set of fundamentals and the RER means that the variables on the two sides of equation (2) should be cointegrated. Consequently, if a variable is stationary, it should not statistically affect the cointegration relation and could be omitted.

The thrust of the G-PPP hypothesis concerns the interrelationships among the n sets of x_{jt} . Assuming each vector of x_{jt} contains the same set of m fundamental variables that are nonstationary⁶, and stacking n independent representations of q_{1jt} together, we get:

$$\begin{pmatrix} q_{11t} \\ q_{12t} \\ \cdot \\ \cdot \\ \cdot \\ q_{1nt} \end{pmatrix} = \begin{pmatrix} \beta_{11} & \beta_{12} & \cdots & \beta_{1m} \\ \beta_{21} & \beta_{22} & \cdots & \beta_{2m} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \beta_{n1} & \beta_{n2} & \cdots & \beta_{nm} \end{pmatrix} \begin{pmatrix} x_{1t} \\ x_{2t} \\ \cdot \\ \cdot \\ \cdot \\ x_{mt} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \cdot \\ \cdot \\ \cdot \\ \varepsilon_{nt} \end{pmatrix} \quad (3)$$

or, using an alternative expression, (3) can be written as:

$$Q_t = \beta X_t + E_t \quad (3')$$

⁶ This assumption simplifies the mathematical illustration of the model. In principle, m should be greater than n , because x_{jt} should contain at least the income processes of the $n+1$ countries in the group under consideration. Since $\text{rank} \leq \min(n, m)$, the following discussion about the rank of β only focuses on its comparison with n .

Although each element in X_t can be nonstationary, the rank of the matrix β reveals the behavior of fundamental macroeconomic variables within the economic region. If the rank is zero, that is every element in β equals zero, then PPP holds for every bilateral real exchange rate. If β has full rank, then there is no evidence of a long run interrelationship among the $n+1$ economies. On the other hand, if the rank of β equals unity, it means that all of the RERs share one single common trend. More generally, Enders and Hurn (1994) show that as long as the rank of β is less than or equal to $n-1$, there is a linear combination of real exchange rates which is stationary. If the rank exactly equals $n-1$, the cointegrating vector will be unique. When the RERs within a set of countries are cointegrated, which is a manifestation of a sufficient interrelationship among their underlying economies, G-PPP will hold and the set of countries can be considered as satisfying one necessary condition for forming the domain of a potential optimal currency area.

When G-PPP holds, the RER between country j and the base country can be expressed as a weighted average of the other RERs in the currency area:

$$q_{12t} = \alpha_0 + \alpha_{13}q_{13t} + \alpha_{14}q_{14t} + \dots + \alpha_{1n}q_{1nt} + \varepsilon_t \quad (4)$$

The weights are functions of the parameters in matrix β that represent linkages among the economies. They reflect not only trade linkages, but also broader linkages such as technology transfers, immigration and financial resource movements.

III. EMPIRICAL TEST OF THE G-PPP HYPOTHESIS⁷

A. Unit Root Tests

The first step in testing G-PPP is to see whether the RERs under consideration are in fact nonstationary. In the two-country case, it is necessary that the bilateral RER is stationary for G-PPP to hold. In the multicountry setting, G-PPP hypothesis suggests that (1) all RERs under the domain of a currency area are nonstationary; (2) these real rates are cointegrated.

When testing the presence of unit roots, both the Augmented Dickey-Fuller test (ADF) and the Phillips-Perron test (PP) are used. It is now well-known that unit root tests have low power, and that whether an intercept and time trend are included in the regression used to obtain the test statistics is critical in interpreting the results. In general, the appropriate procedure is to use the general-to-specific methodology by first including a constant and time trend in the estimation. If the null of a unit root is not rejected in the most general version of the specification, the significance of the trend and intercept can then be tested in turn to see if they can be omitted, thereby increasing the power of the unit root test (Enders (1995)).

