6. A Price-Based Assessment of Economic Integration: The Implications for Monetary Arrangements in East Asia*

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I. Introduction

At the turn of the new millennium, Europe embarked on a new era of economic integration with monetary union. On the other side of the globe, the economies of East Asia have just begun to take the first tentative steps of a process that could eventually result in a similar arrangement. Presumably, this will be a long and involved process, so it might appear presumptuous to make assessments of a possible monetary union.

However, even before the advent of deep integration in the form of an economic and monetary union, one can conceive intermediate levels of macroeconomic coordination. For instance, exchange rates could be further managed or pegged. In order to determine the viability and desirability of such arrangements, one has to assess the degree to which the relevant economies are linked, both in financial and real terms.

It is against this backdrop of initiatives for deeper economic integration that proposals to coordinate exchange rates between Japan, Korea and China have taken on heightened interest.[1] First, barriers to

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the movement of financial capital have slowly eroded over time due to both regulatory initiatives and innovations in information technology. Second, trade in goods and, to a lesser extent, services has increased between these and other regional economies, as trade barriers have been dismantled. Of course, the recent accession of China to the World Trade Organization has only accelerated this process.[2] Finally, rapid expansion of Chinese industrial capacity is causing large changes in relative prices, between China and other East Asian countries, as well as between China and the United States.

In this paper, we examine the quantitative aspects of integration in the context of macroeconomic concerns and characterize the current and future scope for integration and macroeconomic management between the three largest economies of the region—Japan, China and Korea. Specifically, we will examine the conditions of real interest parity, uncovered interest parity and purchasing power parity. These three parity conditions define the key links between markets. They are closely examined in international finance and routinely used as a gauge of the degree of integration in capital, financial and goods markets. The real interest parity condition hinges on the degree to which real interest rate parity holds, which, in turn, depends on the extent to which uncovered interest parity and relative purchasing power parity apply. Since uncovered interest parity involves financial arbitrage between money and foreign exchange markets and relative purchasing power parity entails arbitrage in goods and services, the real interest parity condition encompasses elements of both real and financial integration.

The layout of this paper is as follows. In Section 2, we set out a framework for systematically analyzing the components of financial and real integration. That is, we will describe how deviations from real interest parity can be decomposed into two factors—uncovered interest

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1) Proposals for initial steps aimed at creating a Northeast Asian economic bloc modeled after NAFTA have been circulating over the past year. This arrangement would entail the combination of China-Korea and Korea-Japan free trade agreements. There has also been discussion of initial steps toward implementing some forms of monetary and financial coordination amongst the ASEAN+3. See "East Asia to study goal of common currency system," *Reuters*, August 6, 2003. Greater details on cooperation options for China and East Asia can be found in Cabinet Office (2001) and Lloyd and Crosby (2002).

2) Recent studies analyzing WTO effects include Wang (2001) and Ma (2001).

parity deviations and deviations from relative purchasing power parity. In Section 3, we turn to examining each of these three factors, in terms of their stationarity characteristics, persistence and trends. The compositions of deviations from these parity conditions are studied in the Section 4. Some concluding remarks are offered in Section 5.

One aspect of our approach merits some discussion. For a number of reasons, we use China as the reference country. First, while all three economies underwent structural changes over the period we analyze (1996-2003), it is in China that the evolution of the economic system is most profound. Second, China appears to be determining the relative price of manufactured goods, which in turn has major ramifications for trade with the United States and Europe.[3)]

II. A Framework for Analysis

Theory provides a number of criteria for determining whether the coordination of exchange rate policies is desirable. There are the standard optimal currency area criteria first forwarded by Mundell (1961) and McKinnon (1963).[4)] In addition, there are arguments based upon the use of a hard currency peg as a commitment device. Here, we assess the degree of integration and hence possibilities for coordination using parity measures.

These parity conditions—real interest parity, uncovered interest parity and relative purchasing power parity—are the three pillars in international finance. Various approaches and datasets have been used to examine each of these parity conditions. Among the three, purchasing power parity is perhaps the most intensively tested condition. Besides the question of whether these parity conditions offer an adequate characterization of economic conditions, these conditions are commonly used to infer the linkages and the degree of market integration.[5)] In the

3) As illustrated by concerns over China's "exporting deflation" and the recent debate regarding the appropriate rate to peg the renminbi against the U.S. dollar. See Redward (2003), among others, for a discussion. This is in addition to the earlier debate over whether the Chinese exchange rate unification of 1994 set the stage for the currency crises of 1997-98. See Fernald et al. (1999) and Noland et al. (1998).

4) See for instance Eichengreen (2002), Bergsten and Park (2002), Choo and Wang (2002) and Shin and Wang (2003), among others.

following subsection, we outline the relationship between these parity conditions. Readers who are familiar with the parity conditions should skip this section and go directly to Section 3.

1. An Accounting Identity

Consider the *ex ante* real interest differential between two economies:

$$r_t^{ke} - r_t^{k*e} \equiv (i_t^k - \pi_{t+k}^e) - (i_t^{k*} - \pi_{t+k}^{e*}) \quad (1)$$

where r_t^{ke} is the expected k-period real interest rate in the first economy with the "e" and "k" superscripts indicate the variable is expected and the maturity of the debt instrument. The asterisk denotes the variables for the second economy. The real interest rate is given by the difference between i_t^k, the k-period nominal interest rate, and π_{t+k}^e, the expected inflation rate in k-periods. Hence, equation (1) defines the *ex ante* real rate as the nominal interest rate on an asset of maturity k periods, deflated by the inflation rate expected at time t to prevail over the period t to t+k (annualized).[6] The expected inflation is defined by

$$\pi_{t+k}^e \equiv p_{t+k}^e - p_t \quad (2)$$

where p_{t+k}^e and p_t are, respectively, the price (in log) expected to prevail at t+k and the price at t. The expected inflation in the second economy is similarly defined

$$\pi_{t+k}^{*e} \equiv p_{t+k}^{*e} - p_t^* \ . \quad (3)$$

The expression for the real interest differential on the right hand side of (1) can be re-arranged, and expected depreciation subtracted and added, to yield:

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5) Recent analyses in the East Asian context include Chinn and Frankel (1994) de Brouwer (1999) and Cheung *et al.* (2003a).

6) In this case, we are assuming that the interest rates are on highly liquid, money market instruments of identical default risk characteristics. Hence, we do not address default risk premium in our discussion.

$$r_t^{ke} - r_t^{k*e} \equiv (i_t^k - i_t^{k*} - \Delta s_{t+k}^e) - (\pi^e_{+kt} - \pi_{t+k}^{e*} - \Delta s_{t+k}^e) \quad (4)$$

where expected depreciation is given by:

$$\Delta s_{t+k}^e \equiv s_{t+k}^e - s_t \quad (5)$$

and s_t is the exchange rate between monies in the two economies expressed in logarithm form. Note that the first term on the right hand side of (4) is the uncovered interest differential and the second term is the deviation from *ex ante* relative purchasing power parity.

The uncovered interest differential can be further decomposed into:

$$(i_t^k - i_t^{k*} - \Delta s_{t+k}^e) \equiv [i_t^k - i_t^{k*} - (f_{t,t+k} - s_t)] + (f_{t,t+k} - s^e_{t+k}) \quad (6)$$

where the term in square brackets is called covered interest differential and the term $(f_{t,t+k} - s^e_{t+k})$ is sometimes labeled risk premium. Ideally, in assessing the nature of the factors preventing parity conditions from holding, one would like to discriminate between covered interest differentials[7] and the exchange risk premium. However, data limitations preclude us from doing so in this experiment.[8] Hence, we will conduct the analysis keeping in mind that we impound the covered interest differential and the exchange risk premium into the uncovered interest differential.

2. *Measuring Expectations*

Strictly speaking, real interest parity is an *ex ante* concept defined by expectations rather than realized real interest rates. The theoretical relationship between the three parity conditions is defined by identity

7) The covered interest differential is sometimes termed political risk, associated with capital controls or the threat of their imposition. See Aliber (1973), Dooley and Isard (1980) and Frankel (1984) for applications.

