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Abstract

This is a comparative study on the historical experience of real effective exchange rate (REER) misalignment of Japanese yen, Deutsche mark, Singapore dollar and Taiwan dollar, with regard to the recent dispute over the Renminbi (RMB) valuation. Panel-based misalignment estimates of the four economies show that net foreign asset build-up does not necessarily result in currency misalignment, and the recent misalignment of RMB is not unprecedented in terms of magnitude, duration or currency coverage, whereas volatility in REER misalignment is likely to propagate to inflation of the home economy concerned. The assertion of 'RMB rate manipulation' thus lacks empirical support.

JEL classification: F31; F41; O57; C23

Keywords: REER misalignment, RMB, yen, D-mark, Singapore dollar, Taiwan dollar

‘that men do not learn much from the lessons of history is the most important of lessons history has to teach’

Aldous Huxley

1. Introduction

One of the most popular diagnoses of the global macroeconomic imbalances is ‘currency manipulation’ of those countries with rapidly accumulating foreign reserve surplus.¹ The diagnosis attributes the surplus mainly to ‘unfair’ export advantage due to the exchange rate manipulation of these countries, ie the rates having been controlled at significantly lower levels than what the real values of their currencies should be. The Chinese currency, *Renminbi* (RMB), is at the centre of the latest currency targets in the current debate over the ongoing global imbalance which is widely believed as a main cause of the 2008 global economic recession.

Assessment of exchange rate misalignment conditions essentially on the concept of real equilibrium exchange rate. Although there lacks unanimous measures, empirical studies commonly model the real equilibrium exchange rate as the long-run solution conditioned upon a set of economic fundamentals, such as productivity differentials, and the misalignment is then derived from deviations of the actual REER (real effective exchange rate) from its long-run solution, eg see IEO (2007) and numerous IMF publications. Inevitably, different choices of data, variable and model specification would result in different long-run equilibrium rate estimates and the accompanying misalignment estimates. Imprecision thus poses a serious challenge to the credibility of empirical evaluations of exchange rate misalignment.

In a recent study by Qin and He (2010), the imprecision due to data and model specification is reduced substantially and their resulting estimates of the RMB misalignments show that its undervalued misalignment margin during the earlier part of

¹ For a more detailed discussion on the concept of ‘currency manipulation’, see Staiger and Stykes (2008).

the 2000s has been effectively wiped out by the 2008 global economic recession. However, the statistical significance of their estimates becomes a major contentious issue (see comments on their paper at the ‘economics-ejournal’ website). While it is too obvious to explain the importance of seeking more precise assessments of whether and how much the RMB rate deviates from its equilibrium value, we believe it futile to discuss the issue centred around the term ‘statistical significance’. That concept is simply too narrow and even misleading for the evaluation of economic significance of any misalignment estimates.²

Needless to say, such evaluation is a relative matter. Relativity entails conditioning and reference. The value added of the misalignment estimates produced by Qin and He (2010) condition mainly on the use of wider data coverage and more general model specification than what has been used in most of the previous studies. The issue of economic significance is effectively left untouched, because such evaluation requires conditioning on the relevant cost benefit analysis and on what accounts for economic significance as well. The present study looks into the latter aspect by means of historical cross-country comparison. Since the allegation of ‘RMB rate manipulation’ is closely dependent on the degree and length of the undervalued periods in the RMB misalignment series, such judgment entails international comparison of similar cases. One of the most discussed cases in the recent media is the repeated Japanese yen appreciations since the mid 1980s. Here, we choose to focus and sharpen the comparison via estimating the yen rate misalignment series over the relevant historical period, using principally the same approach as in Qin and He (2010). Furthermore, such comparison is extended to three other cases, namely Germany, Singapore and Taiwan because of their similar experience in export-led growth and current account surplus over the last few decades. The

² See eg McCloskey (1992; 1995) for more methodological discussion.

comparison is aimed particularly at the following questions with respect the results obtained by Qin and He (2010). Has their estimated RMB misalignment, especially the undervalued misalignment part, been more severe and more prolonged than those from the four economies? Are the long-run coefficients in the REER models of the four economies corroborate more the standard theories than those estimated of the China model? In particular, has the factor of relative net foreign assets played a significant and substantive role in equilibrating the REER in accordance to the relevant economy's surplus position, a popular supposition but unconfirmed by the China model? Positive answers to the above questions should provide empirical support to the allegation of 'RMB rate manipulation', considering that all these economies implemented the managed float exchange regime and moved to freer regimes during the historical periods of interest,³ while China had a de factor fixed rate regime for the most part of the sample period examined by Qin and He (2010). In addition, we are also interested in finding out: are the misalignment estimates sensitive to the choice of trading partners vis-à-vis a home economy? For instance, were the Japanese yen undervalued misalignment estimates more severe when we restrict its trading partners to the US and the Euroland only? Finally, how has the movement of the misalignment estimates of a home economy interacted with its inflation and economic growth? This question arises primarily from the observation (see eg McKinnon et al, 1999) that the Japanese economy fell into a deflationary and zero-interest liquidity trap subsequent to the continued yen appreciation during the late 1980s and the early 1990s. It is also a question of great policy concern currently in China.