⁷ The results of this section are obtained by using Eviews and PcFiml econometric software packages.

The results of the ADF and the PP tests are reported in Table 1. The second column indicates how many lag terms are included in carrying out the ADF test. The last column reports whether a time trend (T), or a constant (C), or neither term (N) is included when carrying out both tests using the method described in the previous paragraph. The null that there is a unit root in the data generating process can not be rejected by either ADF or PP tests for any of the RER series studied here. All test statistics are well below the 5 percent and 10 percent significance levels for rejecting the null. Hence, we conclude that the RERs of China, Hong Kong SAR and Japan against the U.S. dollar are all nonstationary.⁸ These results are in line with other findings in the literature using post-Bretton Woods data of industrial countries.

Table 1. Time Series Properties of Individual RER Series

Variable	Lags	ADF	PP	Specification
Hong Kong SAR-United States	1	-1.07	-1.10	N
China-United States	1	-1.90	-1.87	C
Japan-United States	1	-1.34	-1.33	N

Using G-PPP as a criterion, to test whether China and Hong Kong SAR meet the necessary condition for forming the domain of a potential optimal currency area is equivalent to testing whether PPP holds, that is, whether the real exchange rate between Hong Kong SAR and China is stationary. The RER series is constructed using China as the base country, and Figure 2 is the plot of the rate. With neither the constant nor the trend term significant, the ADF statistics is 0.39 with one lag term included, and the PP statistic is 0.35. Both statistics are well below the 5 percent and 10 percent significance levels of rejecting the null of unit root.

Looking at Figure 2, this result should have come at no surprise. Despite increasing social and economic ties between the two economies, Hong Kong SAR and China are at different stages of economic development with rather different economic structures. While the GDP per capita in Hong Kong SAR was more than \$24,000 in 1996, it was less than \$700 in China. Since the late 1970s, Hong Kong SAR has undergone dramatic structural changes, transforming itself from a manufacture-based economy to one that is primarily service-based. The share of the manufacturing sector in GDP was less than 10 percent in the mid-1990s, whereas the share of trade and financial services was more than one-half. (Dodsworth and Mihaljek (1997)). On the other hand, in the late 1970s, mainland China began its transition to a market-oriented economy, starting with a large agricultural sector

⁸ When testing whether there is a unit root in the first difference of the data, both the ADF and PP tests strongly reject the null for every RER series.

and gradually becoming more manufacture-based. Hence, it is of no surprise that the fundamental "forcing" variables behind the RERs do not converge to a stable mean, nor do they share any common trends.

One unique feature about the linkage between Hong Kong SAR and China is that Hong Kong SAR has been an important entrepot for China. China's indirect exports and imports through Hong Kong SAR have been about 20-30 percent of its total trade during recent years. In addition, through reexports and outprocessing activities in the mainland, Hong Kong SAR's own export performance depends to a large extent on China's exports. Also, the Hong Kong SAR's export of financial services to the mainland is closely linked to the economic growth of China. The unique trade and investment linkage between Hong Kong SAR and China may provide one explanation for why Chinese yuan has devalued by 65 percent against the U.S. dollar in nominal terms, yet the Hong Kong dollar has not changed in nominal value since the currency board was established in 1983. A yuan depreciation may promote Hong Kong SAR's exports as much as it promotes China's direct exports, and it may increase Hong Kong SAR's foreign currency reserves.

In summary, at present, the real income processes of Hong Kong SAR and China do not seem to be strongly interrelated. During the period studied here, the two economies have undergone quite different shocks that had permanent real impacts, such as different shocks to productivity due to unrelated structural transformation. Nevertheless, the role of Hong Kong SAR as China's entrepot suggests that these two economies may be linked with other countries through trade and investment, in particular, the United States, to which both of their currencies are closely tied.