8) In particular, we have only incomplete data on forward rates and do not observe expected exchange rate changes. In Chinn and Frankel (1994), expectations are proxied with survey based data, which are unavailable to us for all these currencies.

(4). However, due to the paucity of data on expectations, the identity cannot be used to assess the empirical relevance of these parity conditions. Instead, we employ a version based on *ex post* differentials:

$$r_t^k - r_t^{k*} \equiv (i_t^k - i_t^{k*} - \Delta s_{t+k}) - (\pi_{t+k} - \pi^*_{t+k} - \Delta s_{t+k}) \qquad (7)$$

to examine the data. One way to justify the use of (7) is that, under the rational expectations hypothesis, the *ex post* realizations are unbiased predictors of the *ex ante* counterparts.[9)]

3. *Financial versus Real Integration*

Abstracting from the distinction between *ex ante* and *ex post*, equations (4) and (7) imply that a *necessary* condition for real interest parity to hold is that both uncovered interest parity and relative purchasing power parity hold. While uncovered interest parity pertains to financial integration driven by arbitrage between money and foreign exchange markets—that is, how desirable currencies are viewed and how free money is to move—relative purchasing power parity pertains to how easily goods and services are arbitraged. Hence, real interest parity is a function of *both* financial and real market integration (Frankel, 1991).

To make this assertion concrete, consider a situation where financial markets in two economies were well integrated, while differential inflation rates were not offset by changes in exchange rates. Then, real interest differentials could persist not because financial capital flows were hindered and covered interest parity is violated, but because of the breakdown of relative purchasing power parity due to limited strength of the forces that drive together goods prices (expressed in a common currency).

The condition wherein real interest rate parity holds is sometimes termed real capital mobility. That is, real interest rates are equalized when "real" capital is free to move. To see why some observers make

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9) In other words, we are equating the subjective market expectations with the conditional mathematical expectations, viz., $x^e_{t+k} = E(x_{t+k} | I_t)$, in a steady state such that $x_{t+k} - E(x_{t+k} | I_t) = \xi_{t+k}$ where ξ_{t+k} is a true innovation. The composite hypothesis of UIP and rational expectations is termed the "unbiasedness hypothesis" by Frankel (1984).

this equivalence, consider basic microeconomic theory. An optimizing firm sets the marginal product of capital equal to the user cost of capital. Absent taxes and ignoring capital depreciation, the user cost of capital is nominal interest rate, adjusted by the rate of inflation of its output. Hence, real interest parity is taken as a signal of the equalization of the marginal product of capital.[10]

III. Empirical Results

The data considered in this exercise are monthly observations on one-month interbank interest rates, exchange rates, and consumer price indexes for China, Hong Kong, Japan, Korea, Singapore, Taiwan, and the United Sates from February 1996 to May/June 2003. See the Data Appendix for a more detailed description. The period of analysis is dictated by data availability, and more importantly, by the realities of the liberalization process in China. A unified national interbank market was only established in January of 1996; prior to that the interbank market was substantially controlled (Xie, 2002). Hence, extending the interest rate series backwards would not yield more information relevant to assessing financial integration.[11]

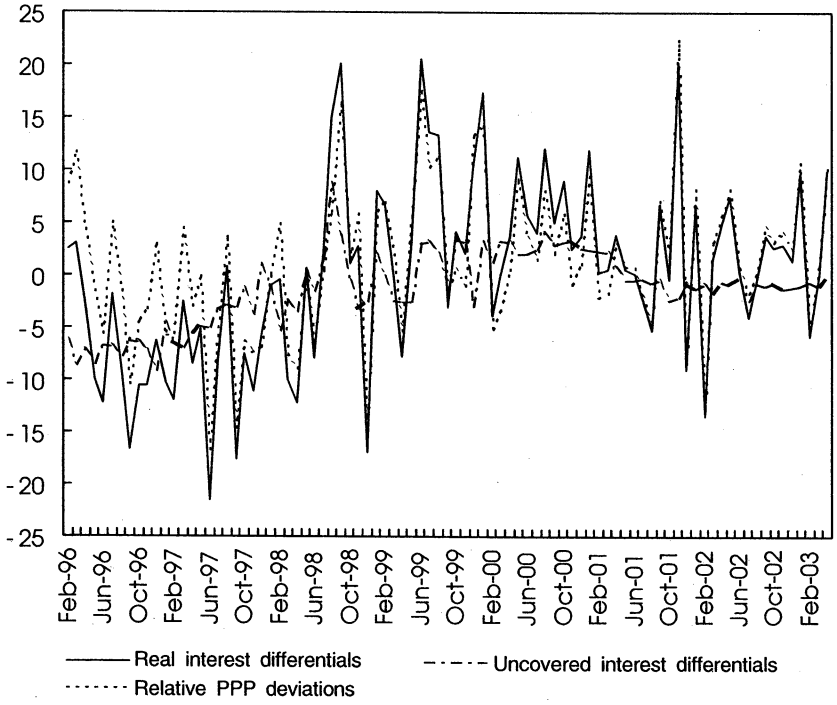
For each pair of economies, the *ex post* real interest differential $(r_t^k - r_t^{k*})$, *ex post* uncovered interest differential $(i_t^k - i_t^{k*} - \Delta s_{t+k})$ and *ex post* relative purchasing power differential $(\pi_{t+k} - \pi_{t+k}^* - \Delta s_{t+k})$ are constructed to examine the relevance of the parity conditions and assess the degree of integration between the various economies. For notational simplicity, we drop the term "*ex post*" hereafter.

The three differential series are graphed in Figures 1 to 6. Clearly, there is some variation in exchange rate-related measures in 1997. These variations are particularly pronounced for Korea; this is a phenomenon that merits some additional discussion, especially in the context of

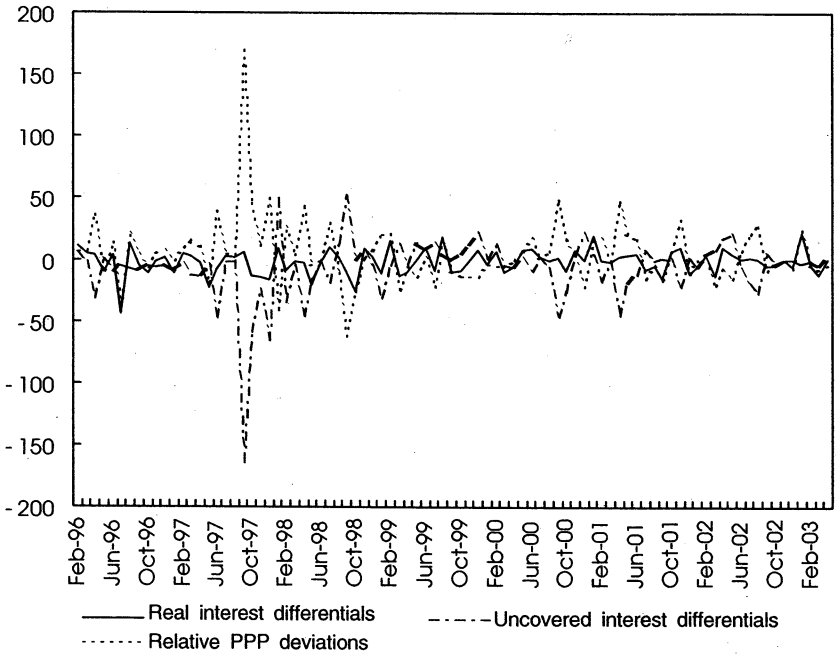
10) There is a subtlety involved in using parity conditions to evaluate integration. When a parity condition is rejected, then variations in the size of the deviations may be due either to greater economic integration, a convergence of economic policies, or both.