The rest of the paper is organised as follows. The next section briefly describes the relevant background of the four economies, compares their positions with China and summarises the available literature on exchange rate misalignment estimates of the four

³ For more description of the exchange rate regimes of these economies, see McKinnon and Ohno (2001), Deutsche Bundesbank (1999), MAS (2001) and Chou and Shih (1995).

economies. Sections 3 and 4 describe our modelling method and the related data issues respectively. The main estimation results are discussed in section 5, where comparison with the results of the China model is also made. The last section concludes with the main lessons drawn from the comparison.

2. Background of four economies for comparison

As mentioned in the previous section, Japan is the most popular country of comparison during the recent debate on the RMB rate evaluation, eg see the latest IMF World Economic Outlook (2010), McKinnon and Schnabl (2003), Yu (2010). Briefly, the rapid export-led growth of Japan since the 1970s made its economic success stand out such that it attracted enormous mercantile trade pressure, especially from the US, during the 1980s. The resulting 1985 Plaza Accord between US, France, Germany, UK and Japan led to drastic and repeated yen appreciations against the dollar during the subsequent decade. The subsequent ‘syndrome of the ever higher yen’ is closely associated with Japan’s post-1990 deep recession and deflation, eg see McKinnon and Ohno (2001). Figure 1 presents the Japanese GDP growth rates, inflation, openness ratios, and the yen exchange rate versus US\$ from the late 1970s to 2000 (see the left-side four graphs). It is interesting to note that the present-day China has far surpassed Japan of that period in terms of the degrees of openness measured by the openness ratios, if we compare the relevant graphs in Figure 1 with those in Figure 3.

To find more comparable cases to China, we examine two other Asian economies: Singapore and Taiwan. Singapore is probably the only Asian economy which has retained, for a relatively long period, a current account surplus at a substantial level comparable to the present Chinese situation, as shown from the third left-side graph of Figure 2. But otherwise, the two economies differ substantially. Singapore has been a very small and open economy. Its total trade was around three times of its GDP during

the 1980s and the 1990s (the second left-side graph of Figure 2). Taiwan was less different in those respects, and forms a natural choice due also to its close tie with the mainland China. Moreover, Taiwan also experienced continued currency appreciation pressure during the late 1980s up to the early 1990s, in the wake of its rising current account surplus following its rapid trade growth in the early 1980s (see the right-side graphs in Figure 2). Still, Taiwan's trade to GDP ratio of the time was much higher than that of the present-day China, since Taiwan is far smaller in size and foreign trade counts much more for its economy than the mainland. A more size-comparable country that we find is Germany (West Germany prior to the reunification). Its trade to GDP ratios during the 1980s were similar to the current Chinese level (see the second right-side graph in Figure 1) and, furthermore, the Deutsche mark (D-mark) also underwent a period of appreciation subsequent to the 1985 Plaza Accord and its rapidly growing current account surplus (see the right-side graphs in Figure 1).

There is a sizeable literature on estimating the exchange rate misalignment of the four currencies under consideration. Table 1 provides a summary of a sample of the previous estimates in literature relevant to the historical periods of interest. It is immediately noticeable from the table that the estimates vary considerably with the modelling approach, and some estimates are even opposite to each other. The estimates sharing the most agreement are probably those during the early 1980s concerning the yen undervaluation. It is also noticeable that the estimates, especially those of undervaluation, have little concurrence with the external trade and current account surplus positions of the economies. Considering the lack of regular time series in those estimates and the large difference in method, data coverage as well as the choice of exchange rate indices (eg some use bilateral rates and others use REER), we have to leave them aside as rough references and carry out our own estimation in order to compare the misalignment

situation of those historical periods with the RMB misalignment estimates obtained by Qin and He (2010). The next three sections report the estimation method and main results.

3. Modelling method

In order to facilitate cross-country comparison, we follow essentially the panel model procedure employed in Qin and He (2010). Note that Qin and He have shown the shortcoming of the panel procedure in assuming homogeneity of all the trading partners, by applying a country-by-country modelling procedure to estimate the bilateral currency misalignment series of the home country versus each of its trading partners. However, we shall not follow that route here for more consistency of model specification in cross-country comparison and for simplicity as well. The theoretical approach we choose is the same as in Qin and He (2010), namely to determine the real equilibrium rate by two fundamentals – productivity differentials and the relative size of net foreign assets.⁴ The first factor is approximated alternatively by the relative real per capita income and the relative ratios of CPI (consumer price index) to PPI (producer price index). The second factor is represented by the relative per capita net foreign assets.