B. Cointegration Analysis

In this subsection, the first hypothesis considered is whether there exists a cointegrating vector between the real rates of Hong Kong SAR, China and the United States. The Johansen (1988), and Johansen and Juselius (1990) full information likelihood approach to the estimation and testing of cointegrated relationship is used in this study. When carrying out the Johansen test, it is assumed that the data has no deterministic trend and there is an intercept but no trend in the cointegration equation. Using the United States as the base country and 12 lags, the results of the cointegration tests are shown in Table 2. Diagnostic tests indicate that 12 lags are sufficient to eliminate any serial correlation in the residuals.

Table 2. G-PPP Tests Across Hong Kong SAR, China and the United States (Base Country)

Ho: r= No.of Cointegrating Vectors	Alternative	λ_{max}	95 percent Critical Value	λ_{trace}	95 percent Critical Value
r = 0	r = 1	9.86	15.7		
r = 1	r = 2	3.88	9.2		
r = 0	r > 0			13.75	20.0
r ≤ 1	r > 1			3.88	9.2

The λ -max statistics test the null of r cointegrating vectors against the alternative of $r+1$ vectors. The λ -trace statistics test the null hypothesis of r cointegrating vectors against a general alternative. Neither the λ -max nor the λ -trace statistics can reject the null of no cointegration between the Hong Kong SAR-United States and China-U.S. real exchange rates. Thus G-PPP does not hold among these three economies; so Hong Kong SAR, China and the United States do not seem to meet the condition that they jointly form a potential optimal currency area.

Similarly, cointegration test is done for the Hong Kong SAR-United States and Japan-U.S. real rates. The null of no cointegration is again not rejected. In fact, Table 3 reports that no pair of bilateral RERs is cointegrated among Hong Kong SAR, China, and Japan.

Table 3. Cointegration Test Statistics for Pairs of Real Bilateral Exchange Rates

Ho: r=0	λ_{max}	Japan-United States	
		95 Percent Critical Value	95 Percent Critical Value
Hong Kong SAR-United States	10.95	15.7	16.08
China-United States	12.49		18.34

The next step is to examine whether there exists cointegrating relationships among the real rates of Hong Kong SAR, China, and Japan against the U.S. dollar. Both the λ -max and the λ -trace statistics in Table 4 point to a single cointegrating vector. The null of no cointegration can be rejected at the 5 percent significance level by both statistics. Hence, G - PPP holds among Hong Kong SAR, China, Japan and the United States. One way to interpret this result is that the real exchange rates of Hong Kong SAR and China seem

to follow the time path that is dictated by events in Japan and the United States. This interpretation is quite intuitive, since more than 30 percent of the total trade of China, as well as of Hong Kong SAR, is with the United States and Japan.

Table 4. G-PPP Tests Across Hong Kong SAR, China, Japan, and the United States (Base Country)

Ho: R= # of Cointegrating Vectors	Alternative	λ_{\max}	95 Percent Critical Value	λ_{trace}	95 Percent Critical Value
R = 0	r = 1	22.21*	22.0		
R = 1	r = 2	7.94	15.7		
R = 2	r = 3	5.80	4.86		
R = 0	r > 0			35.94*	34.9
R ≤ 1	r > 1			13.74	20.0
R ≤ 2	r > 2			5.80	9.2

*Indicates rejecting the null at the 5 percent significance level.

When G-PPP holds, the equilibrium relationship among a group of RERs can be expressed in the form of equation (4). Standardized β and α coefficients are summarized in Table 5.

Table 5. Standardized α and β Coefficients for r = 1

	Constant	Hong Kong SAR	Chin	Japan
β	0.014	1.000	-0.141	-2.015
α		-0.023	-0.031	0.009

The coefficients of β reflect the interrelationships among these three exchange rates. They can be interpreted as long run elasticities. For example, a one percent change in the bilateral China-U.S. real exchange rate will induce -0.14 percent change in the Hong Kong SAR-U.S. real rate. The negative long-run elasticity might be due to the special trade and investment connections between the two economies.