11) There is a separate question of whether the one-month rate is representative of other short-term interest rates, including the commercial paper and repo rates. Li and Peng (2002) argue that in recent years, the segmentation in these short-term instruments has largely disappeared.

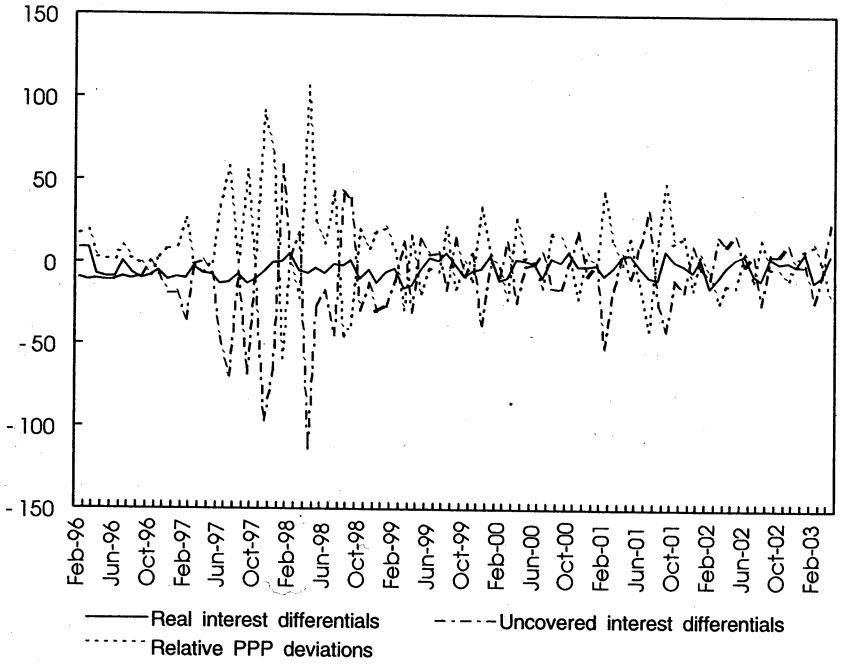
<Figure 1> Deviations from the Parity Conditions between Hong Kong and China



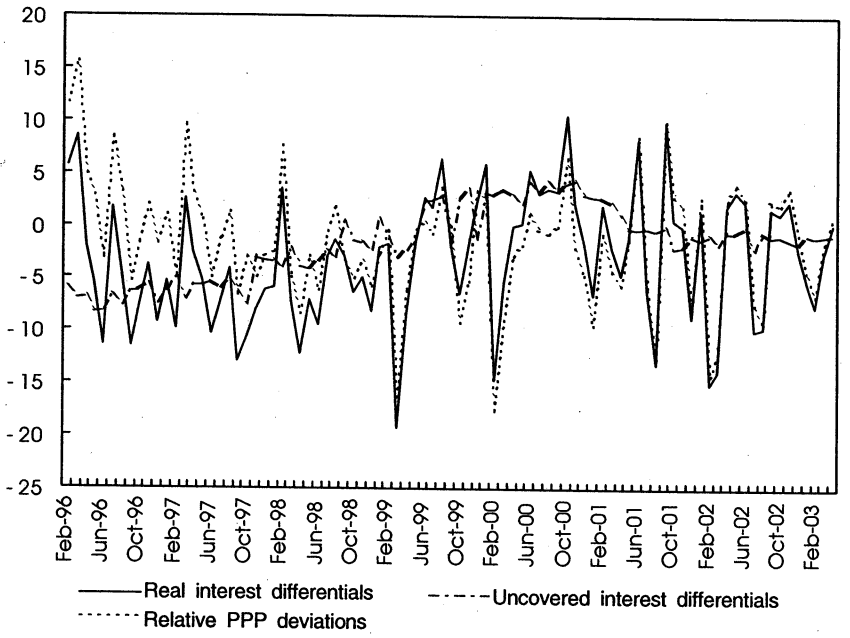
<Figure 2> Deviations from the Parity Conditions between Taiwan and China



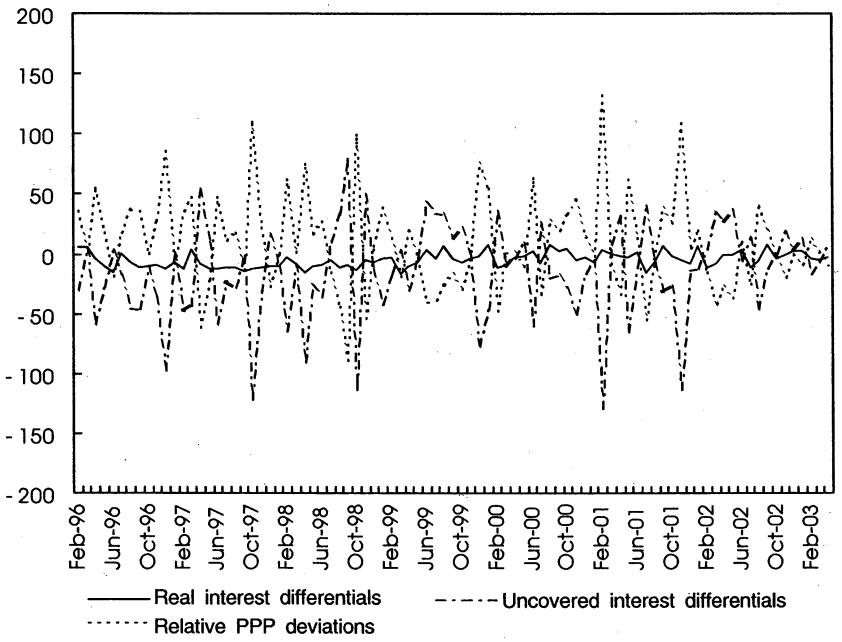
<Figure 3> Deviations from the Parity Conditions between Singapore and China



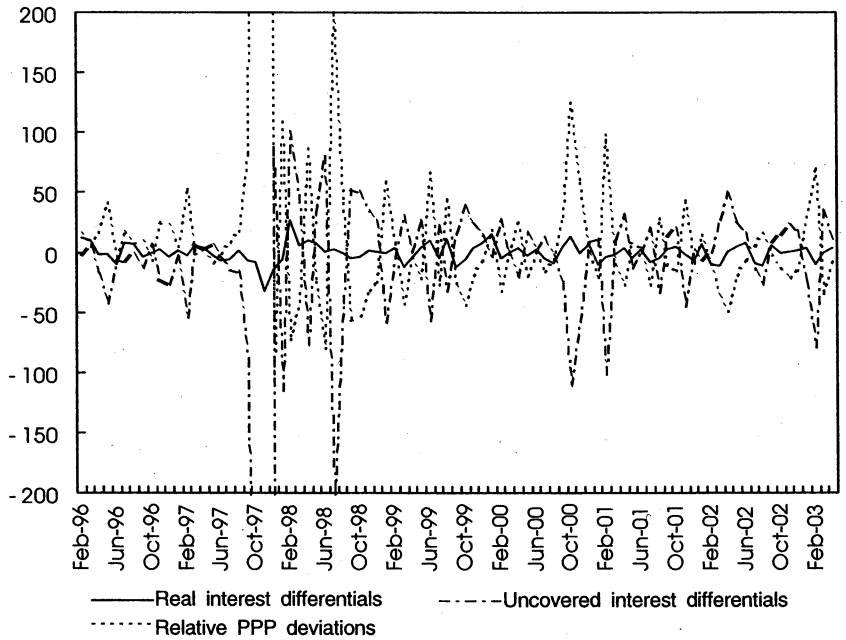
<Figure 4> Deviations from the Parity Conditions between U.S. and China



<Figure 5> Deviations from the Parity Conditions between Japan and China



<Figure 6> Deviations from the Parity Conditions between Korea and China



measuring exchange rate expectations. The rational expectations methodology assumption is not necessarily a bad assumption, and in the face of data constraints, we have few alternatives. Nonetheless, in the case of Korea, this assumption may be inappropriate. Indeed, one might expect that this event constituted a textbook example of the peso problem, where the distribution of exchange rate changes is extremely abnormal so the actual realizations may be poor indicators of