Denote r_{it} as the CPI-based real exchange rate of a home economy vis-à-vis country

i. The basic panel model that we use has the following two versions:

$$\begin{aligned}\ln(r_{it}) &= \alpha_{1i} + \beta_{11} \ln(GDP_{it}) + \beta_{12} NFA_{it} + u_{1it} \\ \ln(r_{it}) &= \alpha_{2i} + \beta_{21} \ln(RPI_{it}) + \beta_{22} NFA_{it} + u_{2it}\end{aligned}\tag{1}$$

where GDP_i , RPI_i and NFA_i denote respectively the relative real per capita GDP, the relative CPI-PPI ratios, the relative per capita net foreign assets between the home economy and country *i*. Under the standard theoretical setting, all the β coefficients in (1)

⁴ We have tried to add the factor of real interest rate differentials, but found it virtually impossible to get cross-country consistently defined quarterly time-series data for the historical periods of interest. On the other hand, the identical variable coverage here with that used in Qin and He (2010) makes the estimates more comparable, although the reason for excluding the interest rate differentials there is very different, ie the lack of a free international capital market in China during the sample period concerned.

are normally expected to be positive. Specifically, $\beta_{11} \geq 0$ and $\beta_{21} \geq 0$ are expected of the Balassa-Samuelson effect. But opposite signs can occur when there is imperfect substitution between tradable and non-tradable goods as well as imperfect competition (eg see Benigno and Theonissen, 2003; MacDonald and Ricci, 2007; MacDonald and Dias, 2007). Likewise, β_{12} or β_{22} could become negative when sustained foreign direct investment results in deterioration of a country's NFA position and appreciation of its currency (eg see Burgess *et al.* 2003).

Model (1) is estimated by the panel dynamic OLS (DOLS) method developed by Kao *et al* (1999) (see also Kao and Chiang, 2000). Since the method entails cointegration, panel unit-root tests are carried out on the individual variables prior to the estimation and on the residuals after the estimation, using one lead and one lag of the difference variable terms. When the long-run coefficient estimate of one of the explanatory variables is statistically insignificant, we re-estimate the model excluding the corresponding variable to check whether the exclusion would result in significant omitted variable bias.

Once the relatively satisfactory estimation results are obtained, we use residuals from the panel DOLS estimation of (1) to derive a pair of misalignment series of the REER for each of the four economies concerned, m_{1t} and m_{2t} , by taking the trade-weighted geometric mean:⁵

$$\begin{aligned} m_{1t} &= \exp\left\{\sum_{i=1}^n w_{it} u_{1it}\right\} \\ m_{2t} &= \exp\left\{\sum_{i=1}^n w_{it} u_{2it}\right\} \end{aligned} \tag{2}$$

where w_{it} denotes the trade weight of country i vis-à-vis the total foreign trade of the home economy under consideration. Obviously, difference between m_{1t} and m_{2t} reflects

⁵ We adopt geometric mean instead of arithmetic mean as the former is widely used by IMF, BIS and many other international organisations.

the effect of choice of proxy variables for productivity differentials. In the event that $|m_{2t}| > |m_{1t}|$, ie price differentials generate larger misalignment than income differentials, we have stronger evidence of ‘unfair’ competitiveness due to pricing than the reverse case. Japan, Germany, Singapore and Taiwan are the home economies to be modelled one by one in turn, as discussed previously.⁶

One major policy concern under a controlled exchange rate regime is the inflationary/deflationary impact of exchange rate adjustments. With regard to the present Chinese case, the government is wary of risking its currency to repeat the Japanese experience of falling into a deflationary and zero-interest liquidity trap subsequent to the yen being forced into repeated appreciations after the 1985 Plaza Accord.⁷ In that context, it is interesting to find out whether such macroeconomic impact of exchange rate adjustments is due to the rate misalignments. We test the hypothesis by means of the Granger non-causality test on the estimated misalignment series with inflation and the GDP growth as well for each home economy.

4. Data coverage and related issues

Quarterly data are used starting mostly from the mid to late 1970s. When quarterly data are unavailable, eg in the case of population, simple interpolation is used to produce quarterly series. The detailed data sources are given in the appendix. The fact that the historical periods of interest go back to two to three decades poses a serious data restriction on the numbers of trading partners that we could include. Selection of trading partners is based on the ranking of trade shares with the home economy concerned and we try to include those with the highest ranks if data permit. Our data set covers 17 economies – Australia, Canada, France, Germany, Italy, Japan, Korea, Malaysia, the

⁶ For Germany, we only consider West Germany prior to the reunification in 1990.

⁷ There was a debate on whether over appreciation of the yen forms a main cause of the stagnation of the Japanese economy, eg see McKinnon *et al* (1999), Heng (2009), Hayashi and Prescott (2002), Hamada and Okada (2009), Krugman (1998), Posen (1998) and Obstfeld (2009).

Netherlands, the Philippines, Singapore, Sweden, Switzerland, Taiwan, Thailand, UK and US. Since several Malaysian series start from 1983, Malaysia is excluded from the panel samples for the Japanese yen and the D-mark.⁸ Both samples start from 1977 whereas the Japanese sample ends in 2000 and the German sample ends in 1990. The samples for the Singapore and Taiwan dollars cover the period of 1984-2000. Time series of the trade shares that these panels cover in the total trade of the home economies are plotted in Figure 4. As seen from these graphs, the trade shares vary during the sample periods but remain well above 50% most of the time. The significant decrease of the shares in the Taiwan case is due to a rapid growth of its trading with mainland China. Ideally, China should have been included in all the four panels as it became an increasingly important trading partner from the late 1980s onwards. But we are prevented from doing so due to lack of data. Similarly, we are unable to include, in the German case, some trading partners which ranked higher in their trading weights than some of the included Asian economies due to data shortage.

