Accounting for Real Exchange Rate Changes in East Asia

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Abstract

This study measures the proportion of real exchange rate movements that can be accounted for by movements in the relative price of non-traded goods among 21 bilateral Asian-Pacific real exchange rates. Following Engel (1999), the decomposition is done at all possible horizons that the data allow - from one month up to 25 years. Evidence presented here is consistent with that from OECD countries. In particular, relative prices of non-traded goods appear to account for virtually none of the movement of Pacific-Rim real exchange rates. This pattern appears unaffected by the cross-sectional variation in either income level, or the degree of openness present among these Pacific-Rim economies. The only exception to these findings occurs when we examine fixed (or semi-fixed) exchange rate regimes separately. However, the one exception (the Hong Kong dollar) is anomalous compared to other managed currencies within the sample, and to the recent findings of Mendoza (2000).

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1. Introduction

The aim of this study is to provide an accounting of real exchange rate movements among six small, open, and generally fast growing Asian-Pacific economies. The primary motivation for this exercise is recent compelling evidence presented in Engel (1999). For a sample of high-income countries, he shows that over the past thirty years, movements in relative prices of non-traded goods appear to account for essentially none of the movements in his sample of U.S. based real exchange rates. That is, movements in aggregate real exchange rates overwhelmingly reflect deviations from purchasing power parity among traded goods.

This evidence stands in stark contrast to the implications of standard theoretical models employed to explain long-term real exchange rate movements based primarily on Balassa (1964) and Samuelson (1964). In these models, Purchasing Power Parity is assumed to hold for traded goods, hence movement in non-traded goods prices become a primary driver of real exchange rates, especially at medium to longer-term horizons. The intuition is straightforward; faster productivity growth in traded goods sectors within an economy bids up wages in both traded and non-traded sectors. As a consequence, domestic inflation rises and the country experiences a real appreciation, assuming no offsetting movement in the nominal exchange rate or foreign prices. Movements in the international relative price of traded goods play no role in this model. Indeed, as emphasized by Obstfeld and Rogoff (2000), a role for relative traded goods prices in real exchange rate determination is absent in most standard theories.

Despite the striking nature of Engel's (1999) results, there are several *a priori* reasons we might expect his conclusions to not reflect the experience of smaller, more open, and faster growing economies. First, many of the economies considered in this study have experienced sustained high rates of economic growth - often accompanied by high rates of productivity change. It is at least plausible that wide movements in the relative price of non-traded goods have accompanied these high rates of growth. Second, several of these economies have pegged their exchange rates to the U.S. dollar for extended periods (e.g., Hong Kong 1983-present, Thailand 1990-97), thus precluding nominal exchange rate adjustment. Third, these economies are generally more reliant on external trade than the high-income industrial countries often studied. And finally, there are wide disparities in income levels among these economies. This latter feature is a crucial aspect of the Balassa-Samuelson hypothesis, since in that model movements in real exchange rates will be driven by differences across economies.

The importance of distinguishing between traded and non-traded goods price movements can be easily conveyed. Express the (log) aggregate price index as a weighted-average of traded (T), and non-traded (N) goods prices, i.e.,

$p = (1-\alpha)p^T + \alpha p^N$, for the domestic country and,
$p^* = (1-\beta)p^{T*} + \beta p^{N*}$ for the foreign country.

Then the real exchange rate, $q = s + p^* - p$, may be written as the sum of the relative price of traded goods (x), and the relative-relative price of non-traded goods (y).

$$q = s + p^{T*} - p^T + \beta\left(p^{N*} - p^{T*}\right) - \alpha\left(p^N - p^T\right) \equiv x + y \tag{1}$$

where : $x = s + p^{T*} - p^T$, and $y = \beta\left(p^{N*} - p^{T*}\right) - \alpha\left(p^N - p^T\right)$.

Thus differences across countries in *internal* relative prices impact the real exchange rate even in the absence of nominal exchange rate changes. As a concrete example, the real appreciation of the yen over the 1975-1995 period is generally associated with the relatively faster output growth in Japan (e.g., Kakkar and Ogaki, 1999, or Krugman and Obstfeld, 1999). However, what this decomposition emphasizes is that the domestic relative price of non-traded goods is only part of y. For it to have an impact on real exchange rate movements, the foreign relative price of non-traded goods must not move similarly.

Recent studies that have focused on the importance of relative non-traded goods prices in real exchange rate determination have had mixed results. Chinn (1996) finds some East Asian real exchange rates (Japan, Korea, the Philippines, and Singapore) do appear cointegrated with relative prices, while others (China, Indonesia, and Thailand) do not. For OECD countries, Canzoneri, Cumby, and Diba (1999) find mixed evidence for cointegration between real exchange rates and relative prices. Kakkar and Ogaki (1999) also find mixed results for the U.S., Japan, the U.K., and Canada. More recently, Chinn and Johnston (1999) and Strauss (1999) find somewhat stronger support for this linkage among OECD countries.

This study takes a different approach. In this paper we ask how much of the variation in the real exchange rate is accounted for by variation in x and by variation in y, separately. That is, we do not directly examine whether Purchasing Power Parity (PPP) holds or fails, nor do we ask whether the real exchange rate (q), and relative prices (y), are cointegrated. There are several reasons for this. First, q and y may be cointegrated, but x may still be an economically significant driver of the real exchange rate. Second, tests for PPP and for cointegration often hinge on specific properties of econometric estimators. The approach followed in this paper is simply an accounting exercise - we want to know (historically) how much of the movements in q can be attributed to movements in y as compared to x. Finally, a major goal of this paper is to study the properties of non-G7, non-OECD real exchange rates.[1] The economic circumstances experienced by the set of currencies studied here have in many ways been very different than those outside East Asia.

Table 1 presents some summary data comparing the sample in this study to that analyzed by Engel (1999). In the first column annual average real GDP growth since 1975 is presented. The economies in the upper panel have (with the exception of Malaysia) generally doubled the growth performance of the higher income economies in Engel's sample. In the second column note that income levels, as measured by real per-capita GDP, are on average barely half those in Engel's study. Finally, openness - as measured by the sum of exports and imports relative to GDP - is given in column 3. As noted above, the Asian-Pacific economies are generally more open. Thus, the 'structural' aspects of the current sample are arguably more conducive to a Balssa-Samuelson analysis of real exchange rate movements. It would be misleading to claim these implicit criticisms are novel - indeed, Engel discusses them briefly in his conclusion.

We follow Engel (1999), and report the proportion of real exchange rate movements that can be accounted for by movements in the relative price of non-traded goods for each bilateral currency pair. The decomposition is done at all possible horizons that the data allow - from one month up to 25 years. Perhaps surprisingly, the evidence presented here is consistent with that from high-income U.S. based real exchange rates. In particular, relative prices of non-traded goods appear to account for virtually none of the movement of Pacific-Rim real exchange rates. This pattern appears unaffected by the cross-sectional variation in either income level, or the degree of openness present among these Pacific-Rim economies. The only exception to these findings occurs when we examine fixed (or semi-fixed) exchange rate regimes separately. However, the one exception (the Hong Kong dollar) is anomalous compared to other managed currencies within the sample, and to the recent findings of Mendoza (2000).

1 One of the countries studied here (South Korea) became an OECD member in 1996, mid-way through the sample.

2. Traded and Non-Traded Price Indexes

The first step in the decomposition of real exchange rate movements is constructing traded and non-traded price indexes. This study uses consumer price index data from six Asia-Pacific countries: Hong Kong, Korea, Malaysia, Singapore, Taiwan, Thailand; and the United States, to construct measures of traded and non-traded goods prices for each country.[2] One advantage of obtaining data from higher income countries is that there is more data, and often of better quality. Hence, Engel (1999) was able to construct (and decompose) five separate measures of real exchange rates - using consumer prices, producer prices, etc. His findings were robust to all measures. Additionally, in a related exercise, Isard and Symansky (1996) construct three annual measures of real exchange rates for each of the economies studied here. Again, these authors find their conclusions robust to the alternative measures. Given these findings, we will focus exclusively on consumer prices in this study.

As in Engel (1999), geometric weights for major components of the "all items" series were estimated from logarithmic regressions of the form

$$\Delta(\text{cpi} - \text{rent}) = \sum_i \phi_i \Delta(\text{traded}_i - \text{rent}) + \sum_j \phi_j \Delta\left(\text{services}_j - \text{rent}\right) + \varepsilon ,$$

where, cpi = cpi_all items, rent = cpi_rent, etc., and the geometric weight for rent is computed residually as: $1 - \sum_i \phi_i - \sum_j \phi_j$.[3] For each currency, the number of separate components of traded goods, and non-traded goods varies (between one and three) according to the data available.