Assuming that the real exchange rates are only influenced by real output processes of the various nations, Enders and Hurn (1994) show that the more similar are a country's aggregate demand parameters (such as the marginal propensity to consume and the cross price elasticity of demand between two goods), the smaller are the parameters of the

cointegrating vector. Since β is small between Hong Kong SAR and China, one might interpret it as evidence that the aggregate demand relations between these economies are not very dissimilar.

The second row of Table 5 reports the weights with which a discrepancy from the G-PPP equilibrium affects the real rate between country i and the United States, and they can be interpreted as the "speed of adjustment" towards the equilibrium. All α_i coefficients are rather small, indicating that any deviation from G-PPP can take a relatively long period of time to correct itself. Hence, it is possible that a yuan devaluation may put downward pressures on the Hong Kong dollar in the short run due to factors such as loss of investors' confidence. Nevertheless, the coefficients of β suggest that the long run elasticity between these two exchange rates is negative.

IV. CONCLUSIONS

This study explores the long-run relationship between the real exchange rates of Hong Kong SAR and China in the context of the G-PPP hypothesis. As originally elaborated by Enders and Hurn (1994), regions (or nations) may constitute the domain of an optimal currency area if the time paths of their real economies, and therefore their real exchange rates, share common trends. Using the G-PPP criterion, the findings of this study do not support the proposition that Hong Kong SAR and China meet one necessary condition for a successful currency integration. The data generating process indicates that these two economies have been evolving on divergent time paths during the past 20 years. However, their strong linkages with the outside world, as well as their unique linkages with each other, point to a sufficient interrelationship between their economies and their two biggest trading partners, the United States and Japan. Generalized purchasing power parity does hold for these four economies. One interpretation of these results is that the forcing variables behind the real exchange rates (such as the real income processes) of Hong Kong SAR and China are strongly influenced by developments in the larger industrial nations. The bilateral real exchange rate between them are affected by *all* other countries in the potential currency area.

There are many factors that govern a country's choice of exchange rate arrangement. When a country decides to peg its exchange rate, compared with the choice of pegging to a currency basket, pegging to a single currency provides it with the benefits such as greater transparency and credibility. On the other hand, there are also costs associated with pegging to a single currency, in particular if the country in concern has many important trading partners other than the one it chooses to peg its currency to. The findings of this paper suggest that there may be potential adjustment costs when Hong Kong SAR or China choose to peg to a single currency, be it the dollar or the yen. In terms of an optimal currency area, a basket peg that at least includes both the Japanese yen and the U.S. dollar seems to be more beneficial to these two economies.

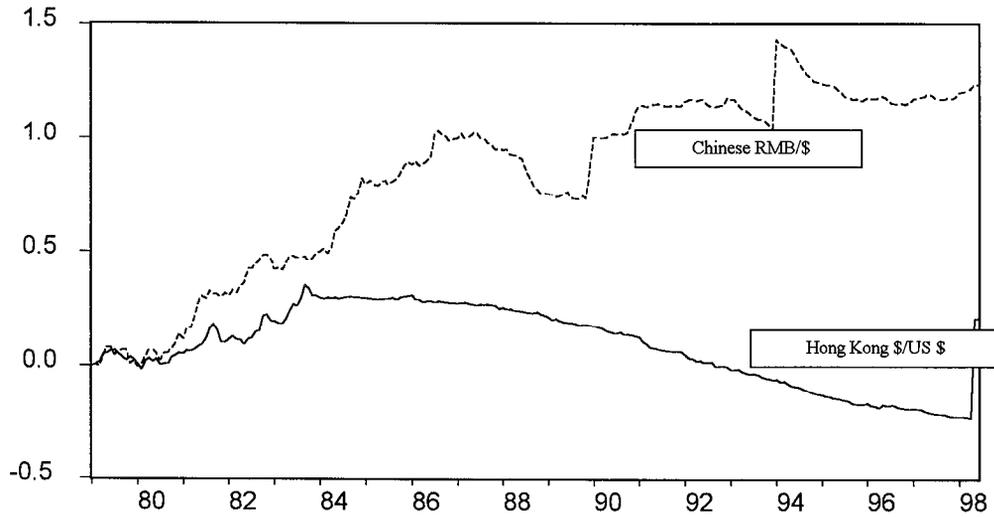
Another interesting finding of this study is that, although the magnitude is small, the long-run elasticity between the real exchange rates of Hong Kong SAR and China against the U.S. dollar is negative. This may seem *prima facie* surprising, especially in light of the heated discussion since late 1997 on possible yuan and/or Hong Kong dollar devaluation. Most analysts assume that any devaluation of Chinese yuan would trigger the devaluation of Hong Kong dollar through psychological factors and trade channels.⁹ However, cointegration analysis of G-PPP hypothesis reveals that Hong Kong dollar tends to appreciate in real terms in response to a real depreciation of the Chinese yuan. One possible explanation for this long run negative correlation may lie in the fact that, while China's gradual opening up of its economy and trade liberalization has led to a depreciation of its equilibrium exchange rate, Hong Kong SAR's equilibrium exchange rate has appreciated via the Balassa-Samuelson effect, partly due to shifting its productive facilities to China and continuous growth in its service sector.