Since the representativeness of panel-based REER series is susceptible to the trade coverage of selected panels, we try to check the representative adequacy by comparing our panel-based REER series with the series published by the IMF and the BIS (Bank of International Settlement), see the right side of Figure 4.⁹ As seen from the REER graphs, our panel-based series are relatively similar to the IMF and/or the BIS series on the whole. There is some discrepancy in the German series but that is more pronounced between the IMF and the IBS series than between our series and those two. The case with the largest discrepancy is Taiwan. That is due to the fact that the BIS series does not cover Malaysia, the Philippines and Thailand, three economies whose trading weights with Taiwan have ranked well above a number of countries covered in the BIS panel, such as Belgium,

⁸ The trade weights of Malaysia in the Japanese and German total trades were roughly 2% and 0.3% respectively during 1980-90.

⁹ IMF's publication does not cover Taiwan.

Finland, Greece, Ireland, Mexico, Portugal, Spain etc. Hence, our REER should be more representative than the BIS series.

Qin and He (2010) show that the RMB misalignment series are sensitive to the panel choice. Their estimates from a sub panel of the US and the Euroland countries differ substantially from the results based on a full panel of 22 economies. Here, we shall adopt the same strategy and construct a sub panel of the US and the countries in the full panel, which are from the Euroland for separate estimation.

5. Empirical results and comparison

The key estimation results are reported in Tables 2.¹⁰ One immediate striking feature of the table is that the coefficient estimates of NFA_{it} are negative and small in all the full-panel estimation though insignificant in the Singapore and Taiwan models as well as the GDP version of the Japan model. This result is similar to the China case, as shown from Tables 2-4 in Qin and He (2010). The finding implies that relatively large net foreign asset differentials due to sustained current account surplus of a home economy does not necessarily result in a positive and significant long-run effect on the REER of its currency. For example, Singapore has the highest current account surplus among the four (see Figure 2), but NFA_{it} remains insignificant nevertheless in all versions of the Singapore model, a result which confirms to the previous study by Montiel (1997). The finding poses serious doubt on those theories which assume as the key condition an equilibrium current account balance position for equilibrium REER.

Table 2 also report the key sub-panel estimation results, ie sub-panels which include only the US and the Euroland economies. If we compare the sub-panel results with those from the full panel, we notice that the biggest difference is in the Japanese case: the

¹⁰ Unit-root test, run on individual variables of $\ln(r_{it})$, $\ln(GDP_{it})$, $\ln(RPI_{it})$ and NFA_{it} shows that all the series are first-difference stationary. The test on the residuals after the DOLS estimation confirms stationarity as well. The test results are not reported to keep the paper short.

coefficient estimates of NFA_{it} become significantly positive, albeit very small. This may reflect the fact that the repeated yen rate appreciations from the late 1980s onwards were mainly driven by pressures from the US and the West.

Figure 5 plots the estimated misalignment series of the four economies as well as the misalignment series of the RMB estimated by Qin and He (2010) to facilitate comparison. Two pairs of misalignment series (one for the GDP_i version of the model and the other the RPI_i version) are drawn for each economy – one pair from the full-panel estimation and the other the sub-panel estimation. Let us examine the misalignment situation of the four currencies in turn.

The first case is the Japanese yen. It is discernible from the first row of Figure 5 that the yen remained undervalued during the first half of 1980s, reaching 15-20% if estimated by the GDP_i version of the model and over 25% by the RPI_i version. The misalignment series switched into a sustained overvaluation phase after 1985, except for two brief periods – around 1990-1 when bubbles in Japanese stock and land prices burst and then 1997 when the Asian currency attack occurred. The yen overvalued misalignment peaked around 1995, over 20% if estimated by the GDP_i version of the model and over 40% by the RPI_i version. On the whole, these estimates do not differ substantially from what has been reported in the literature. In fact, they are relatively close to those obtained by Bénassy-Quéré *et al* (2009). If we look at the undervalued period of the RMB during the early-mid 2000s (see the last row of Figure 5), the magnitude (5-10%) is far less than that of the yen during the early 1980s prior to the 1985 Plaza Accord. Moreover, there are two noticeable differences. The RMB was distinctly more undervalued if evaluated against the US\$ and the euro whereas the yen misalignments remained more or less the same whether evaluated by the full panel or

only a sub panel of the US and the Euroland; and the yen misalignment estimates by the RPI_i version of the model were more severe than those of the GDP_i version, the opposite to the RMB case. These results suggest that Japanese case during the early 1980s was more severe, more universal in terms of currency coverage and more relative price-based than the Chinese case during the mid 2000s. The finding confirms to the previous studies which show that the Japanese traded sector experienced rapid productivity growth during the decade starting from the mid 1970s, especially versus the US, eg. See Marston (1986), McKinnon and Ohno (2001). But from our comparative perspective, the finding is somewhat unexpected since the Japanese economy of the 1980s was believed to be freer than China of the 2000s in terms of both the exchange rate management and the price setting of traded goods.