Then the traded and non-traded price indexes are computed as

$$p^T = \frac{1}{1-\alpha} \sum_i \phi_i \,\text{traded}_i \quad \text{and,}$$

$$p^N = \frac{1}{1-\beta} \sum_j \phi_j \,\text{service}_j \ .$$

Where $1-\beta = \sum_j \phi_j \,\text{service}_j$ and, $1-\alpha = \sum_i \phi_i \,\text{traded}_i$.

In general, traded goods price indexes consist of each country's aggregate "goods" components of the CPI, while the non-traded goods price indexes consist of the services and rent components. Wherever possible, the non-traded price indexes exclude obvious traded goods components, e.g., rent, excluding fuel and power. In the end, these remain imperfect measures. However, results in Engel (1999) suggest effects of such mismeasurement are not serious for accounting purposes. This conclusion is based on several robustness checks. First, in his study he presents results using five different measures of traded and non-traded goods prices. Second, he examines one case in detail (Japan), for which data on marketing services is available. And finally, he explicitly examines the size of the bias on his estimates of α and β. In all cases, his conclusions remain the same.

2 The choice of countries was dictated by data availability. The countries studied are all of the countries available in the CEIC database.

3 Appendix 1 lists the CPI sub-indexes used and the range of available data for each economy examined. Nominal exchange rates as well as CPI data are taken from the CEIC database. This equation assumes geometric weighting for price indexes.

The next step is to construct the real exchange rates and the traded and non-traded components, x and y (in equation 1). In this study we can construct 21 real exchange rates - six bilateral U.S. real exchange rates plus 15 cross-rates. Appendix Figures 1 and 2 plot the nominal and real exchange rates separately. Two aspects of Appendix Figure 1 are notable. First, the reaction to the recent currency crisis (1997-98) was varied, with some nominal exchange rates (e.g., the HK dollar/U.S. dollar, and the Singapore dollar/ Taiwan dollar) remaining relatively stable. And related, the response does not merely depend on the particular institutional exchange rate arrangement. Appendix Figure 2 reveals some cases of extended trend movements as well as the relatively large real exchange rate movements associated with the recent crisis.

The focus of this study is on accounting for the movements in Appendix Figure 2. In particular, we wish to attribute shares of the historical movement in real exchange rates to movements in traded goods prices (x), and non-traded goods prices (y). It is to this that we now turn.

3. Accounting for Real Exchange Rates

Movements in the real exchange rate q may be due to movements in (i) the trend (drift), (ii) the variance, or comprehensively (iii) the mean squared error. In each case we will decompose movements into those attributable to traded goods (x, in equation 1), and those attributable to non-traded goods (y, in equation 1). We proceed sequentially.

a. The drift in the real exchange rate

The average one-month drift in the real exchange rate is equal to

$\overline{\Delta} q = \frac{1}{N-1}\left(\sum_{t=2}^{N} (q_t - q_{t-1}) \right)$. Then, the average n-month drift is simply $n\overline{\Delta} q$.

The time dimension is relevant since some theories may relate to the 'short run', while others concern longer run movements. In this study, we consider all possible horizons (i.e., one month to n months) that the data allow. For the data examined here, the maximum value of n varies by country-pair. For the bilateral South Korea-U.S. real exchange rate, the longest n-period drift is 303 months, i.e., slightly more than 25 years. For country pairs involving Malaysia and Thailand we have considerably less data, only 123 months.

Since the drift may be positive or negative, and thus potentially offsetting, we focus on the mean squared drift, $n^2\overline{\Delta q}^2$. The question we are interested in is how much of the squared drift in the real exchange rate is attributable to x? Using equation (1), we have:

$$\text{Traded goods share of n-period drift} = \frac{n^2\overline{\Delta x}^2}{n^2\overline{\Delta x}^2 + n^2\overline{\Delta y}^2}. \qquad (2)$$

Table 2 presents this drift decomposition for each of the 21 bilateral real exchange rates.[4] First, note that the fraction of the drift attributable to the traded goods component varies considerably. In 13 out of the 21 cases, drift in the relative price of traded goods accounts for virtually all (more than 80%) of the drift in the real exchange rate. This is striking and essentially reproduces Engel's results. However, there are exceptions. First, the two anomalous bilateral U.S. cases - Hong Kong, and Singapore - are simultaneously the most open, richest, and among the fastest growing. Beyond this it is difficult to make generalizations. In the cases of the HK dollar/Thai baht and Malaysian ringgit/Singapore dollar, variations in y appear very important indeed.

Thus, for most of the bilateral pairs studied, there is substantial evidence that drift in relative traded goods prices contributes significantly to the drift in real exchange rates we have observed. This implies substantial market segmentation among the economies studied - despite the relative importance of imports and exports in these economies. However, for about one-third of the bilateral real exchange rates we study, movements in the drift in non-traded goods prices has contributed as much or more to the overall drift in real exchange rates in the region as has the drift in relative traded goods prices. This evidence is new; however prior to interpretation we need a measure of how much of the total variation in exchange rates can be attributed to the drift. In order to address this we must first consider the second component of the variation in real exchange rates. We come back to the issue of the contribution of drift to total variation in section 3d below.

4 For this and all subsequent decompositions, we assume the cov(x_t-x_{t-n}, y_t-y_{t-n}) = 0. Appendix 2 presents the average (across all horizons) covariance for all 21 exchange rates. These covariances are indeed close to zero.

b. The variance of the real exchange rate

A second aspect of real exchange rate movement is its variance. We can consider the fraction of the n-period variance accounted for by x. As discussed by Engel (1999), the n-period sample variance has extreme small-sample bias for large n. Thus we follow Engel and adopt the (small sample, unbiased) measure proposed by Cochrane (1988):

$$\mathrm{var}(q_t - q_{t-n}) = \frac{N}{(N-n-1)(N-n)} \sum_{j=1}^{N-n} \left(q_{j+n} - q_j - n\overline{\Delta q}\right)^2$$

Then, the fraction of the $\mathrm{var}(q_t - q_{t-n})$ accounted for by $\mathrm{var}(x_t - x_{t-n})$ is:

$$\text{Traded goods share of n-period variance} = \frac{\mathrm{var}(x_t - x_{t-n})}{\mathrm{var}(x_t - x_{t-n}) + \mathrm{var}(y_t - y_{t-n})} \tag{3}$$

Figure 1 presents these decompositions graphically for all 21 real exchange rates. Note that the horizontal axis measures the horizon. Here the message is stronger. In virtually all cases, at all horizons, variation in traded goods prices is essentially 100% of the variation in the real exchange rate. This is precisely the result Engel (1999) found for his industrial country sample. The only movement (in the panels of Figure 1) away from 100% are at the very long horizons. First, very few observations are used in the calculations, and thus the potential for single influential observations becomes greater. Second, at these longer horizons, the impact of the 1997-98 crisis becomes more important, since it is included in more and more of the sample data points. Hence, to the extent the 1997-98 crisis represented an ‘unusual’ event we might plausibly put less weight on it. Finally, even in the cases with the fewest observations, the message is that at horizons out to eight years essentially all of the variation in the real exchange rate comes from variation in traded goods prices. We next turn to a comprehensive measure of real exchange rate variation.

c. The mean squared error of the real exchange rate

The mean squared error is the sum of drift and variance components. Hence the decomposition of the mean squared error (MSE) is:

$$\text{Traded goods share of n-period MSE} = \frac{MSE(x_t - x_{t-n})}{MSE(x_t - x_{t-n}) + MSE(y_t - y_{t-n})} \tag{4}$$

Figure 2 presents these decompositions. The message from Figure 2 is exactly the same as from the variance decompositions, i.e., virtually 100% of the total variation (MSE) of the 21 real exchange rates we consider is contributed by variation in traded goods prices. This is true at all horizons the data allow, from one month to over 25 years. The Malaysian ringgit represents a possible exception to the above generalizations. That is, at horizons above 100 months, the importance of variation in x drops off precipitously relative to total variation in q. However note two things. First, one should not overlook that prior to the eighth year, variation in the real ringgit is almost completely determined by variation in traded goods prices. Second, note that the importance of variation in x remains above 50% for all but one horizon out to the maximum of 118 months. Finally, and more generally, note that these conclusions do not seem to vary systematically with the cross-sectional variation in openness, income level, or (nominal) exchange rate regime.