It has been only one year and a half since Hong Kong SAR became the Special Administrative Region of China. Caution should be exercised when interpreting the results of this study, since new developments and increasing integration of the two economies may in time render these results obsolete. Nevertheless, cointegration analysis of G-PPP hypothesis is a relevant starting point when studying the long-run price and exchange rate behavior in the region.

⁹ There are notable exceptions to this view. Using a CGE model, Wei et al. (1998) concludes that the negative effect of yuan devaluation on Hong Kong's trade balance and foreign reserves is very small quantitatively.

Figure 1. Evolution of Real Exchange Rates (Base country = the United States)
(January 1979-June 1998)

1a. China and Hong Kong SAR



1b. Japan

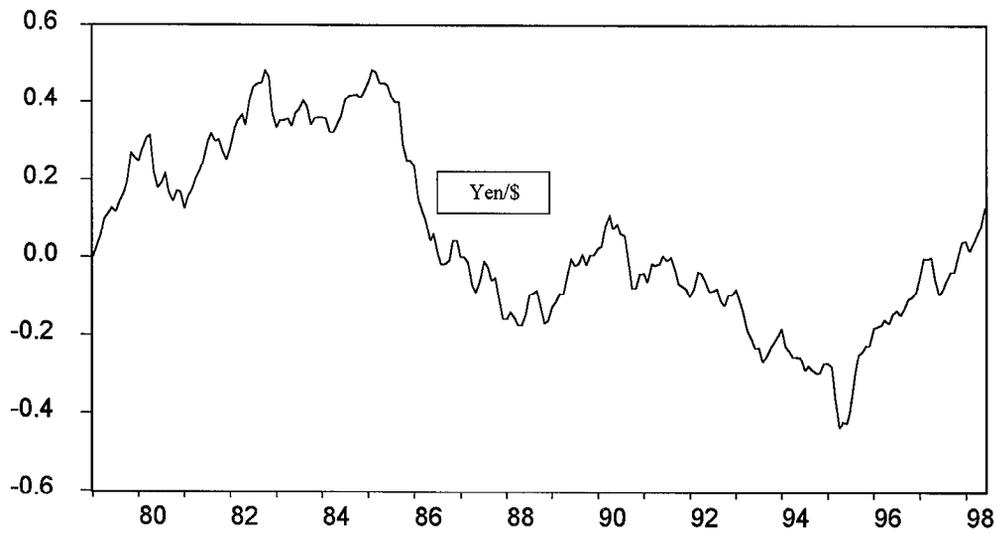
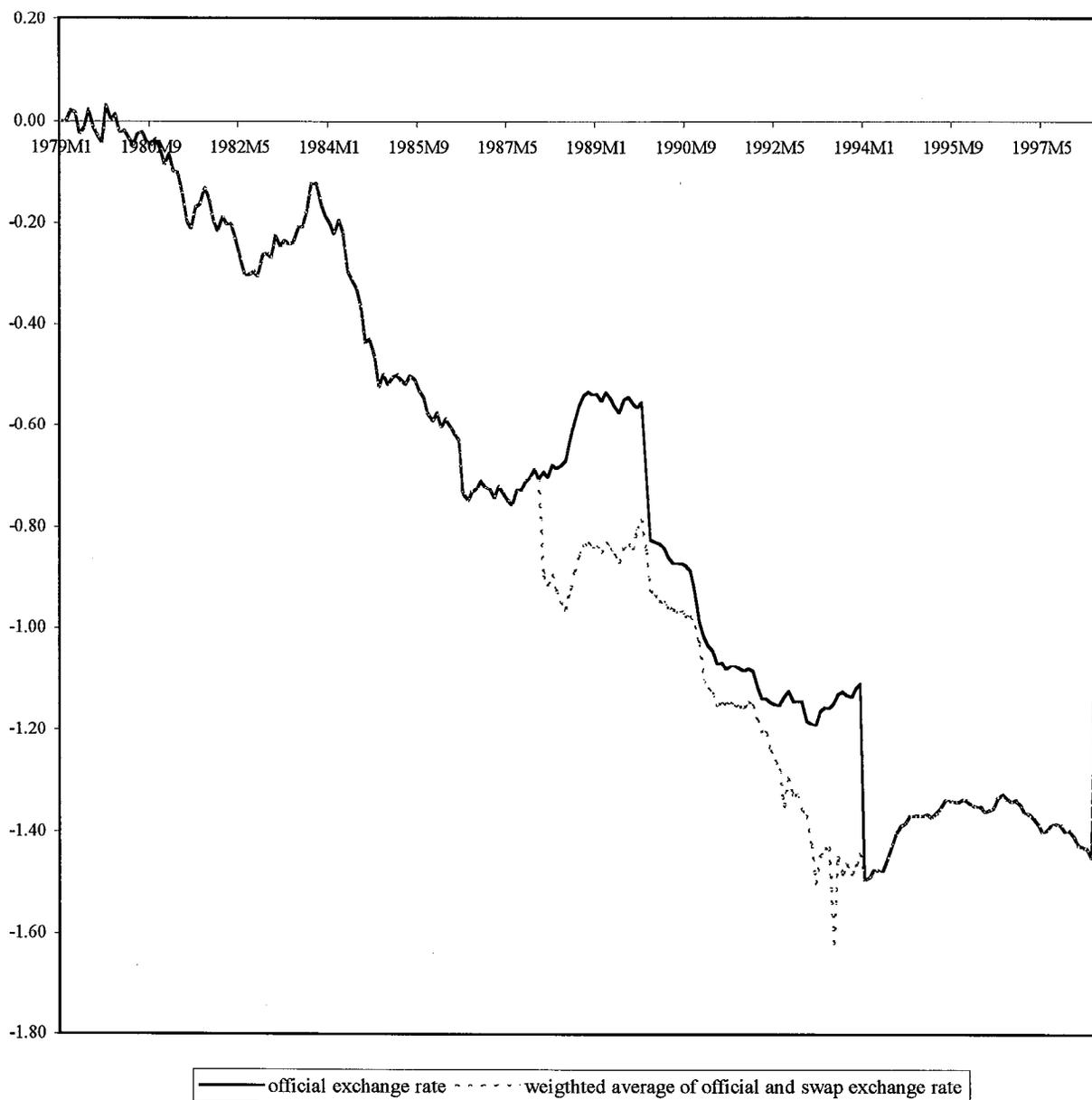


Figure 2. Evolution of Real Exchange Rate between Hong Kong SAR and China



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