<Table 1> Descriptive Statistics

	Hong Kong	Taiwan	Singapore	U.S.	Japan	Korea
A. Real interest differentials						
Mean	0.071	-1.710	-3.639**	-3.181**	-4.761**	0.532
Maximum	20.595	21.610	8.412	10.582	8.347	27.171
Minimum	-21.587	-44.284	-15.620	-19.323	-16.250	-12.265
Std.dev.	8.870	10.444	6.023	6.156	6.406	7.240
B. Uncovered interest differentials						
Mean	-1.243**	-6.988*	-9.664**	-1.635**	-14.967**	-3.901
Maximum	8.798	51.857	58.647	4.395	79.048	99.838
Minimum	-9.186	-163.544	-113.265	-8.302	-128.590	-201.721
Std.dev.	3.568	25.390	26.477	3.505	39.902	45.225
C. Deviations from relative purchasing power parity						
Mean	1.314#	5.277#	6.025*	-1.546*	10.205*	4.433
Maximum	22.347	169.727	106.280	15.528	131.774	204.188
Minimum	-16.637	-62.288	-58.337	-17.573	-88.403	-79.629
Std.dev.	7.241	26.743	25.532	5.901	40.199	45.463

Notes: The real interest differentials, uncovered interest differentials and deviations from relative purchasing power parity are all annualized and measured in percentage terms. The economy-pairs are labeled in the first row. China is the reference country. "**", "*", and "#" indicate that the sample mean is significantly different from zero at the 1%, 5% and 10% levels, respectively. For Korea, the sample excludes 1997 observations due to an unusual scale of movements driven by the financial crisis.

expectations.[12] Consequently, for the Korea-China pair, we will report results that are based upon the exclusion of 1997 observations.

The effects of the 1997/98 crisis are not very obvious in the graphs of real interest differentials but are quite easy to identify in the other differential series for the Taiwan-China and Korea-China series in Figures 2 and 6 (and to a lesser extent for U.S.-China). It is likely that the effects of the crisis on uncovered interest and relative purchasing power differentials work in offsetting directions such that the combined effect on real interest differentials is mitigated.

Table 1 presents some of their descriptive statistics. Several observations are in order. The composite measure of integration—real interest differentials—appears to be only significantly different from zero in three cases: the Japan, Singapore and U.S. pairs. Chinese real interest rates are on average between 3 to 5 percent higher than the corresponding foreign rates. The Korean differential is quite small, suggesting that the degree of integration is fairly high.

In contrast, measures of financial integration—the uncovered interest differentials—suggest more extant barriers to financial flows. All the deviations are statistically different from zero, save those of the Korean pair, but in certain instances are quite small numerically.[13] For instance, the Hong Kong and U.S. differentials are between negative 1-2 percent, while those for others range up to 15 percent, with much larger standard deviations. It is no coincidence that these highly variable pairs involve floating exchange rates; hence, some component of this greater variability may be attributable to larger exchange rate "surprises."

The absolute values of the relative purchasing power parity deviations follow a mirror image. The smallest deviations are for the fixed exchange rate pairs involving Hong Kong and the United States. Interestingly, even for these two pairs, the variability is about twice what it is for the corresponding UIP deviations. This pattern suggests that goods market integration is less advanced than financial, in some diffuse sense, for these economy pairs.[14]

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12) See Lizondo (1983) for a discussion of the peso problem.

13) Once a dummy variable is used to control for the 1997 effect, the uncovered interest differentials for the Taiwan pair become insignificantly different from zero.

14) A conclusive assertion cannot be made since prices are measured with less

In the following subsections, we evaluate the parity conditions via a few perspectives. First, we test for the presence of a unit root in these differential series. Second, we assess the predictive ability of the past values of a differential series. Third, we examine whether the deviations from the parity condition are shrinking over time or not.

1. Real Interest Parity

In some earlier studies, regression methods are used to determine the validity of real interest parity (Cumby and Obsfeld, 1984). For example, interest rate differentials are regressed on inflation differentials and the coefficient estimates are used to assess whether the real interest rate parity condition holds.[15] In this study, we use the concept of mean or trend stationarity to evaluate the parity condition. If the deviations from *ex post* real interest parity are transitory and stationary, then even though the condition does not hold in the short run, deviations from parity are transitory. The argument follows from the property of a stationary time series—a stationary time series will revert back to its equilibrium value after being disturbed by external shocks. On the other hand, if the deviations from parity are not stationary, shocks can lead to permanent displacements from equilibrium and there is no built-in mechanism to restore the parity conditions, even in the long run.[16] The use of the stationarity criterion is appropriate because a parity relation is usually established under some ideal conditions that are unlikely to hold in the short run. The use of stationarity tests can also be rationalized by recalling that we only observe *ex post* inflation and depreciation rates; hence it makes no sense to assume that the *ex post* parity conditions hold

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precision than interest rates and this measurement error may impart a bias to measured deviations that may be more visible when exchange rate variability is near zero.

15) There is an extensive literature on testing real interest parity. See Mishkin (1984), Mark (1985) and Cumby and Mishkin (1986). Following general practice, the test results in Tables 2 to 5 are based on the exact formula rather than the log approximations described in the text.

16) The constant associated with the real interest parity deviation can be interpreted as a time-invariant difference in the default risk or liquidity attributes of the money market instruments that have been assumed away in the algebraic expressions.

instantaneously. As long as the parity conditions hold *ex ante* and the expectations errors are mean stationary, tests for stationarity will be informative.

An augmented Dickey-Fuller (ADF) test is used to test for stationarity. Consider a series $\{q_t\}$; q_t = real interest differential, uncovered interest differential and relative purchasing power differential. The ADF test is based on the regression:

$$q_t = c + \beta t + \delta q_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta q_{t-i} + \varepsilon_t \,. \tag{8}$$

The two statistics that allow for a deterministic time trend (ADF^{τ}) and for only an intercept (ADF^{μ}) are considered. The lag length is selected using the Bayesian information criterion and are cross-checked for residual serial correlation with the Box-Ljung Q-statistics for lag orders of 6 and 12.

The results of applying the tests to the six real interest differential series are presented in Panel A of Table 2. For all six series, the residual Q-statistics indicate that the selected lag specifications are quite adequate. Both the ADF^{τ} and ADF^{μ} test statistics are negative and, with only two exceptions (mean stationarity for Hong Kong and U.S. pairs), significant indicating that real interest differential series are stationary. When a 1997 crisis dummy was included, the ADF^{μ} statistics for the HK and U.S. pairs are less than -7, soundly rejecting the unit root hypothesis. Hence, the evidence suggests that, after allowing for the 1997 crisis effect, real interest rates in this region tend to converge in the long run.

Panel B of Table 2 reports the results of the following regression

$$q_t = \alpha_0 + \sum_{k+1}^{p} \alpha_k q_{t-k} + \varepsilon_t \,. \tag{9}$$

This regression specification has been used in several previous studies of parity conditions. Under instantaneous real interest parity, the expected real interest differential is random, has a zero mean and cannot be predicted by available information. Thus, the significance of in (9) is considered evidence against the validity of α_k the (instantaneous) parity condition.