These results should come as a surprise. If PPP held, x should be a constant and therefore contribute nothing to an explanation of variations in the real exchange rate. A primary motivation for examining the East Asian currencies in this study was an apparent difference in the economic conditions and experiences of these economies as compared to the experience of high-income, moderately growing economies previously examined. Yet we conclude that even in this special case, the data offers very little support for any of the theories of real exchange rate behavior that rely on variation in relative non-traded goods prices. We make several further attempts at reconciling these results before concluding.

d. Reconciliation

An outstanding issue discussed above relates to the contribution of the drift in overall real exchange rate variation. According to Table 2, a substantial part of the drift in the real exchange rate could, for a third of the real exchange rates examined, be attributed to drift in relative non-traded goods prices. Yet, according to Figure 2, virtually 100% of the total variation in the real exchange rate (as measured by the MSE) was due to variation in relative traded goods prices. For these two observations to be true, it must be the case that the drift accounts for a relatively small part of the total variation in real exchange rates. Table 3 presents one relevant summary statistic: the average drift contribution to the MSE for each exchange rate. The data support the conjecture - the maximum contribution of the drift is 18% for the Korean won/U.S. dollar real exchange rate, and except for two other cases, this contribution is always in single digits. Hence, we conclude that variation in the drift in relative non-traded goods prices is generally only trivially relevant to total variation in real exchange rates.

Another issue noted in the introduction is the role of fixed exchange rates. Under flexible exchange rates, the variability of the exchange rate could swamp variability in the two national currency traded goods price indexes. Thus, the dominance of the traded goods component of the real exchange rate would be driven by variability in the nominal exchange rate. In fixed exchange rate regimes, this cannot be the case. Hence, it would indeed be surprising if traded goods prices were necessarily more variable, and thus were always the dominant driver of real exchange rates.

To isolate the impact of fixed (or nearly fixed) exchange rates, we look at the three cases of fixed, or semi-fixed exchange rates in our sample, i.e., the Hong Kong dollar, the Malaysian ringgit, and the Thai baht. In particular, we focus on the Hong Kong dollar from 1983:10 to the present, on the Malaysian ringgit from 1990:01 to 1997:05, and on the Thai baht from 1990:01 to 1997:06. Only the Hong Kong dollar maintained a true peg; the ringgit and baht varied within fairly narrow bounds. The top panel of Figure 3 presents the variance decompositions (i.e., the fraction of the variance in the real exchange rate accounted for by variance in traded goods). The bottom panel plots the MSE decompositions (i.e., the fraction of the total variation in the real exchange rate accounted for by MSE of traded goods).

There is another reason to examine the fixed exchange rate cases separately. In a related study, Mendoza (2000) finds that variability in the relative price of non-tradable goods accounts for up to 70% of the variability of the peso-dollar real exchange rate during periods in which Mexico had a managed exchange rate regime. Figure 3 presents the most evidence yet for the importance of variation in non-traded goods prices in real exchange rate movements. But even here, the evidence is not unanimous. For the Hong Kong dollar, variation in the relative price of non-traded goods approaches 50% (of the MSE) at six-year horizons, but at longer horizons (to 17 years) declines back to 25%. However, note that even in this case, non-traded goods prices never approach the 70% found by Mendoza (2000), and the maximum effect for the Hong Kong dollar occurs at much longer horizons than for the peso (six years versus six months). Moreover the U-shaped pattern exhibited by the Hong Kong dollar in Figure 3 is not matched by either the Thai or Malaysian currencies. Finally, for the ringgit, at horizons exceeding eight years the importance of variation in traded goods prices (x) declines to roughly 75%, but for the baht there is only a slight decline. Thus, Mendoza's results regarding the importance of managed exchange rates do not readily generalize, suggesting that fixing the nominal exchange rate may be necessary, but by no means sufficient for reducing the importance of variation in traded goods prices in real exchange rate variation.

A final question is what has happened to the components of the relative-relative price, y. That is, it is widely believed that some economies in the region have witnessed wide relative price changes. Why haven't these translated into real exchange rate changes? The answer is provided by the definition of y. As noted above, changes in the relative price of non-traded goods across countries must not be 'similar' if such movements are to be reflected in the real exchange rate. Figure 4 presents graphs of $\left(p^N - p^T\right)$ and $\left(p^{N*} - p^{T*}\right)$ for all 21 bilateral pairs. What is most often the case in the plots is that $\left(p^N - p^T\right)$ and $\left(p^{N*} - p^{T*}\right)$ move together. Thus their difference (weighted) tends to zero, which makes the contribution of internal relative prices less important in the overall decomposition. There are some exceptions. Notably, Hong Kong internal relative prices have moved much more than have those in the U.S. However, this is reflected in the MSE decomposition for the HK/U.S. real exchange rate. In the first panel in Figure 2 the curve begins near 100% and drops to about 80% before beginning to rise toward 100% again. This is one of the most pronounced movements in all the figures. However, since the curve remains near 100% overall, it must be the case that variation in traded goods prices dwarfs this internal price difference. More puzzling in Figure 4 is the movement of internal relative prices in Thailand. Between roughly 1994 and 1998, internal relative prices in Thailand moved (generally) opposite those in each of the six bilateral pairs presented.

4. Conclusion

This study examined the proportion of real exchange rate movements that can be attributed to movements in the relative price of non-traded goods among 21 bilateral Asian-Pacific real exchange rates, for as far back historically as the data permits. Three decompositions of real exchange rate movements were examined: drift, variance, and mean squared error. Following Engel (1999), the decomposition is done at all possible horizons that the data allow — from one month up to 25 years.

Evidence presented here is consistent with that from high-income U.S. based real exchange rates. In particular, relative prices of non-traded goods appear to account for virtually none of the movement of Pacific-Rim real exchange rates. This pattern is unaffected by the cross-sectional variation in either income level or the degree of openness present among these Pacific-Rim economies.

The only exception to these results is for the Hong Kong dollar during the recent fixed exchange rate regime. In this case the importance of variation in relative traded goods prices declines from 75% to 50% (at six years) before rising back to 75%. This is reminiscent of the result found by Mendoza (2000) for the Mexican peso under managed exchange rate periods. However, in contrast to his results, the other two pegged, or managed, currencies studied here do not demonstrate this pattern. Moreover, the pattern exhibited by the Hong Kong dollar is more protracted (the maximum impact of non-traded goods relative prices occurs at six years), and is smaller than for the case of the peso. These differences suggest that examining more cases of purely fixed exchange rates in future research may prove fruitful.

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Table 1: Summary Data

	RGDP Growth*	Real Per Capita GDP Relative to the U.S.**	Exports + Imports Per cent of GDP
Hong Kong	6.7	90.6	286
Korea	6.2	42.1	61
Malaysia	3.7	31.0	156
Singapore	7.3	72.1	341
Taiwan	7.6	45.1	89
Thailand	6.1	21.6	77
Average	**6.3**	**42.4**	**145**
Engel's Sample			
Canada	2.8	90.6	54
Denmark	2.3	80.7	66
Finland	2.3	67.3	53
France	2.2	78.5	45
Germany	2.7	87.0	60
Norway	3.3	73.6	79
Japan	2.8	85.8	18
Average	**2.6**	**78.8**	**54**

Sources: International Financial Statistics (column 1), and Summers and Heston, Penn World Tables, version 5.6 (columns 2 and 3).

* RGDP growth is computed as average annual growth, for the longest available period from 1975-1999.

** 1992 values are used except for Korea (1991), and Taiwan (1990).

Table 2: Fraction of Drift in Real Exchange Rate Attributable to Traded Goods (All Horizons)

U.S. Dollar rates	Observations	Traded Goods Component
Hong Kong dollar/U.S. dollar	157	0.512
Korean won/U.S. dollar	301	0.906
Malaysian ringgit/U.S. dollar	121	0.882
Singapore dollar/U.S. dollar	193	0.556
Taiwan dollar/U.S. dollar	229	0.990
Thai baht/U.S. dollar	121	0.906
Cross rates		
Hong Kong dollar/Korean won	229	0.568
Hong Kong dollar/Malaysian ringgit	121	0.844
Hong Kong dollar/Singapore dollar	193	0.999
Hong Kong dollar/Taiwan dollar	229	0.941
Hong Kong dollar/Thai baht	121	0.150
Korean won/Malaysian ringgit	121	0.485
Korean won/Singapore dollar	193	0.836
Korean won/Taiwan dollar	229	0.801
Korean won/Thai baht	121	0.907
Malaysian ringgit/Singapore dollar	121	0.227
Malaysian ringgit/Taiwan dollar	121	0.726
Malaysian ringgit/Thai baht	121	0.849
Singapore dollar/Taiwan dollar	193	0.866
Singapore dollar/Thai baht	121	0.581
Taiwan dollar/Thai baht	121	0.904

Table 3: Average Drift Contribution to MSE of Real Exchange Rates

U.S. Dollar rates	**Drift (x_t+y_t) / MSE (x_t+y_t)**
Hong Kong dollar/U.S. dollar	0.159
Korean won/U.S. dollar	0.184
Malaysian ringgit/U.S. dollar	0.058
Singapore dollar/U.S. dollar	0.060
Taiwan dollar/U.S. dollar	0.074
Thai baht/U.S. dollar	0.052
Cross rates	
Hong Kong dollar/Korean won	0.178
Hong Kong dollar/Malaysian ringgit	0.063
Hong Kong dollar/Singapore dollar	0.039
Hong Kong dollar/Taiwan dollar	0.075
Hong Kong dollar/Thai baht	0.060
Korean won/Malaysian ringgit	0.039
Korean won/Singapore dollar	0.107
Korean won/Taiwan dollar	0.044
Korean won/Thai baht	0.034
Malaysian ringgit/Singapore dollar	0.021
Malaysian ringgit/Taiwan dollar	0.023
Malaysian ringgit/Thai baht	0.014
Singapore dollar/Taiwan dollar	0.088
Singapore dollar/Thai baht	0.027
Taiwan dollar/Thai baht	0.027