Let us now look at the D-mark situation. Similar to the yen, the D-mark is found to be undervalued during the first part of the 1980s, though to a somewhat less degree (around 10% maximum, see the second row of Figure 5). The misalignment estimates are also larger in magnitude from the RPI_i version of the model than the per capita income based version (the GDP_i coefficient estimate becomes insignificant in the sub-panel case), and the difference between the full-panel and the sub-panel estimates is largely indiscernible. Unlike the yen, the undervalued margin of the D-mark ebbed away gradually after the 1985 Plaza Accord, without significant over-correction. Our estimates during the first half of the 1980s are consistent to the history prior to the Plaza Accord and also in agreement with those by Fischer and Sauernheimer (2002). Roughly, the length and severity of the undervalued misalignment in the D-mark of the 1980s are comparable to the full-panel result of the RMB during the mid 2000s, though the RMB misalignment is less pronounced from the relative price version of the model. Again, the

feature of the particularly strong undervaluation of the RMB against the US\$ and the euro finds no resemblance in the D-mark.

Next, we turn to the case of the Singapore dollar. Our estimation shows that the Singapore dollar went from being greatly overvalued prior to 1985 to a period of undervaluation in the late 1980s, and that it became slightly overvalued during the 1990s till the 1997 Asian crisis. The undervalued misalignment was around 2-5% in the late 1980s when estimated using the full-panel data set but reached over 10% in the sub-panel estimation (see the price-based model version). The latter result resembles the RMB case, although the sub-panel feature in the RMB case is far more pronounced from the per capita income version of the model than the price-based version. On the whole, our results are quite similar to those by MacDonald (2004). What is particularly interesting in the present case is that we find no evidence of the Singapore dollar being substantially undervalued during the 1990s prior to the Asian crisis in spite of the fact that the country's current account surplus remained rising (see the third graph on the left side of Figure 2). The result demonstrates that persistent current account surplus does not necessarily imply downward exchange rate misalignment.

The misalignment series of the Taiwan dollar from the two model versions are the closest of the four currencies (see the fourth row of Figure 5). Otherwise, the misalignment series share certain similarities with those of the Singapore dollar. It was found being undervalued during the mid 1980s and went into a period of overvaluation till the 1997 Asian crisis. Only, the overvaluation started earlier and much stronger than the case of Singapore dollar, due probably to the widely held expectation and/or speculation of continued Taiwan dollar appreciation at the time, subsequent to the rapid growth of Taiwan's current account surplus from fast expanding foreign trade. Interestingly, the difference between the full-panel estimates and the sub-panel estimates

are the largest of the four cases. During the mid-late 1980s, there was undervalued misalignment around 5% for over two years when estimated using the full-panel data set. The period extended to over three years and reached over 15% when estimated by the sub-panel data set. The situation resembles closely to the RMB case, indicating that the appreciation expectation or pressure at the time was heavily based on the US and the Western regional perspective.

Overall, these misalignment estimates provide us with clear precedent to the recent RMB misalignment situation. The magnitude and currency coverage of the undervalued misalignment of the Japanese yen prior to the Plaza Accord is more severe than the RMB during the early to mid 2000s. The RMB undervalued situation is more comparable to the D-mark case during the 1980s in terms of both magnitude and length. The currency limited nature of the RMB undervaluation, ie it being more severe when evaluated against the US\$ and the euro than a much larger set of currencies, echoes the situation of the Taiwan dollar in the mid 1980s and also the Singapore dollar of the same period to a certain extent.

If we look at the adjustment process of those undervalued periods of the four currencies, we notice that the adjustment processes in the Japanese yen and the Taiwan dollar are more volatile than those of the D-mark and the Singapore dollar. The history tells us that the Japanese economy sank into recession and deflation during the 1990s and that Taiwan experienced higher inflation and lower growth in the 1990s while Singapore maintained more stable economic growth till the East Asian crisis.¹¹ The history leads us to the question how the dynamics of REER misalignment adjustment interact with the dynamics of key macro variables such as inflation and GDP growth. Since it is beyond the scope of the present study to specify a full macro model of an open economy, we

¹¹ It is difficult to discuss Germany because of the reunification.

simply seek primary answers to the question by means of the Granger non-causality test. Interestingly, the test based on a 3-variable VAR (Vector AutoRegression) (GDP growth, inflation and REER misalignment) results in no Granger causality between GDP growth and REER misalignment series for all the economies including China. Therefore, the test results reported in Table 3 are based on a 2-variable VAR. It is easily seen from the table that the evidence is decisively one-sided: It is the REER misalignment which Granger-causes inflation rather than vice versa. In other words, the REER disequilibrium is shown to have a leading and ‘error-correction’ impact on the inflation dynamics.¹² In particular, this finding corroborates what has been diagnosed of the Japan’s trap by economists such as McKinnon *et al* (1999) and Obstfeld (2009). It sounds Chinese policy makers a warning of the inflation risk by over-adjusting exchange rates.