As reported in Panel B, the real interest differentials for all the economy pairs display statistically significant persistence. That is the

<Table 2> Real Interest Differentials

	Hong Kong	Taiwan	Singapore	U.S.	Japan	Korea
A. Unit root test statistics						
ADF-μ	-2.487 [4]	-2.678$^{\#}$[6]	-6.875**[1]	-2.334 [8]	-2.667$^{\#}$[4]	-7.801**[1]
Q(6)	5.442	0.850	4.607	0.939	2.732	5.129
Q(12)	16.360	3.848	18.039	14.694	13.762	8.100
ADF-τ	-5.020**[2]	-6.859**[4]	-7.667**[2]	-7.154**[2]	-7.168**[2]	-7.744**[1]
Q(6)	10.071	9.423	2.885	0.954	3.384	5.130
Q(12)	17.735	11.600	11.729	18.466	15.351	8.105
B. Persistence						
AR(1)	0.288*	-0.180$^{\#}$	0.291**	0.279*	0.186$^{\#}$	0.153
	(0.109)	(0.094)	(0.103)	(0.116)	(0.108)	(0.109)
AR(2)	0.163	-0.136	-	-0.120	0.064	-0.022
	(0.113)	(0.096)		(0.118)	(0.110)	(0.109)
AR(3)	-0.086	-0.025	-	-0.014	0.059	-0.223*
	(0.114)	(0.097)		(0.119)	(0.108)	(0.107)
AR(4)	0.284*	-0.000	-	0.181	0.258*	-
	(0.110)	(0.099)		(0.116)	(0.106)	
AR(5)	-	0.122	-	0.019	-	-
		(0.098)		(0.116)		
AR(6)	-	0.379**	-	0.046	-	-
		(0.095)		(0.117)		
AR(7)	-	-	-	0.215$^{\#}$	-	-
				(0.115)		
AR(8)	-	-	-	-0.144	-	-
				(0.111)		
Adjusted R^2	0.204	0.172	0.075	0.071	0.110	0.044
C. Trends in annual absolute averages						
Individual	-0.719**	-0.811*	-0.574*	-0.295$^{\#}$	-0.835*	-0.054
	(0.163)	(0.227)	(0.194)	(0.137)	(0.249)	(0.144)
Group	-		-0.560**		-0.355$^{\#}$	
			(0.115)		(0.168)	
Common			-0.476**			
			(0.090)			

Notes: Results on the properties of real interest differentials are presented. The economy-pairs are labeled in the first row. China is the reference country. Panel A gives the ADF τ and ADF μ unit root test results. Levels of significance are determined using finite sample critical values (Cheung and Lai, 1995). Figures in square brackets are lag parameters selected by the Bayesian information criterion. Q(6) and Q(12) are the Box-Ljung Q-statistics based on the first six and 12 autocorrelations of the estimated residuals. Panel B gives the persistence of real interest differentials estimated from equation (9). Panel C gives the common and economy-pair (individual) specific trend estimates of the annual average of absolute real interest differentials (equation (11)). Estimates involving the Korea-China pair incorporate a dummy variable for 1997. Robust standard errors are reported in parentheses underneath coefficient estimates. Significance at the 1%, 5% and 10% levels are indicated by "**," "*" and "#," respectively.

deviation from the real interest parity is predictable and the markets are not efficient in this specific sense. The explained component, as indicated by the adjusted-R^2, ranges from 4 percent of the Korea-China real interest differentials to 20 percent of the Hong Kong-China differentials.

Next, we use a simple panel setting to uncover any trends in deviations from parity. Specifically, we investigate whether the magnitude of deviation is declining over the sample period. To this end, we construct an annual measure of absolute deviation by averaging the monthly absolute real interest differentials. For a given calendar year t and economy-pair i, the annual absolute deviation is defined by

$$\tilde{q}_{i,t} = 12^{-1} \sum_{k=1}^{12} abs(q_{i,t,k}) \tag{10}$$

where $abs(q_{i,t,k})$ is the absolute value of the i-th economy-pair's k-th month real interest rate differential during year t, i = all economy-pairs and t = 1996, , 2002.[17] The results of estimating the trend term in the panel regression

$$\tilde{q}_{i,t} = \alpha_i + \beta t + \varepsilon_{i,t} \tag{11}$$

are reported in Table 2, Panel C. The economy-pair specific intercept term α_i allows individual absolute deviation series to have different means. The sign of the coefficient estimates indicates that the real interest rate gaps tend to decline over time, although that for Korea is not statistically significant. The common trend term is significant at -0.48; indicating that the magnitude of the deviation from the parity condition declines during the sample period.[18]

Since there is some interest in the degree of integration between the candidate members of the Northeast Asian monetary union versus that with non-candidate countries, we re-estimated (11) with individual economy-pair specific trend terms and reported the results in Panel C. The gaps between China and the Korean and Japanese economies exhibit a smaller decline during the sample (-0.36) versus those between China

17) The year 2003 is excluded because we have only six observations for that year.

18) The negative trend term should properly be interpreted as a description of in-sample behavior that does not necessarily extend beyond the sample period. Otherwise, one has to deal with the issue of a "negative" absolute deviation.

and the other four non-candidate economies (-0.56).

2. *Uncovered Interest Parity*

The real interest parity condition incorporates aspects of both real and financial integration. Although the results in the previous subsection are supportive of long-run real interest parity, it may be instructive to isolate the sources of rejection of short-run integration. To this end, we examine the cases of financial and real integration individually. The results related to financial integration between the Chinese, Japanese and Korean economies are given in Table 3 in a format analogous to that used in Table 2.

Panel A presents the results of applying the unit root tests on the uncovered interest differential series. The unit root hypothesis is strongly rejected by both ADF^{τ} and ADF^{μ} test statistics for all pairs, save the HK and U.S. ones. Similar to the case of real interest differentials, after controlling for the 1997 crisis effect, both HK and U.S. differential series reject the unit root hypothesis.[19] These results are largely consistent with the real interest parity result, insofar as UIP is a component of RIP. One might worry that the findings we obtain are a consequence of the drastic movements in asset prices during the financial crises of 1997-98; however, the test results are robust to inclusion of a dummy variable for 1997.

The results of fitting uncovered interest differential to equation (9) are given in Panel B. The deviation from uncovered interest parity does not appear random for the Hong Kong, Taiwan and U.S. pairs. For these cases, the lagged uncovered interest differential variables are positively significant and indicative of strong persistence. The adjusted-R^2 is quite high in two instances and fairly low for the Taiwan-China pair. If monies are free to move across markets, arbitrage can generate profits based on the pattern of persistent deviation and help restore the parity. The observed persistent deviations are consistent with the capital controls prevailing in China, which make this kind of arbitrage activity quite difficult, especially in the short run. However, we would expect

19) In the presence of a 1997 dummy, the unit root test results for HK are ADF^{μ} = -3.827 and ADF^{τ} = -4.026 and for the U.S. are ADF^{μ} = -3.595** and ADF^{τ} = -3.225. These statistics are significant and pass the diagnostic tests.

<Table 3> Uncovered Interest Differentials

	Hong Kong	Taiwan	Singapore	U.S.	Japan	Korea
A. Unit root test statistics						
ADF-μ	-2.346 [4]	-5.168**[2]	-8.355**[1]	-1.597 [3]	-9.228**[1]	-8.543**[1]
Q(6)	9.332	9.455	5.345	4.335	7.067	0.106
Q(12)	11.703	18.414	11.936	17.336	14.509	0.265
ADF-τ	-2.292 [3]	-4.647**[4]	-8.846**[1]	-1.143 [3]	-9.511**[1]	-8.592**[1]
Q(6)	9.904	1.506	6.531	4.334	8.162	0.330
Q(12)	12.834	11.950	10.930	17.335	14.635	0.842
B. Persistence						
AR(1)	0.551**	0.191#	0.082	0.447**	-0.007	0.070
	(0.108)	(0.110)	(0.109)	(0.107)	(0.109)	(0.108)
AR(2)	0.061	0.108	-	0.211#	-	-
	(0.123)	(0.109)		(0.115)		
AR(3)	0.221*	0.185#	-	0.268*	-	-
	(0.105)	(0.109)		(0.105)		
AR(4)	-	-0.236*	-	-	-	-
		(0.109)				
Adjusted R^2	0.626	0.079	-0.005	0.833	-0.011	-0.006
C. Trends in annual absolute averages						
Individual	-0.879**	-1.760	-2.239	-0.912**	-2.100	-1.811
	(0.200)	(1.747)	(2.274)	(0.211)	(1.644)	(4.742)
Group	-		-1.637		-1.971	
			(1.011)		(11.415)	
Common			-1.179			
			(4.427)			