Appendix 1: Consumer Price Data

Hong Kong	CPI Housing Rent: private (HIEE)	1981.01 - 2000.03
	CPI Misc Services (HIEL)	
	CPI Durable goods (HIEI)	
	CPI Misc Goods (HIEJ)	
	CPI All items (HIEA)	
Korea	CPI Housing: House Rent (KIAEA)	1975.01 - 2000.03
	CPI Medical Care: Medical Services (KIAPC)	
	CPI Food (KIAB)	
	less CPI Food: Eating Out (KIABK)	
	CPI All items (KIAA)	
Malaysia	CPI Gross Rent, Fuel and Power (MIAF)	1990.01 - 2000.03
	CPI Services (MIAM)	
	CPI Durable Goods (MIAI)	
	CPI Semi-durable Goods (MIAQ)	
	CPI Non Durable Goods (MIAR)	
	CPI All items (MIAA)	
Singapore	CPI Housing: Accommodation (SIKQ)	1984.01 - 2000.01
	CPI Misc: Household Services (SIAYB)	
	CPI: Non Cooked food (SIAC)	
	CPI All items (SIAA)	
Taiwan	CPI Housing (WIAN)	1981.01 - 2000.03
	CPI Services (WIAJ)	
	CPI Commodity Group including food (WIAD)	
	CPI All items (WIAA)	
Thailand	CPI Housing and Furnishing: Shelter (TIANA)	1990.01 - 2000.03
	CPI Health and Personal Care (TIAD)	
	CPI Food and Beverages (TIAB)	
	CPI All items (TIAA)	
United States	CPI Housing (UIAC)	1975.01 - 2000.03
	CPI All Commodities (UIAJA)	

All CPI data are taken from the CEIC database. Nominal exchange rates are expressed in domestic currency per U.S. dollar and are period averages, also from CEIC.

Appendix 2: Average Covariance between Traded and Non-Traded Components of Real Exchange Rates

		$Cov(x_t - x_{t-n}, y_t - y_{t-n})$	
U.S. Dollar rates	**Average**	**Minimum**	**Maximum**
Hong Kong dollar/U.S. dollar	0.00099	-0.00075	0.00286
Korean won/U.S. dollar	0.00026	-0.00246	0.00248
Malaysian ringgit/U.S. dollar	-0.00054	-0.00156	0.00006
Singapore dollar/U.S. dollar	0.00053	-0.00099	0.00178
Taiwan dollar/U.S. dollar	0.00047	-0.00031	0.00180
Thai baht/U.S. dollar	0.00052	-0.00049	0.00215
Cross rates			
Hong Kong dollar/Korean won	0.00285	-0.00070	0.00802
Hong Kong dollar/Malaysian ringgit	-0.00213	-0.00520	0.00147
Hong Kong dollar/Singapore dollar	-0.00100	-0.00200	0.00000
Hong Kong dollar/Taiwan dollar	0.00380	-0.00082	0.00960
Hong Kong dollar/Thai baht	-0.00054	-0.00233	0.00190
Korean won/Malaysian ringgit	-0.00037	-0.00113	0.00020
Korean won/Singapore dollar	-0.00128	-0.00348	0.00147
Korean won/Taiwan dollar	-0.00097	-0.00223	0.00063
Korean won/Thai baht	-0.00053	-0.00136	0.00000
Malaysian ringgit/Singapore dollar	-0.00076	-0.00201	0.00054
Malaysian ringgit/Taiwan dollar	-0.00086	-0.00182	0.00006
Malaysian ringgit/Thai baht	-0.00039	-0.00117	0.00019
Singapore dollar/Taiwan dollar	-0.00074	-0.00156	0.00000
Singapore dollar/Thai baht	-0.00009	0.00083	0.00058
Taiwan dollar/Thai baht	-0.00030	0.00148	0.00071

Figure 1: Variance Decompositions, domestic currency per U.S. dollar
(Per cent of variance in real exchange rate accounted for by variance in relative price of traded goods)

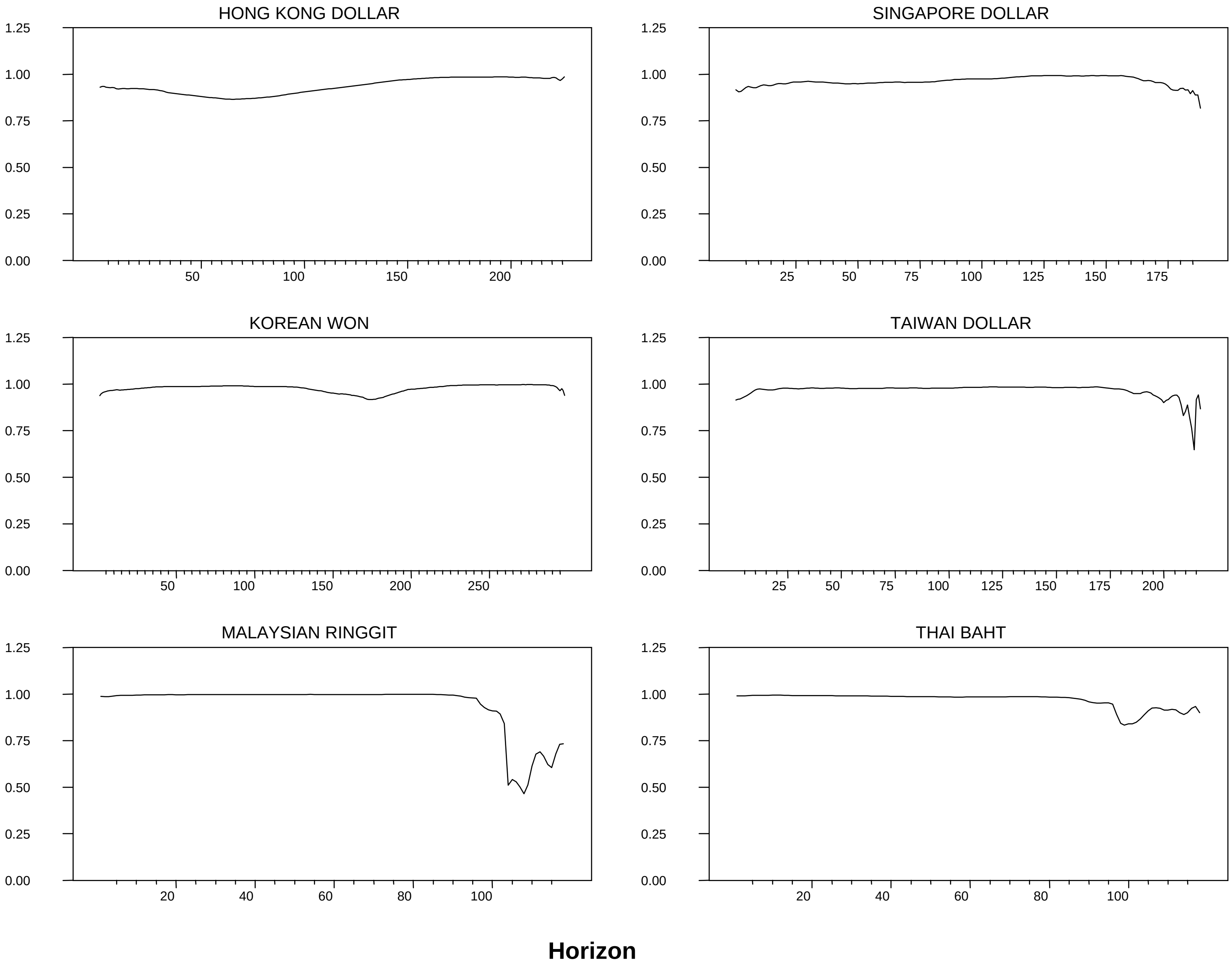


Figure 1: Variance Decompositions, bilateral cross rates
(Per cent of variance in real exchange rate accounted for by variance in relative price of traded goods)