6. Concluding remarks

Let us review the questions raised in the introduction section. Remarkably, the empirical results provide us with no positive answers to any of the questions. Specifically, the long-run coefficient estimates of the REER models of the four economies do not corroborate the standard theories more than those estimated of the China model by Qin and He (2010) and the role of the factor of relative net foreign assets is as marginal and nonstandard. Further, their RMB misalignment estimates are not found to be unprecedented when compared to the estimated misalignment series of the four economies. For instance, the undervaluation of the Japanese yen prior to 1985 is found to be more severe, more universal and more price-differential based than that of the RMB during the mid 2000s; the Singapore dollar is not found to be undervalued in the decade from the late 1980s in spite of the rapid increase of the country’s current account surplus.

¹² Note that the error terms in model (1) would become effectively error-correction terms for inflation if we extend (1) into the error-correction model and assume rigidity of the nominal rate due to a controlled exchange rate regime.

In short, the empirical evidence yielded here shows that, were the RMB manipulated during the last decade, the ‘manipulation’ has been no more than that of the Japanese yen, the D-mark, the Singapore dollar or the Taiwan dollar in the recent history. It is thus non sequitur to assume that a fixed exchange rate regime should result in more severe rate misalignments or pricing differentials than regimes with freer exchange rate control, or that the currency of an economy must be undervalued if it experiences rapid build-up in its net foreign assets. However, it is beyond the scope of the present study to provide further evidence on how REER misalignments are related to trade and especially export growth, another aspect of ‘currency manipulation’, since the relationship entails more elaborate modelling of foreign trade flows with respect to both nominal exchange rate and relevant price movements, eg see Staiger and Stykes (2008).

Finally, our study suggests that the volatility in exchange rate disequilibrium subsequent to the rate adjustment is likely to propagate into a home economy via inflation. Policy makers should thus be aware of the possible side effect of exchange rate over-adjustment on inflation when such adjustment is considered as a major tool for correcting current account surplus.

Appendix. Variable definitions and sources

Variable definitions:

HE: Home economy, ie Japan, Germany, Singapore, Taiwan in turn; subscript i : trading partner country i in the panel.

$r_i = (\text{CPI(HE)}/\text{CPI}_i)(e_i/e(\text{HE currency}))$; e = exchange rate per US\$; all r_i series are adjusted to having the 2000Q1 value as one.

$\text{GDP}_i = (\text{per capita GDP(HE)}/\text{per capita GDP}_i)(e_i/e(\text{HE currency}))$

$\text{RPI}_i = (\text{CPI(HE)}/\text{PPI(HE)})/(\text{CPI}_i/\text{PPI}_i)$

$\text{NFA}_i = (\text{per capita NFA(HE)}/\text{per capita NFA}_i)$; NFA is calculated as the historical sum of current account balance

$W_i = (\text{HE's export}_i + \text{HE's import}_i)/(\text{sum of HE's exports and imports to all economies in the panel})$

Data sources and derivation:

Exchange rates: post-1999 data of France Franc, D-mark, Lire and Guilder are from Datastream; Taiwan dollar: 1977Q1-1980Q1 from IFS (IMF International Financial Statistics CD-ROM), 1980Q2-2000Q4 from Taiwan Quarterly Economic Indicators; the rest are from IFS.

CPI: Germany, Korea and Taiwan are from Datastream; the rest are from IFS, 2005=100.

PPI: France before 1998, German and Taiwan are from Datastream; the rest are wholesale prices or producer prices from IFS, 2005=100.

Population (annual): Germany is from Datastream, the rest are from IFS; quarterly series are interpolated.

Current account balance in US\$: Taiwan post-1979 data are from Datastream; Malaysia data of 1984-1998 and Singapore data of 1977-1994 are annual and used as the end of year observation; the rest are from IFS.

Exports and imports: Taiwan: 1977-1987 from Taiwan Monthly Statistics of Exports and Imports, 1988-2000 from Datastream; the rest are from IMF Direction of Trade Statistics.

GDP in constant price: Australia, Canada, France, Germany, Italy, Japan, Korea, the Netherlands, Sweden, Switzerland, UK, US are derived from IFS, except for Italy and Sweden of 1977-79, which are derived from Datastream; Singapore and Taiwan are calculated from Datastream; Malaysia of 1984-1987 and Thailand of 1977-1992 are calculated from the annual IFS data and interpolated into quarterly frequency, the rest period is calculated from IFS; the Philippines of 1977-1980 are calculated from Datastream annual data and interpolated into quarterly frequency, the post-1981 period is calculated from IFS. Series with significant seasonal fluctuations are seasonally adjusted using Eviews.

REER (BIS): from BIS website www.bis.org/statistics/eer/index.htm ;

REER (IMF): from IFS.