Notes: Results on the properties of real interest differentials are presented. The economy-pairs are labeled in the first row. China is the reference country. Panel A gives the ADF τ and ADF μ unit root test results. Levels of significance are determined using finite sample critical values (Cheung and Lai, 1995). Figures in square brackets are lag parameters selected by the Bayesian information criterion. Q(6) and Q(12) are the Box-Ljung Q-statistics based on the first six and twelve autocorrelations of the estimated residuals. Panel B gives the persistence of real interest differentials estimated from equation (9). Panel C gives the common and economy-pair (individual) specific trend estimates of the annual average of absolute uncovered interest differentials (equation (11)). Estimates involving the Korea-China pair incorporate a dummy variable for 1997. Robust standard errors are reported in parentheses underneath coefficient estimates. Significance at the 1%, 5% and 10% levels are indicated by "**," "*" and "#," respectively.

similar conditions to apply to Japan-China and Korea-China links as well. We conjecture that for the Hong Kong-China and U.S.-China pairs, the existence of a *de facto* pegged exchange rate regime results in easier detection of serial correlation.

We used the annual absolute deviation from uncovered interest parity, which is constructed in the same manner as the absolute deviation from real interest parity (equation (10)), to assess the trending behavior of uncovered interest disparity. All the estimated common and economy-pair specific time trends have a negative sign—indicating the differentials are narrowing during the sample. However, only the estimates of Hong Kong-China and U.S.-China pair are statistically significant. The other estimates are larger (in absolute value) but have an even larger standard error.[20]

The group trend for the Japan and Korea pairs is negative at -2.0 but is only slightly larger than the group trend for the non-candidate pairs (-1.6). In neither instance are the trend estimates statistically significant. These estimates correspond to specifications incorporating a dummy for 1997; excluding the dummy leads to an improbably large negative coefficient on the candidate group trend of -30.9. Since this estimate is not statistically significant, we focus on the results incorporating the intervention dummy.

3. *Relative Purchasing Power Parity*

The relative purchasing power differential series are used to assess the real integration between the three candidate economies.[21] The empirical results are presented in Table 4. The ADF^{τ} and ADF^{μ} tests strongly reject the presence of a unit root in these differential series. While the stationarity result is expected from the identity (7) and the results in the previous two subsections, it is comforting to see the unit root hypothesis is rejected by the actual data. Thus, there is evidence of

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20) Note that we are using the Korea-China trend after including a dummy for 1997. If a dummy is not included in the regression, the rate of decline is on the order of 60 percent per year.

21) Note that we are equating real integration with relative purchasing power parity holding. Given the difficulties in comparing widely differing consumption baskets, we do not refer to absolute purchasing power parity in levels for measuring goods market integration.

<Table 4> Deviations from Relative Purchasing Power Parity

	Hong Kong	Taiwan	Singapore	U.S.	Japan	Korea
A. Unit root test statistics						
ADF-μ	-8.109**[1]	-8.166**[1]	-8.921**[1]	-7.935**[2]	-9.546**[1]	-8.562**[1]
Q(6)	9.763	4.864	5.359	1.413	6.781	0.093
Q(12)	15.598	18.053	11.388	17.804	13.728	0.254
ADF-τ	-8.598**[1]	-4.599**[4]	-9.191**[1]	-8.002**[2]	-9.630**[1]	-8.612**[1]
Q(6)	7.187	1.119	6.156	1.304	7.401	0.313
Q(12)	9.940	16.120	11.870	18.095	14.102	0.834
B. Persistence						
AR(1)	0.128	0.114	0.022	0.173#	-0.039	0.067
	(0.111)	(0.108)	(0.109)	(0.103)	(0.108)	(0.108)
AR(2)	0.078	-	-	-0.191#	-	-
	(0.111)			(0.100)		
AR(3)	-0.125					
	(0.111)					
AR(4)	0.226*					
	(0.111)					
Adjusted R^2	0.028	0.001	-0.011	0.038	-0.010	-0.007
C. Trends in annual absolute averages						
Individual	-0.228	-1.805	-1.233	0.134	-0.954	-1.959
	(0.153)	(1.268)	(1.994)	(0.167)	(1.401)	(4.408)
Group	-		-0.968		-1.405	
			(0.858)		(11.291)	
Common			-0.668			
			(4.406)			

Notes: Results on the properties of real interest differentials are presented. The economy-pairs are labeled in the first row. China is the reference country. Panel A gives the ADF τ and ADF μ unit root test results. Levels of significance are determined using finite sample critical values (Cheung and Lai, 1995). Figures in square brackets are lag parameters selected by the Bayesian information criterion. Q(6) and Q(12) are the Box-Ljung Q-statistics based on the first six and twelve autocorrelations of the estimated residuals. Panel B gives the persistence of real interest differentials estimated from equation (9). Panel C gives the common and economy-pair (individual) specific trend estimates of the annual average of absolute relative purchasing power parity differentials (equation (11)). Estimates involving the Korea-China pair incorporate a dummy variable for 1997. Robust standard errors are reported in parentheses underneath coefficient estimates. Significance at the 1%, 5% and 10% levels are indicated by "**," "*" and "#," respectively.

real integration between the three economies in the long run.

The results in Panel B are quite different from the corresponding panels in the two preceding tables. The coefficient estimates of the lagged deviation from relative purchasing power parity are small and insignificantly different from zero, except in the cases of the HK-China and U.S.-China pairs. Thus, if the information set is restricted to lagged relative purchasing power parity deviations, $(\pi_{t+k} - \pi^*_{t+k} - \Delta s_{t+k})$ is a random series. The result is supportive of the efficient market purchasing power parity in Roll (1979), which postulates $\{\pi^e_{+kt} - \pi^{e*}_{t+k} - \Delta s^e_{t+k}\}$ is a zero mean random series.[22]

The results in Panel C of Table 4 are based on fitting absolute relative purchasing power differentials to equation (11). There is little evidence of a decrease in the magnitude of relative purchasing power deviations. Even though the trends are negative, none of the estimates are statistically significant. Again, the results are in contrast with the corresponding ones in Tables 2 and 3, which find substantial evidence of diminishing deviation from the two interest parities. Note, however, that China opened its goods and services markets, albeit in a gradual fashion, long before launching financial reforms in the late 1990s. It is possible that the magnitude of relative purchasing power deviations declined before the current sample period and, hence, does not manifest itself in a declining trend in recent years.

To entertain the possibility that the substantial real integration occurred before 1996, we repeat the exercise using monthly data from January 1983 to December 2002 and report the results in Table 5. For the extended sample, the common trend estimate is -0.266 with a standard error 0.281. This result implies that, for the extended sample, the magnitude of relative purchasing power deviations *is* decreasing. For the economy-pair specific time trends, only the two for the pairs involving Hong Kong and the U.S. are negative and statistically significant. The estimate of the Hong Kong-China pair time trend is -1.104 and for the U.S.-China pair, -0.879. On the first count, the results are consistent with the observation that due to its special political and economic status, Hong Kong is better positioned to integrate with China.[23] On the

22) It may be that the serial correlation is easier to detect when exchange rates are fixed, and exchange rate variability is therefore zero.

23) See related discussions in Ha and Fan (2002) and Shellekens (2002).