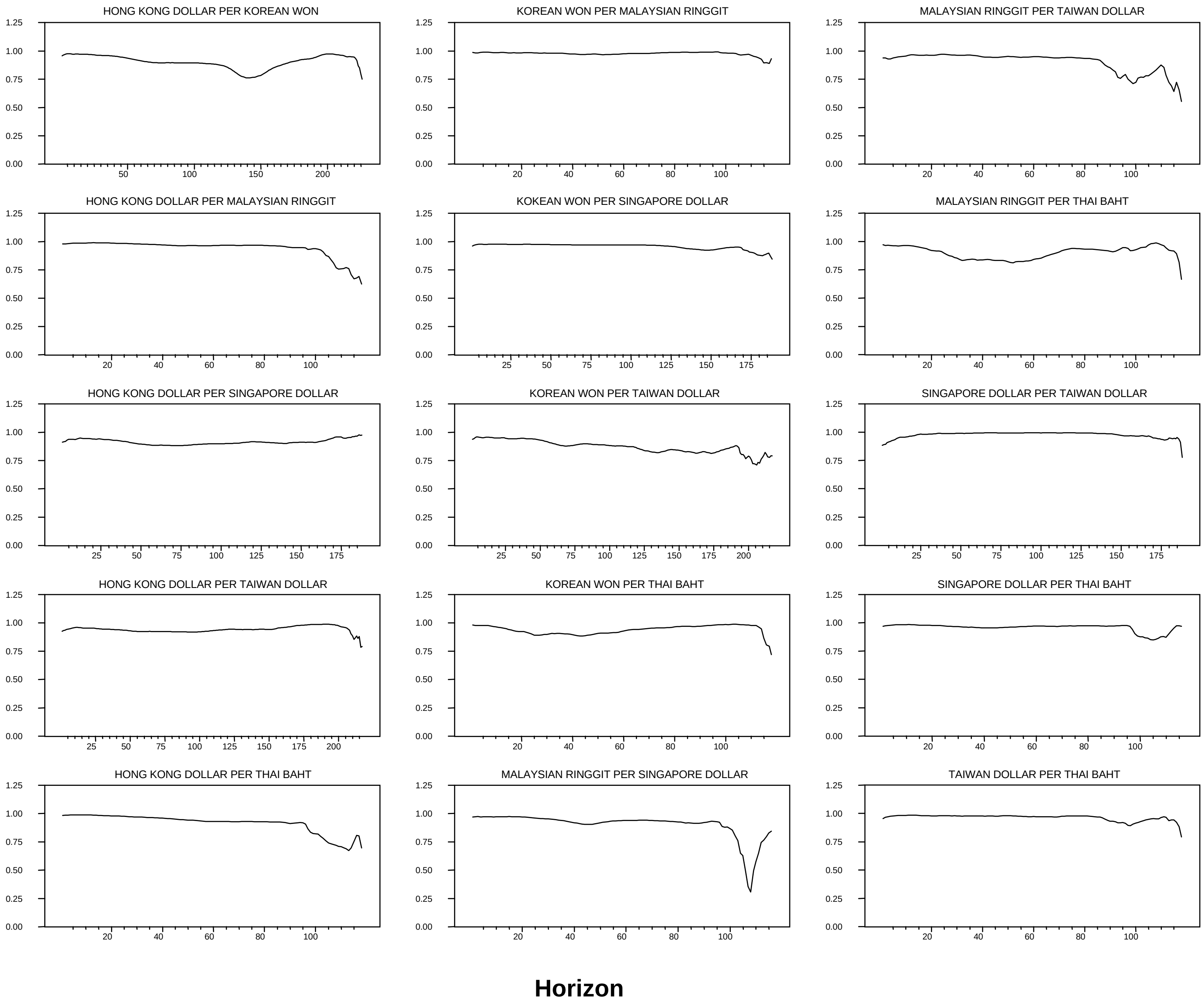


Figure 2: Mean Squared Error Decompositions, domestic currency per U.S. dollar
(Per cent of total variation (MSE) in real exchange rate accounted for by MSE of relative price of traded goods)

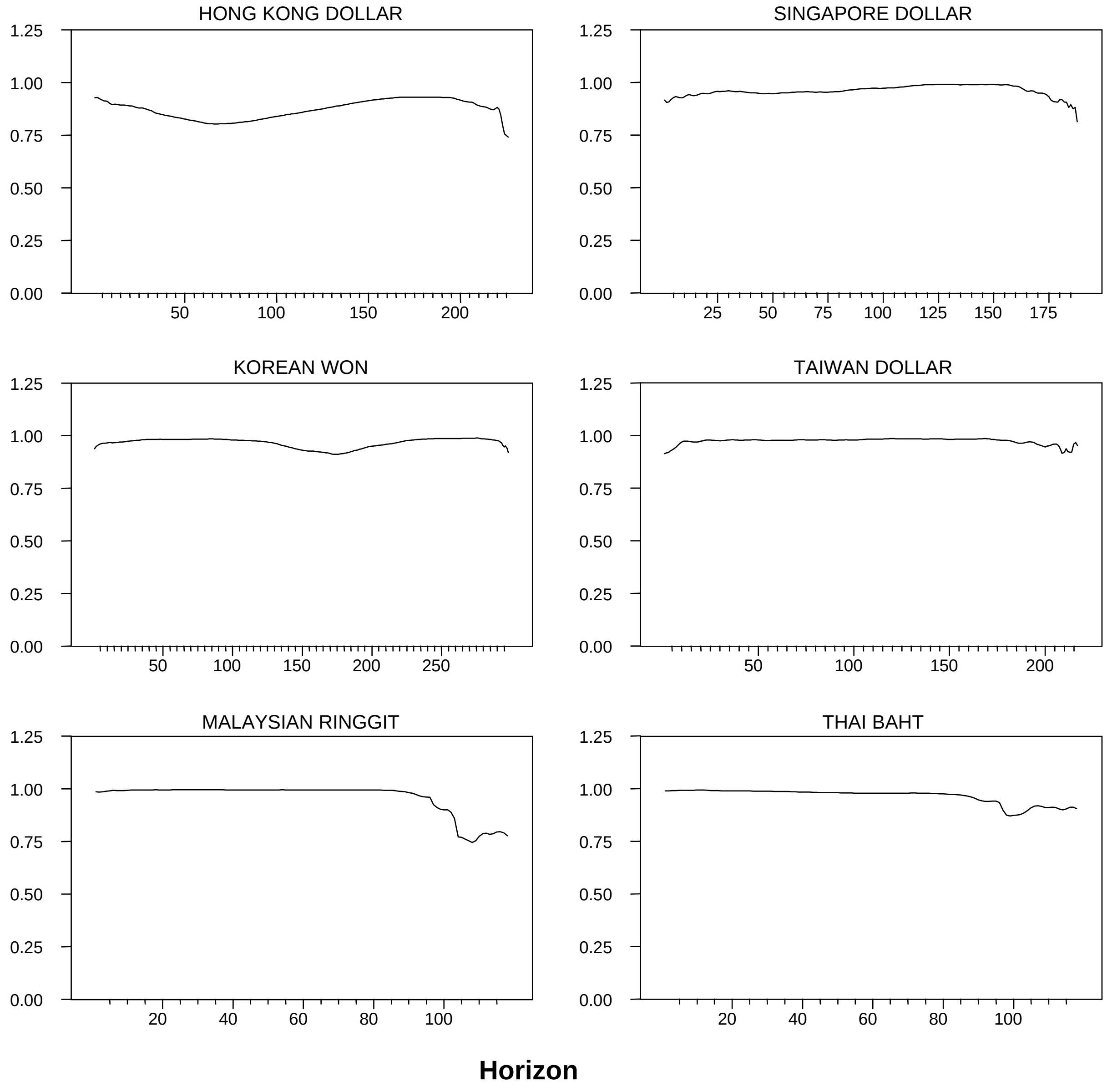


Figure 2: Mean Squared Error Decompositions, bilateral cross rates
(Per cent of total variation (MSE) in real exchange rate accounted for by MSE of relative price of traded goods)