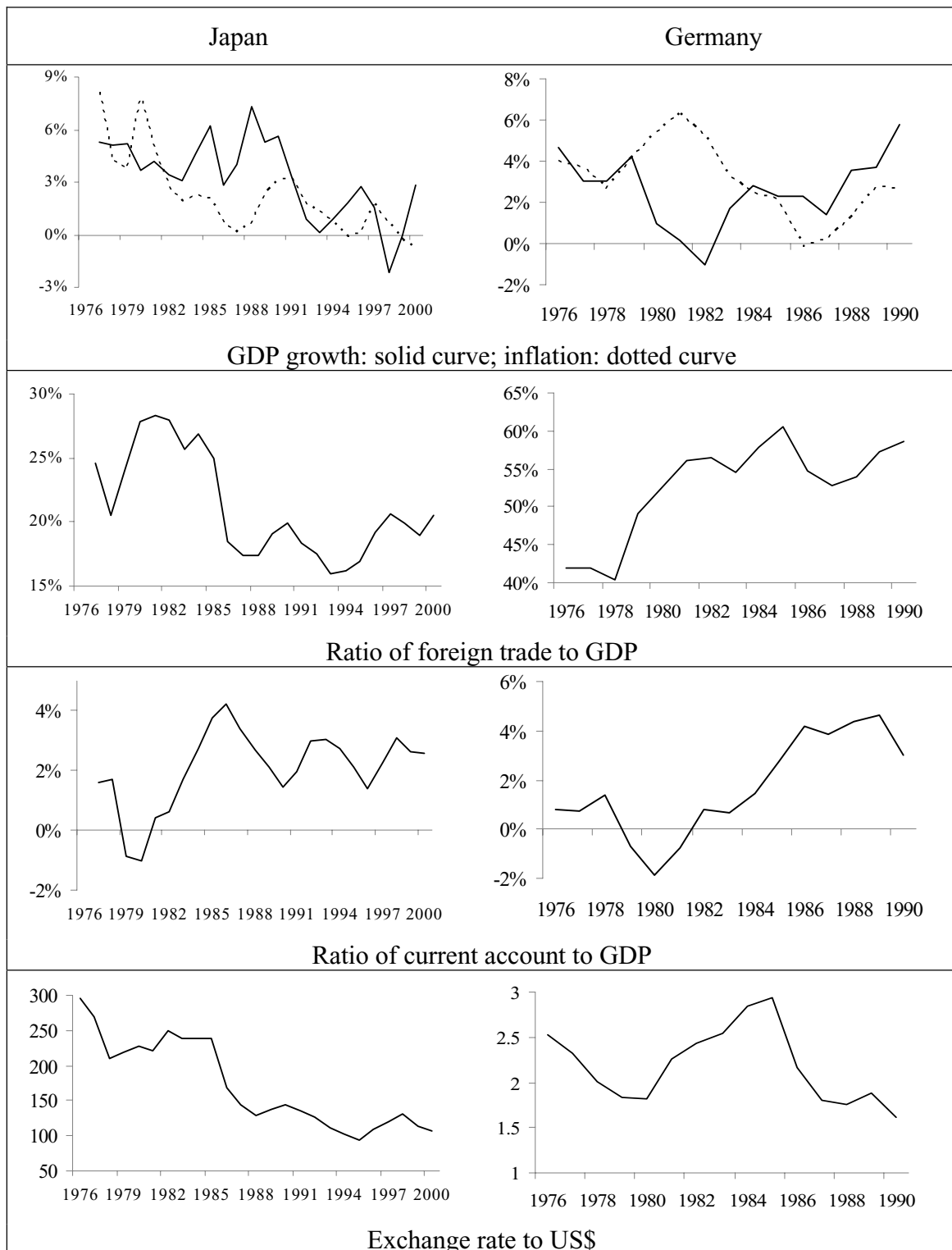
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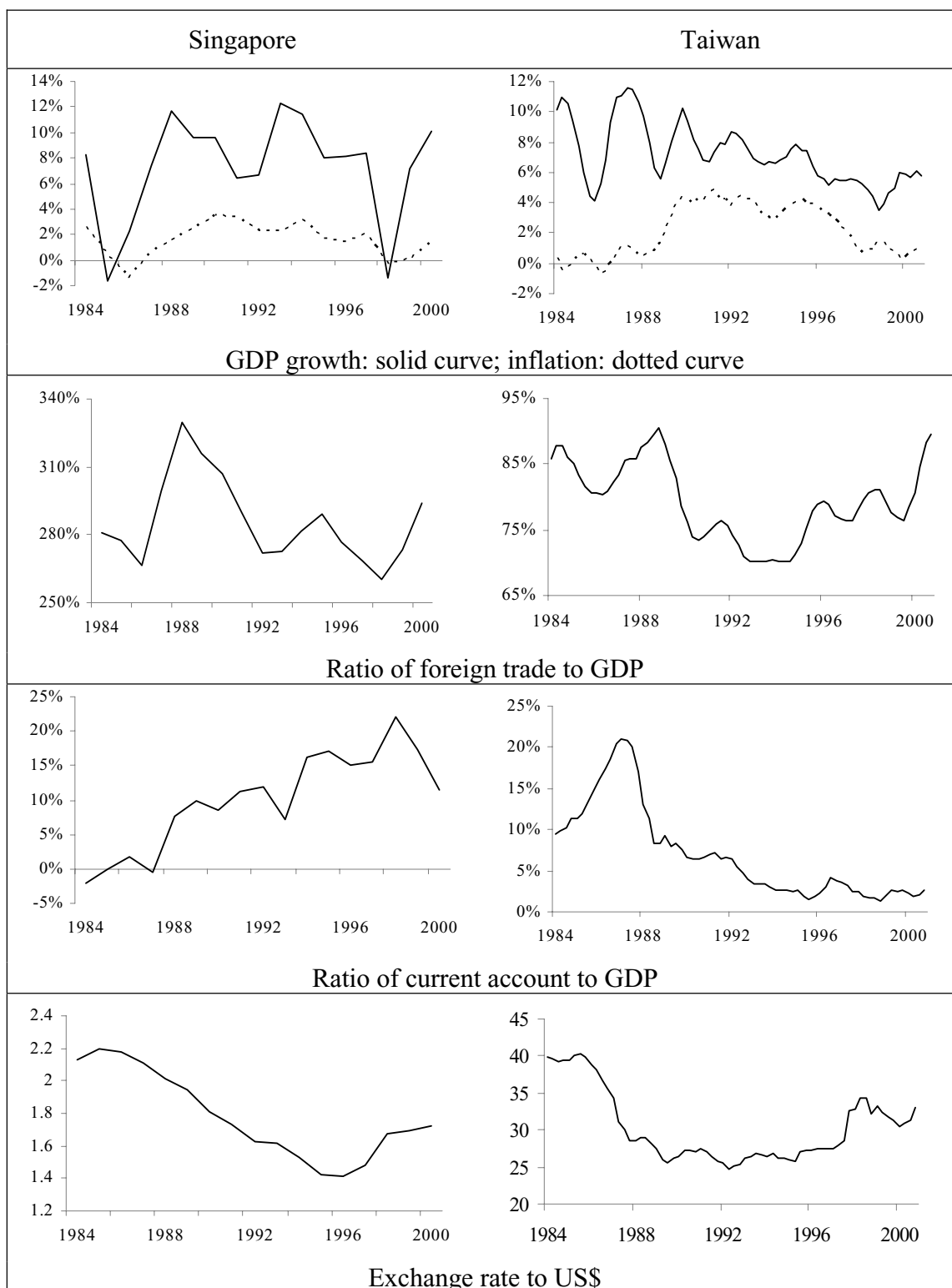
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Figure 1. Main macro indicators – Japan and West Germany