<Table 5> Deviations from Relative Purchasing Power Parity: 1983-2003

	Hong Kong	Taiwan	Singapore	U.S.	Japan	Korea
A. Unit root test statistics						
ADF-μ	-5.152*[4]	-6.073*[3]	-12.660*[1]	-6.661*[2]	-9.451*[2]	-14.373*[1]
Q(6)	1.486	1.977	3.349	5.562	3.650	0.091
Q(12)	17.958	4.130	12.846	17.474	17.915	0.287
ADF-τ	-5.249*[4]	-6.212*[3]	-12.715*[1]	-6.664*[2]	-13.681*[1]	-14.392*[1]
Q(6)	1.494	1.983	2.813	5.531	4.473	0.128
Q(12)	17.362	4.078	11.367	17.409	18.265	0.374
B. Persistence						
AR(1)	0.145*	0.150*	0.200**	0.260**	0.125#	0.076
	(0.064)	(0.063)	(0.063)	(0.062)	(0.064)	(0.064)
AR(2)	0.107#	0.102	-	0.269**	0.072	-
	(0.064)	(0.064)		(0.062)	(0.064)	
AR(3)	0.183**	0.196**	-	-	-	-
	(0.064)	(0.063)				
AR(4)	0.083	-	-	-	-	-
	(0.064)					
Adjusted R^2	0.105	0.084	0.036	0.184	0.015	0.001
C. Trends in annual absolute averages						
Individual	-1.104**	-0.207	-0.234	-0.871**	0.059	0.884
	(0.218)	(0.269)	(0.300)	(0.263)	(0.370)	(0.579)
Group	-		-0.437*		0.448	
			(0.169)		(0.619)	
Common			-0.266			
			(0.281)			

Notes: Results on the properties of real interest differentials are presented. The economy-pairs are labeled in the first row. China is the reference country. Panel A gives the ADFt and ADF unit root test results. Levels of significance are determined using finite sample critical values (Cheung and Lai, 1995). Figures in square brackets are lag parameters selected by the Bayesian information criterion. Q(6) and Q(12) are the Box-Ljung Q-statistics based on the first six and twelve autocorrelations of the estimated residuals. Panel B gives the persistence of real interest differentials estimated from equation (9). Panel C gives the common and economy-pair (individual) specific trend estimates of the annual average of absolute relative purchasing power parity differentials (equation (11)). Estimates involving the Korea-China pair incorporate a dummy variable for 1997. Robust standard errors are reported in parentheses underneath coefficient estimates. Significance at the 1%, 5% and 10% levels are indicated by "**," "*" and "#," respectively.

second, however, it seems that a pegged exchange rate regime is a large contributor to relative PPP holding. Both of the Japan and Korea pairs have positive, but insignificant, trends. Overall, results pertaining to the extended sample and those in Table 4 suggest only limited evidence of real integration between China and the economies of Korea and Japan.

4. Summing Up

The results of testing the parity conditions are summarized in Table 6. All in all, there is evidence that the three parity conditions hold in the long run. The unit root null is rejected for almost all the series and, thus, the deviations from these parities are stationary. Given the short sample considered and the usual concern about the power of unit root tests, the evidence in favor of the three long-run parity conditions is quite strong. However, it would be inappropriate to conclude that the markets are efficient in the sense of UIP holding and Roll's hypothesis. Moreover, the trend is not necessarily such that the deviations are shrinking in absolute value. Hence, it appears that real and financial integration between China and the other economies has not progressed particularly rapidly, relative to what has occurred with respect to Hong Kong, or even the United States.

IV. The Composition of Deviations from Parity Conditions

The variance of a differential series provides a measure of the extent of deviation from a parity condition. For example, consider real interest parity. If the parity condition holds instantaneously, then the real interest differential series will be identically equal to zero. If the parity is subject to large shocks, then the variance of the differential series will be large. Thus, a large differential variance is indicative of substantial deviation from the parity condition. An obvious caveat is that a constant deviation from the parity yields a zero variance for the differential series. While a constant deviation from the parity is rarely observed in data, the caveat raises the possibility that, due to impediments to capital flows including formal barriers and transaction costs, the parity condition may not hold exactly in reality. The impediments can create a zone in which it is not feasible for arbitrage to restore the parity. Under such circumstances, the observed differential series does not have a zero mean and its variance

<Table 6> Summary of the Parity Conditions

	HongKong	Taiwan	Singapore	U.S.	Japan	Korea
A. Real Interest Parity						
Stationarity	yes	yes	yes	yes	yes	Yes
Short-Run Persistence	yes	yes	yes	yes	yes	Yes
Declining Trend - individual	yes	yes	yes	yes	yes	No
- group			yes		yes	
- common			yes			
B. Uncovered Interest Parity						
Stationarity	yes[1]	yes	yes	yes[1]	yes	yes
Short-Run Persistence	yes	yes	no	yes	no	no
Declining Trend - individual	yes	no	no	yes	no	no
- group			no		no	
- common			No			
C. Relative PPP						
Stationarity	yes	yes	yes	yes	yes	yes
Short-Run Persistence	yes	no	no	yes	no	no
Declining Trend - individual	yes[2]	no	no	yes[2]	no	no
- group			yes[2]		no	
- common			no			

Note: The table summarizes the test results reported in Tables 2, 3, 4, and 5. The rows labeled "Stationarity," "Short-Run Persistence" and "Declining Trend" correspond to the "Unit root test statistics," "Persistence" and "Trends in absolute annual averages" presented in the preceding tables.
1. The test result with a 1997 dummy variable.
2. The result based on the extended sample discussed in the text

can be interpreted as a measure of deviation from parity allowing for impediments to capital flows.

The use of the variance of differential series offers a direct way to assess the components of disparity. In the case of real interest parity, the variance of real interest differential can be equivalently written as

$$Var(r_t^k - r_t^{k*}) \equiv Var(i_t^k - i_t^{k*} - \Delta s_{t+k}) + Var(\pi_{t+k} - \pi_{t+k}^* - \Delta s_{t+k}) - 2Cov(i_t^k - i_t^{k*} - \Delta s_{t+k},\ \pi_{t+k} - \pi_{t+k}^* - \Delta s_{t+k}). \quad (12)$$

The intensity of deviation from real interest parity depends on the extent of financial and real disintegration and the comovement between deviations from uncovered interest parity and relative purchasing power parity. The decomposition of $Var(r_t^k - r_t^{k*})$ using actual data can pinpoint whether it is the barriers in financial markets or in goods markets that cause the failure to equalize real interest rates.

The variances are reported in Table 7. In the first row, the real interest differential between Singapore and China has the smallest standard deviation while the one between Taiwan and China has the largest variance.[24] Turning to the second and third rows, respectively, one finds that the relative contributions of uncovered interest disparity and relative purchasing power disparity are quite different across the various economy-pairs. The UID standard deviations are smallest for the economy-pairs involving pegged exchange rate regimes—Hong Kong/China and U.S./China. For these two cases, it is also true that UID variability is smaller than RPD variability, suggesting that real integration is less than financial integration in these two instances.[25]

For the other pairs involving managed floating exchange rate regimes the ratio of the UID and RPD variabilities is about 1:1. One is

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24) This outcome, which is unrelated to exchange rate surprises, is not entirely unexpected. Despite ongoing reductions in trade and financial barriers (Ma *et al.*, 2002), substantial formal and informal restrictions remain.

25) The results of the decomposition reflect the exchange rate arrangements of these economies. During the sample period, both Hong Kong and China effectively pegged their currencies to the U.S. dollar, while the other exchange rates are, relatively speaking, more flexible. The Korea-China exchange rate was also stable up to the crisis of 1997.