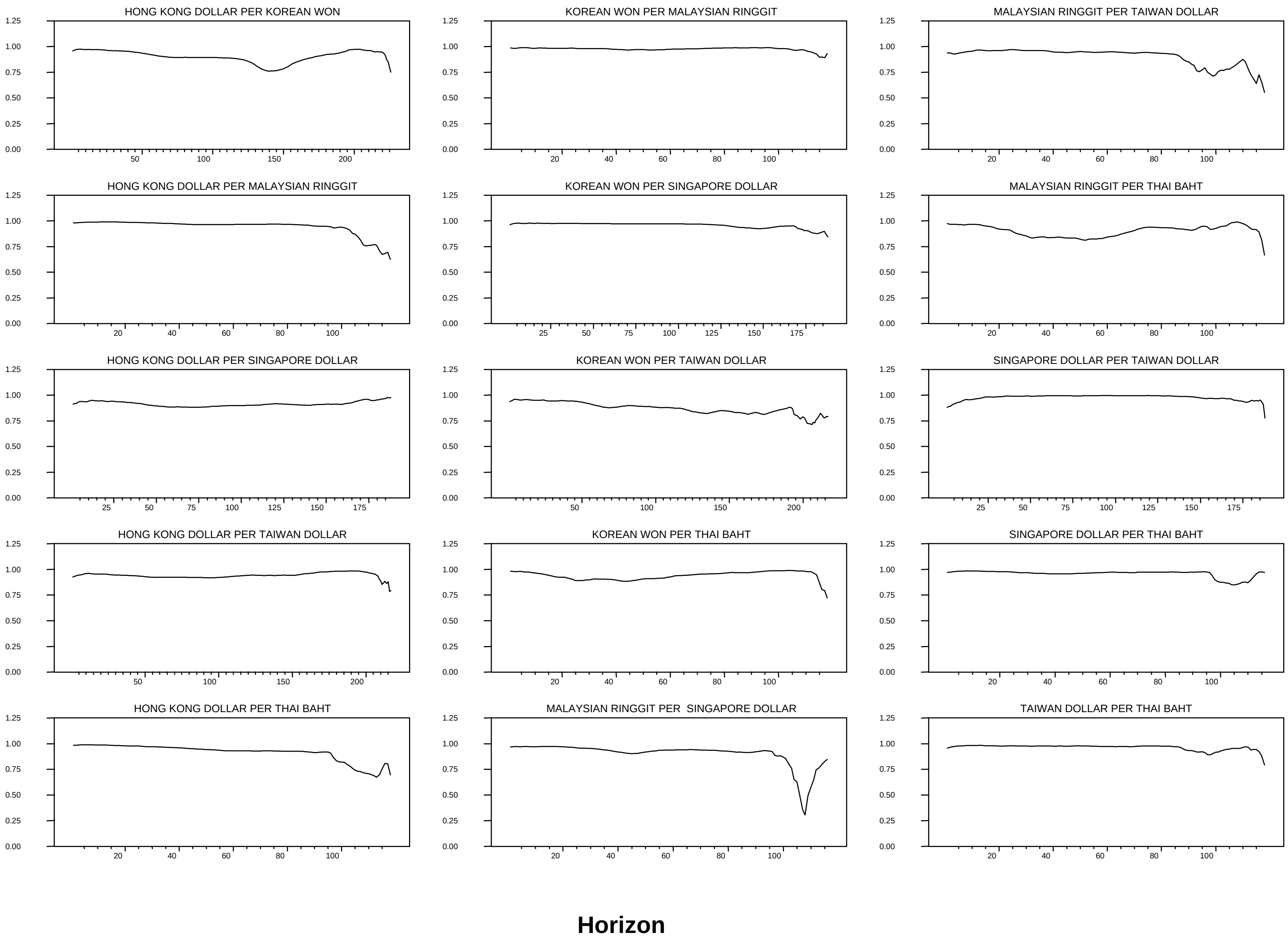


Figure 3: Variance and MSE Decompositions
(Fixed and Semi-fixed Exchange Rate Sample Only)

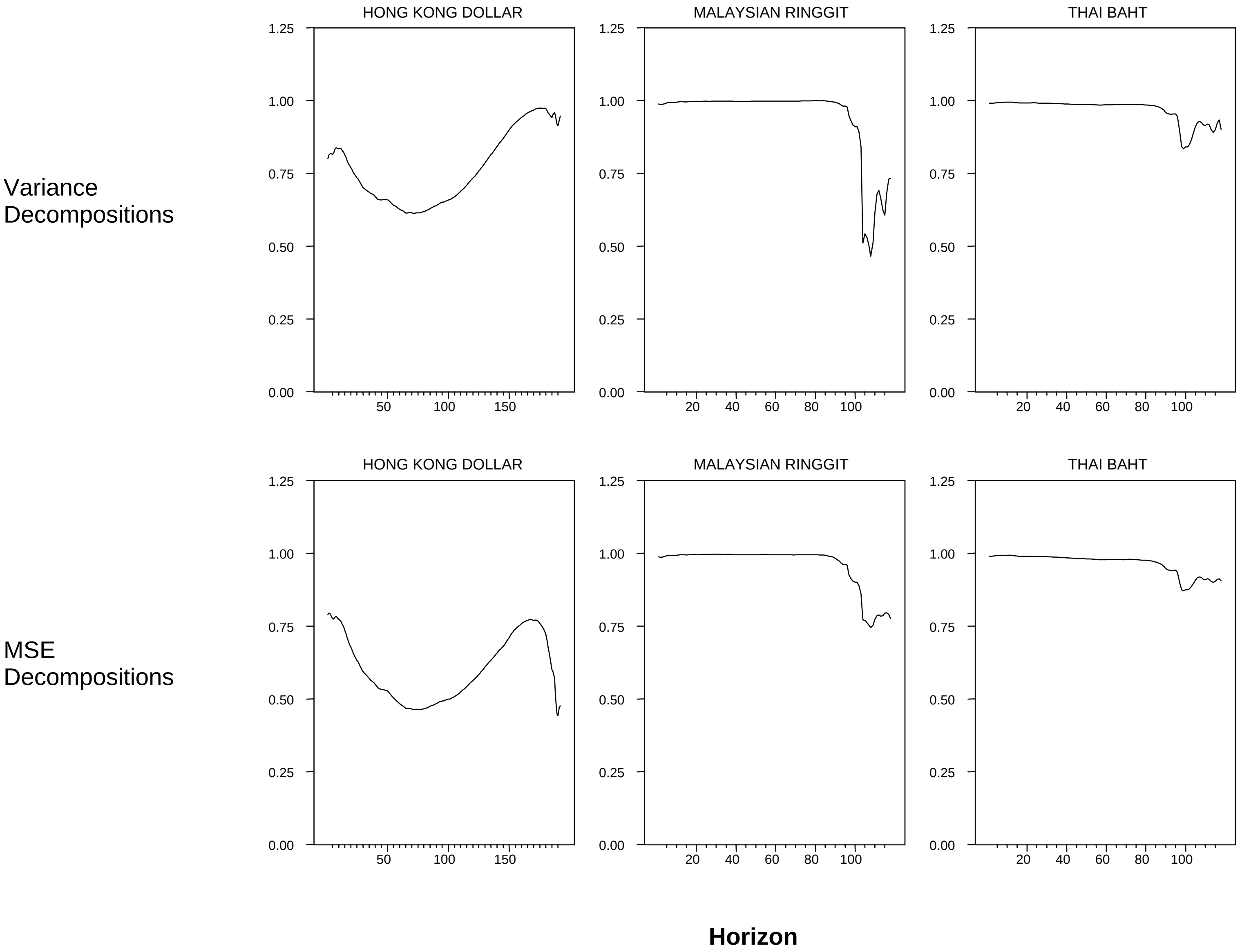


Figure 4: Internal Relative Prices $\left(p^N / p^T \right)$

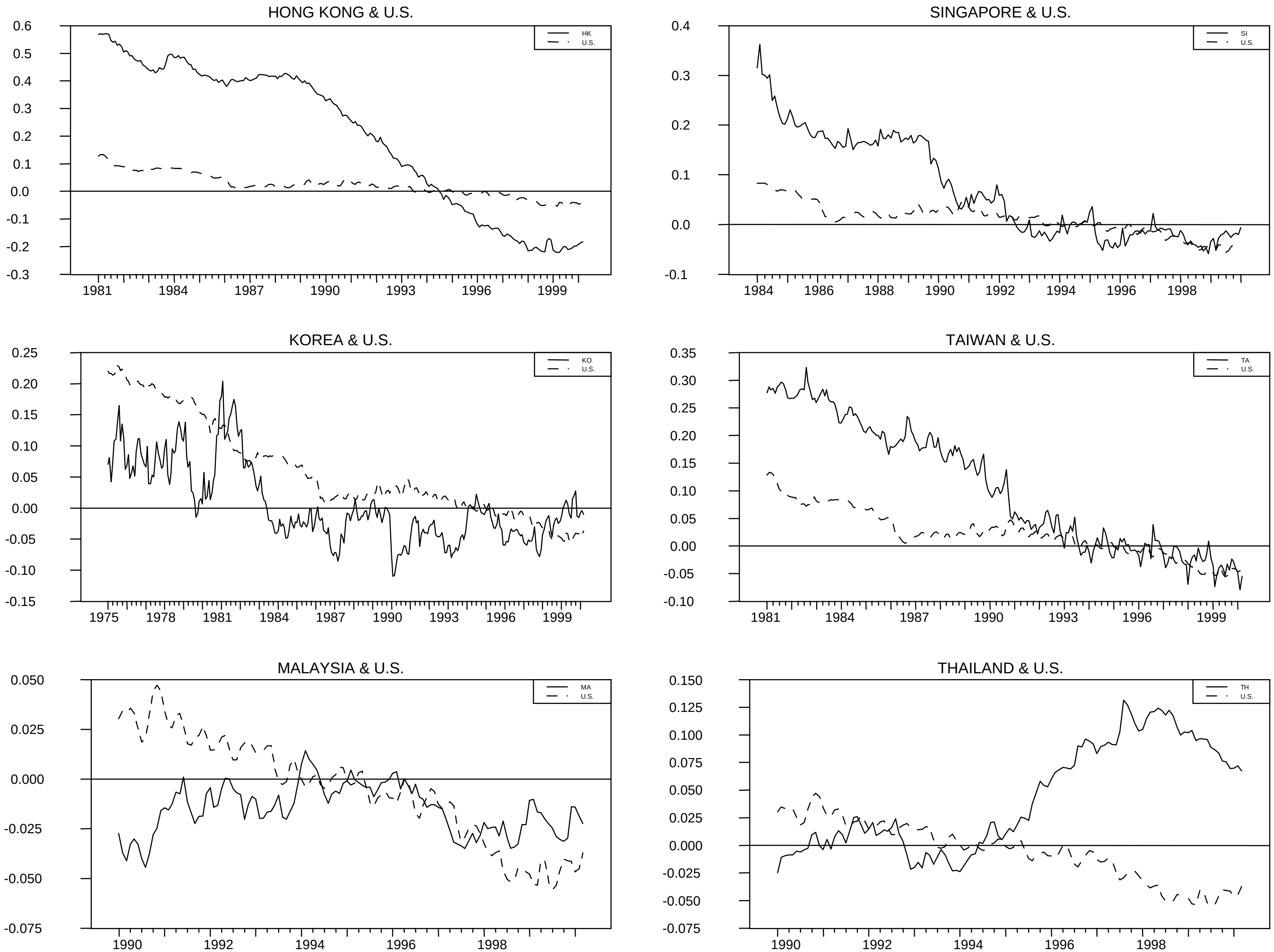
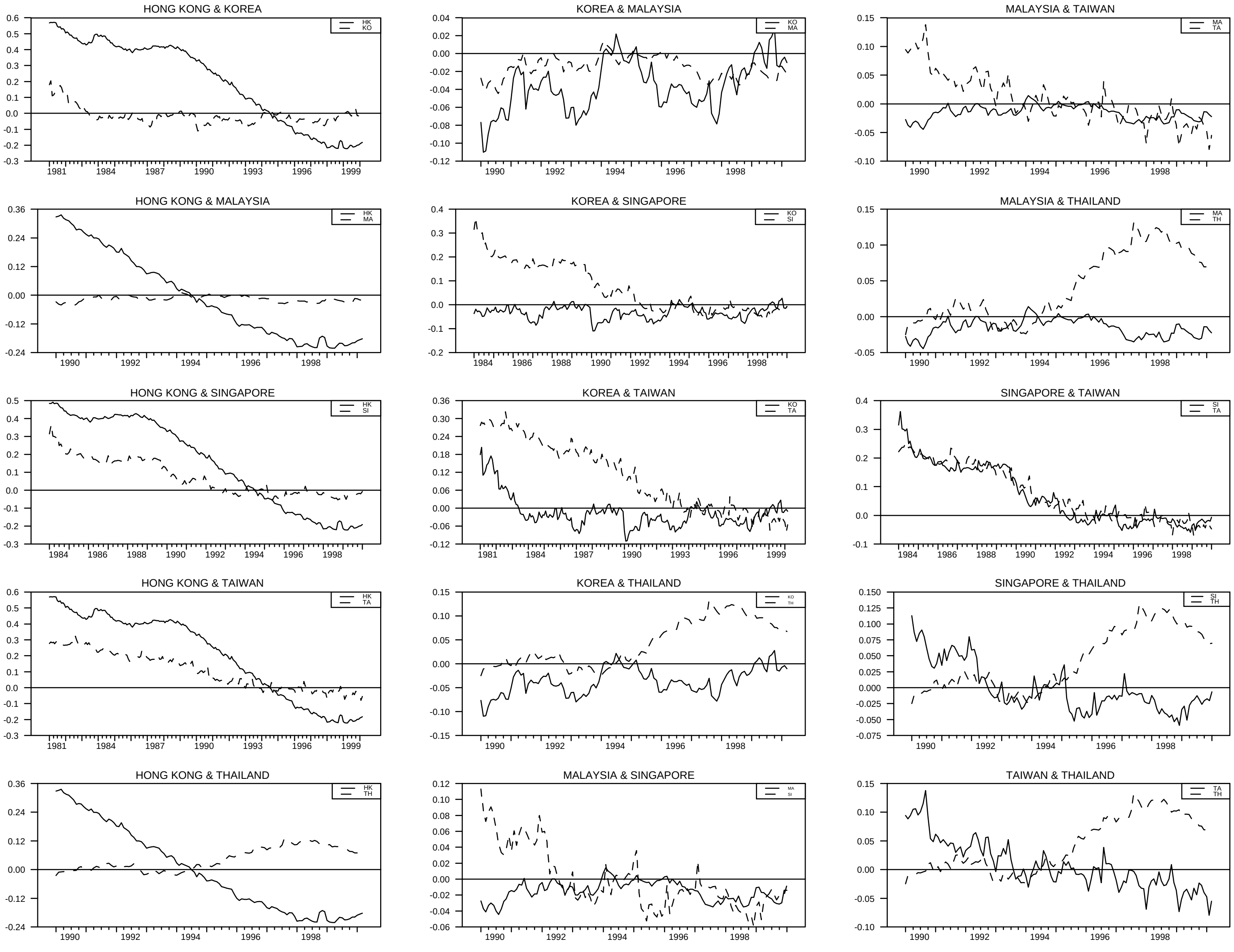
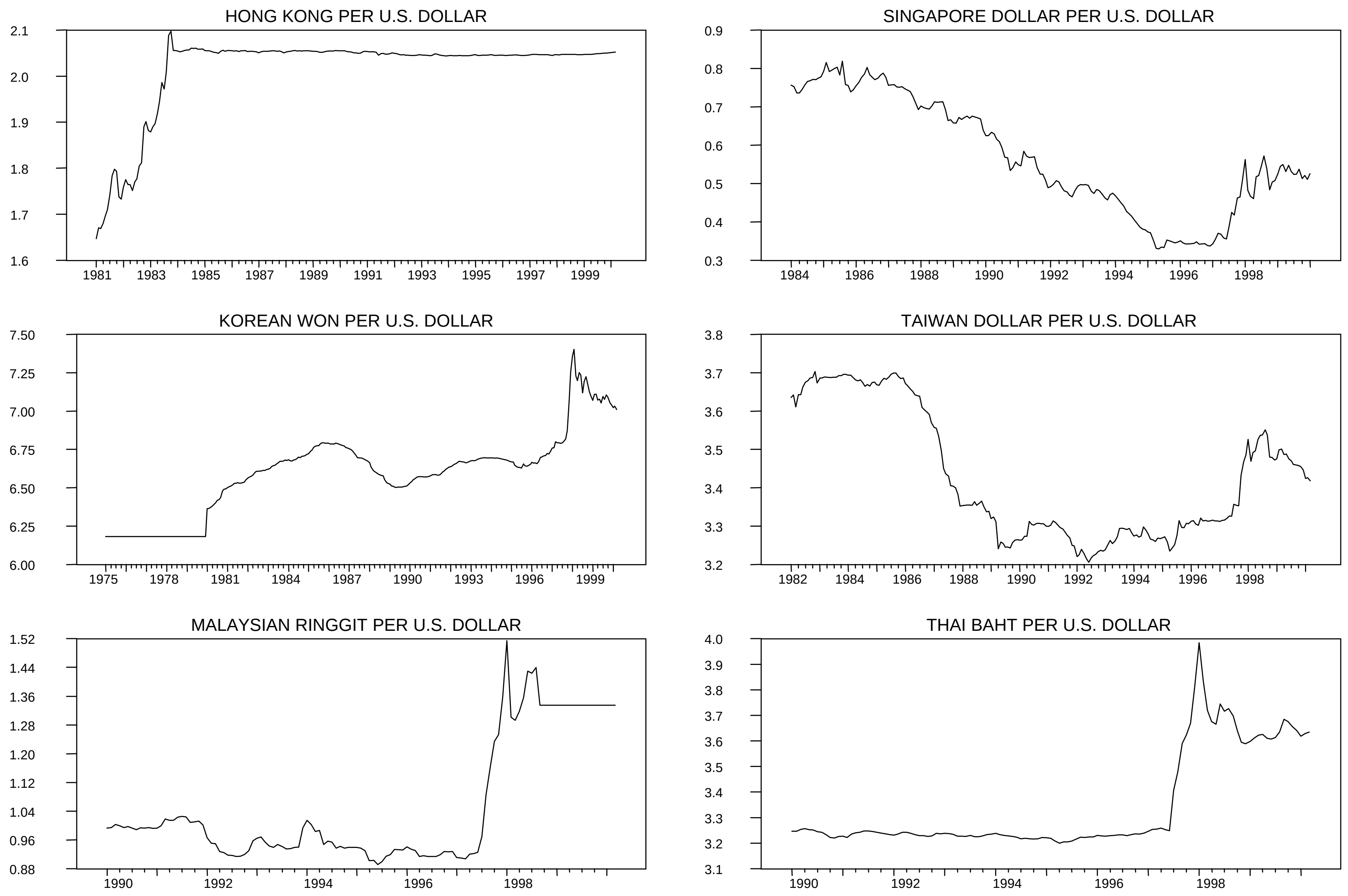