<Table 7> Decomposition of Parity Differential Variances

	Hong Kong	Taiwan	Singapore	U.S.	Japan	Korea
A. Var(RID)	78.686	109.083	36.286	37.896	41.049	52.423
Var(UID)	12.735	644.686	701.033	12.289	1592.247	2045.372
Var(RPD)	52.433	715.194	651.896	34.826	1616.006	2066.899
Cor.(UID, RPD)	-0.261	0.921	0.973	0.222	0.987	0.987
B. Var(UID)	12.735	644.683	701.033	12.289	1592.247	2045.372
Var(i-i^*)	11.937	8.177	9.633	11.544	13.164	8.450
Var(Δs)	0.870	628.218	674.725	0.193	1531.110	2055.344
Cor.(i-i^*,Δs)	0.011	-0.057	-0.103	-0.184	-0.168	0.069
C. Var(RPD)	52.433	715.194	651.896	34.826	1616.006	2066.89
Var(Δp-Δp^*)	52.371	105.475	32.225	34.884	32.784	47.372
Var(Δs)	0.870	628.218	674.725	0.193	1531.110	2055.344
Cor.(Δp-Δp^*,Δs)	0.059	0.035	0.186	0.048	-0.116	0.057

Notes: The economy-pairs are labeled in the first row. China is the reference country.For Korea, the sample excludes 1997 observations due to an unusual scale of movements driven by the financial crisis. Panel A gives the variance of real interest differentials and its components according to $Var(r_t^k - r_t^{k*}) \equiv Var(i_t^k - i_t^{k*} - \Delta s_{t+k}) + Var(\pi_{t+k} - \pi_{t+k}^* - \Delta s_{t+k}) - 2Cov(i_t^k - i_t^{k*} - \Delta s_{t+k}, \pi_{t+k} - \pi_{t+k}^* - \Delta s_{t+k})$. "Var(RID)" gives, $Var(r_t^k - r_t^{k*})$ "Var(UID)" gives, $Var(i_t^k - i_t^{k*} - \Delta s_{t+k})$ "Var(RPD)" gives $Var(\pi_{t,k} - \pi_{t,k}^* - \Delta s_{t,k})$, and "Cor(UID, RPD)" gives the correlations between $(i_t^k - i_t^{k*} - \Delta s_{t+k})$ and $(\pi_{t,k} - \pi_{t,k}^* - \Delta s_{t,k})$.

Panel B gives the variance of uncovered interest differentials and its components according to $Var(i_t^k - i_t^{k*} - \Delta s_{t+k}) \equiv Var(r_t^k - r_t^{k*}) + Var(\Delta s_{t+k}) - 2Cov(i_t^k - i_t^{k*} - \Delta s_{t+k})$. Similarly, Panel C gives the variance of relative purchasing power parity differentials and its components according to $Var(\pi_{t+k} - \pi_{t+k}^* - \Delta s_{t+k}) \equiv Var(\pi_{t+k} - \pi_{t+k}^*) + Var(\Delta s_{t+k}) - 2Cov(\pi_{t+k} - \pi_{t+k}^*, \Delta s_{t+k})$. The definitions of labels in Panels B and C are similar to those in Panel A.

tempted to say that this means that the levels of financial and real integration are about the same, but because the exchange rate change enters both terms, it may be that this factor swamps the others so we

cannot tell in which market the impediments are most pronounced. We report the correlation coefficient between UID and RPD in the fourth row of Table 6. Correlations near unity indicate that the offsetting comovement between relative purchasing power and uncovered interest differentials that allows for a much smaller variability of real interest differentials than the corresponding UID and RPD variability.[26]

By the same token, the variances of uncovered interest and relative purchasing power differentials can be expressed as

$$Var(i_t^k - i_t^{k*} - \Delta s_{t+k}) \equiv Var(i_t^k - i_t^{k*}) + Var(\Delta s_{t+k}) - 2Cov(i_t^k - i_t^{k*}, \Delta s_{t+k}) \quad (13)$$

and

$$Var(\pi_{t+k} - \pi_{t+k}^* - \Delta s_{t+k}) \equiv Var(\pi_{t+k} - \pi_{t+k}^*) + Var(\Delta s_{t+k}) - 2Cov(\pi_{t+k} - \pi_{t+k}^*, \Delta s_{t+k}). \quad (14)$$

Using equations (13) and (14), we can assess the relative roles of nominal interest rates, exchange rate changes, relative inflation rates and their comovements on deviations from financial and real parity conditions. These decomposition results are also reported in Table 7. Without over-emphasizing the relevance of exchange rate arrangements, the decomposition results reflect the impact of exchange rate volatility on UID and RPD. In the case of Hong Kong and the U.S., which have *de facto* pegged exchange rates with China, exchange rate variability accounts for only a small portion of UID and RPD. For the other economies, exchange rate variability dominates the variances of uncovered interest and relative purchasing power differentials.

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26) The case of the Korea-China pair merits some discussion. If the 1997 data are included, the variances of the UID and RPD so radically exceed that of RID that it is clear that the currency crisis Korea experienced in 1997-98 complicates the assessment of integration. In particular, the presence of discrete events like this makes the time series process for Korea non-ergodic.

V. Concluding Remarks

In this study, we have examined the behavior of exchange rates, interest rates and prices in order to assess both the degree and trend of economic integration. Clearly, there are alternative approaches, including i) direct measurement of trade flows, ii) comparison of yields on similar assets—for instance equities—in different economies and iii) evaluating the correlation of (output) shocks across economies and the relative contributions of common and economy-specific shocks to output variations. While the pursuit of these alternative approaches is beyond the scope of this paper, it is our belief that these approaches complement the insights we have obtained. One future research topic is to identify and investigate the factors that are driving the integration process.[27]

We have obtained one key finding: According to these parity conditions, the degree of integration between China and Japan and China and Korea is not particularly high relative to other regional economies. A caveat is necessary, to the extent that the underlying relationship between China and Korea is obscured by the 1997/98 financial crisis despite our exclusion of 1997 data. As for the Japan-China link, it may be that the extraordinary macroeconomic and microeconomic conditions prevailing in Japan may have distorted relative prices. For instance, the zero interest bound on interest rates in that country means that the standard Fisherian relationship that underpins real interest parity may not hold. If Japanese policymakers are able to reverse the process of deflation, then we may find the conclusions regarding integration change drastically.

We also find that in all instances, the parity conditions hold in the long run, in the sense that deviations from parity are stationary. Moreover, the magnitude of the deviations has been shrinking over the past seven years, although the trend is not statistically significant in several cases. Even though the statistical results offer some evidence of integration, we recognize that there are non-negligible restrictions on both physical and financial flows between China and the other economies.

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27) We undertake a preliminary analysis for a subset of these economies in Cheung *et al.* (2003b). We relate deviations to capital account restrictions and trade barriers, as well as macro uncertainty.

We conclude that the evidence is ambiguous regarding the viability of a common currency area involving China, Japan and Korea. Our uncertainty is further elevated by the fact that accelerated trade liberalization will necessarily alter the measured extent of integration. On the other hand, our findings imply that these economies have considerable scope for the managing exchange rates and interest rates, at least in the short run.

Data Appendix

The data are collected from a few sources—Bloomberg Financial Services, CEIC database, International Financial Statistics, the Hong Kong Monetary Authority, and the Bank of Korea. The interest and exchange rates are end-of-month figures. The monthly series retrieved from Bloomberg is the China one-month interbank offer rate. The monthly series retrieved from CEIC are the Hong Kong one-month interbank offer rate, the Taiwan one-month interbank offer rate, the Taiwan-U.S. exchange rate, the Hong Kong consumer price index and the Taiwan consumer price index. The Taiwan interest rate is the middle rate given by a simple average of the high and low rates.

The Korean one-month interest rate used in this study is implicitly derived from the 91-day CD rate available from the Bank of Korea according to the following method. Assuming rational expectations under term structures, we equate a return on a three-month rate with a three-month return on a one month instrument so that $(1+\frac{91}{360}\tilde{r}) = (1+\frac{30}{360}r)^3$, where $\tilde{r}$ is the three-month rate and r is the one-month rate. Substituting the 91-day CD rate into $\tilde{r}$, we solve for r.

The monthly exchange rate series from *International Financial Statistics* are dollar-based exchange rates of Hong Kong dollar and Chinese yuan. The Hong Kong Monetary Authority provided the China consumer price series.

The sample period is from February 1996 to May or June 2003. The X-12 routine (with multiplicative factors on the levels) was used to seasonally adjust all the price series. In the case of China, the X-12 routine was applied to three different subsamples. The Japanese CPI series also had an adjustment for the imposition of new taxes in April 1997.

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