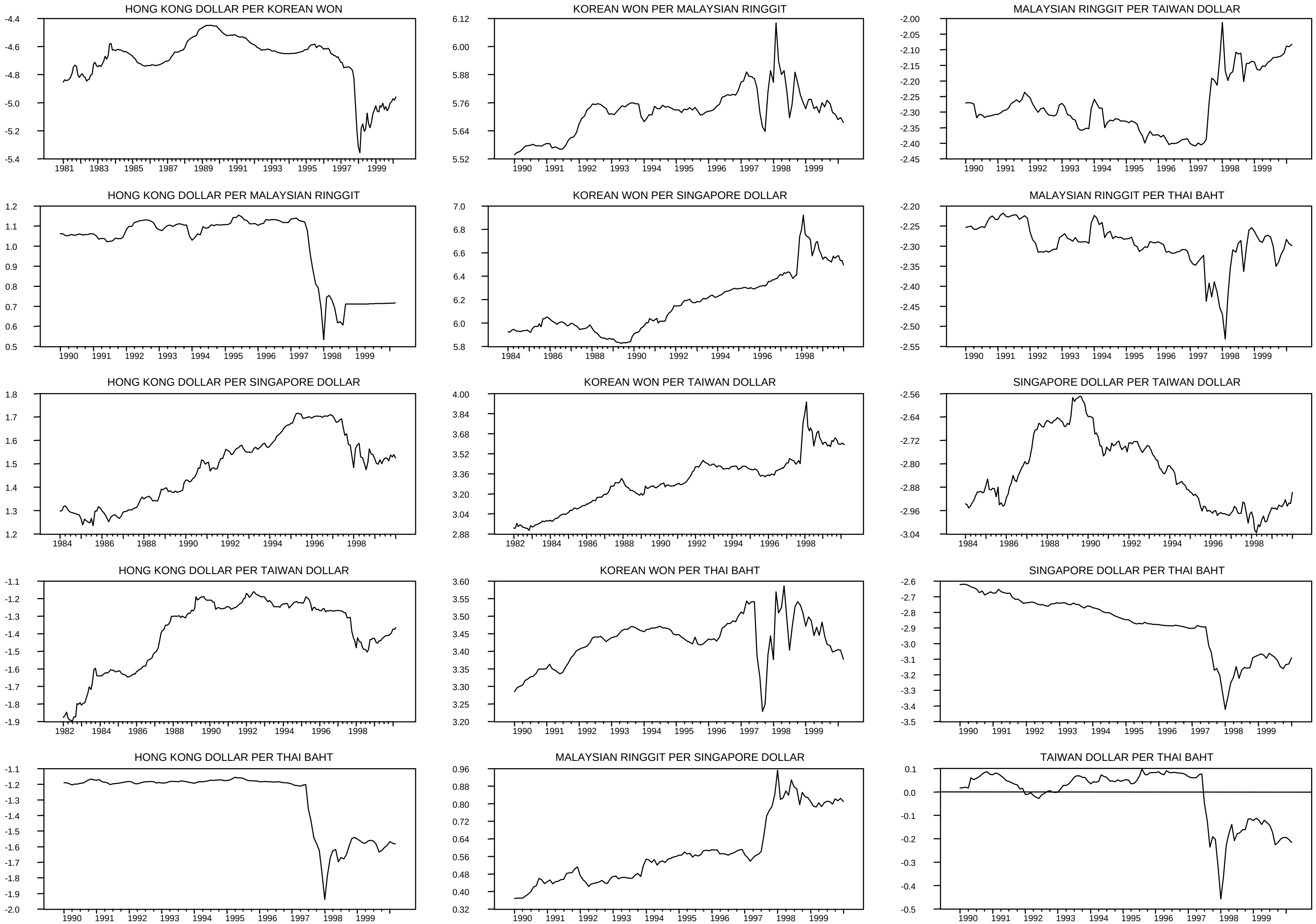
Figure 4: Internal Relative Prices $\left(p^{N} / p^{T} \right)$



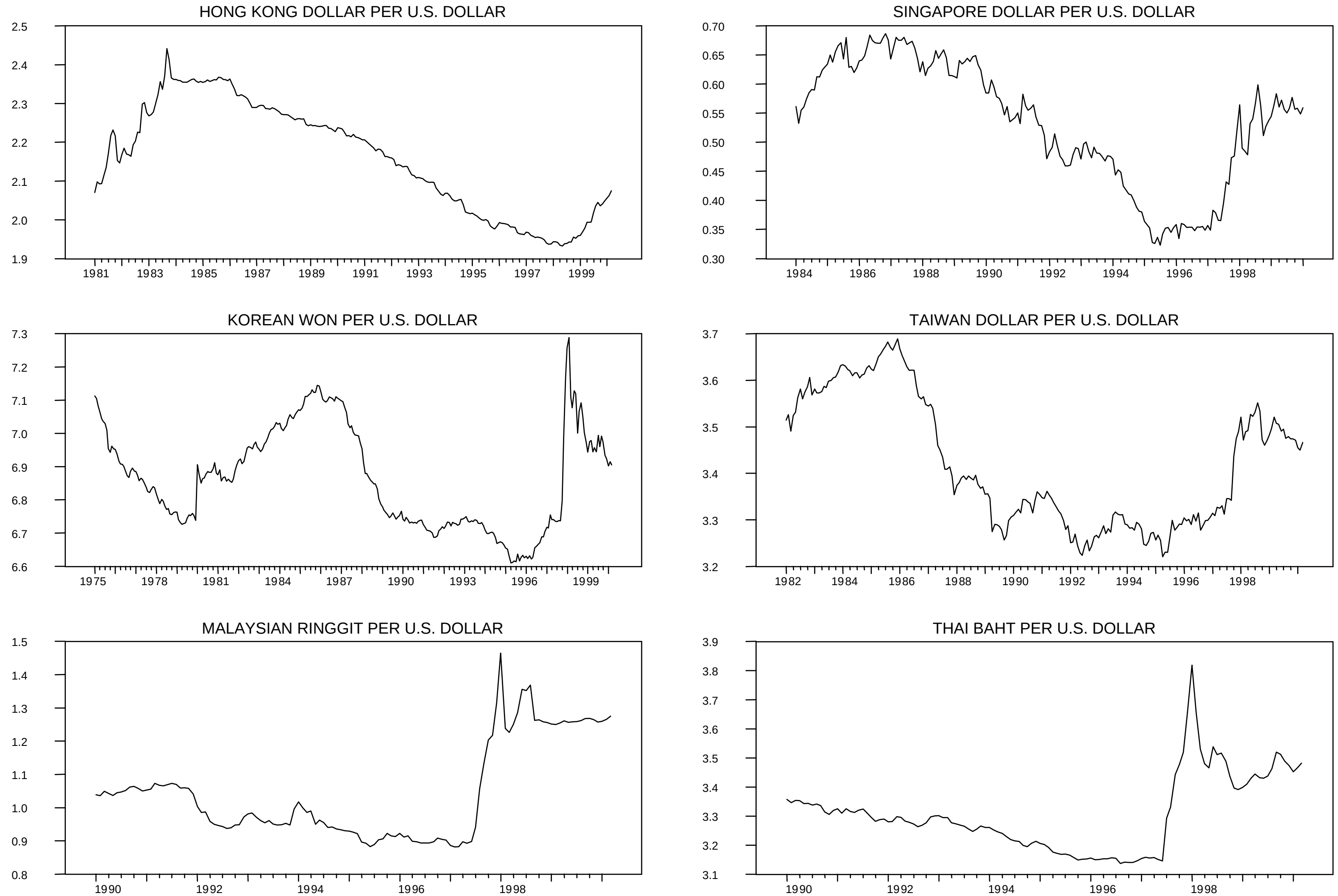
Appendix Figure 1: Nominal Exchange Rates, domestic currency per U.S. dollar (logs)



Appendix Figure 1: Nominal Exchange Rates, bilateral cross rates (logs)



Appendix Figure 2: Real Exchange Rates, domestic currency per U.S. dollar (logs)



Appendix Figure 2: Real Exchange Rates, bilateral cross rates (logs)