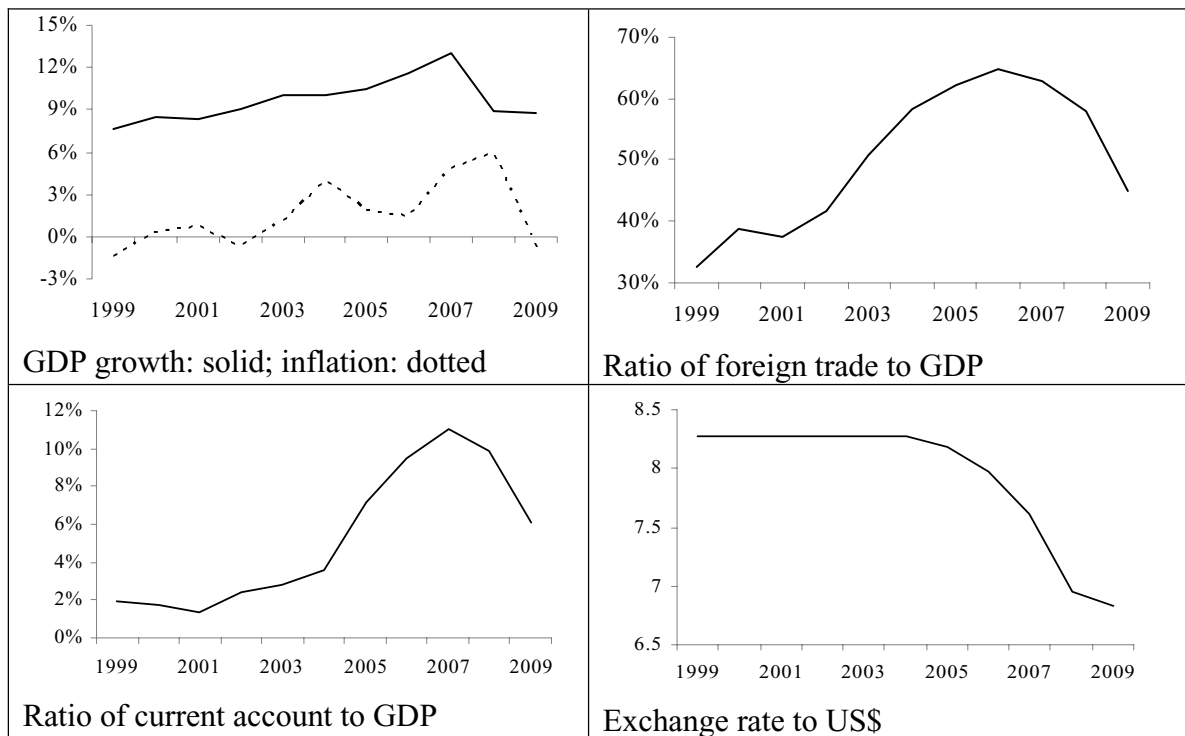
Data source: IMF IFS in annual frequency.

Figure 2. Main macro indicators – Singapore and Taiwan



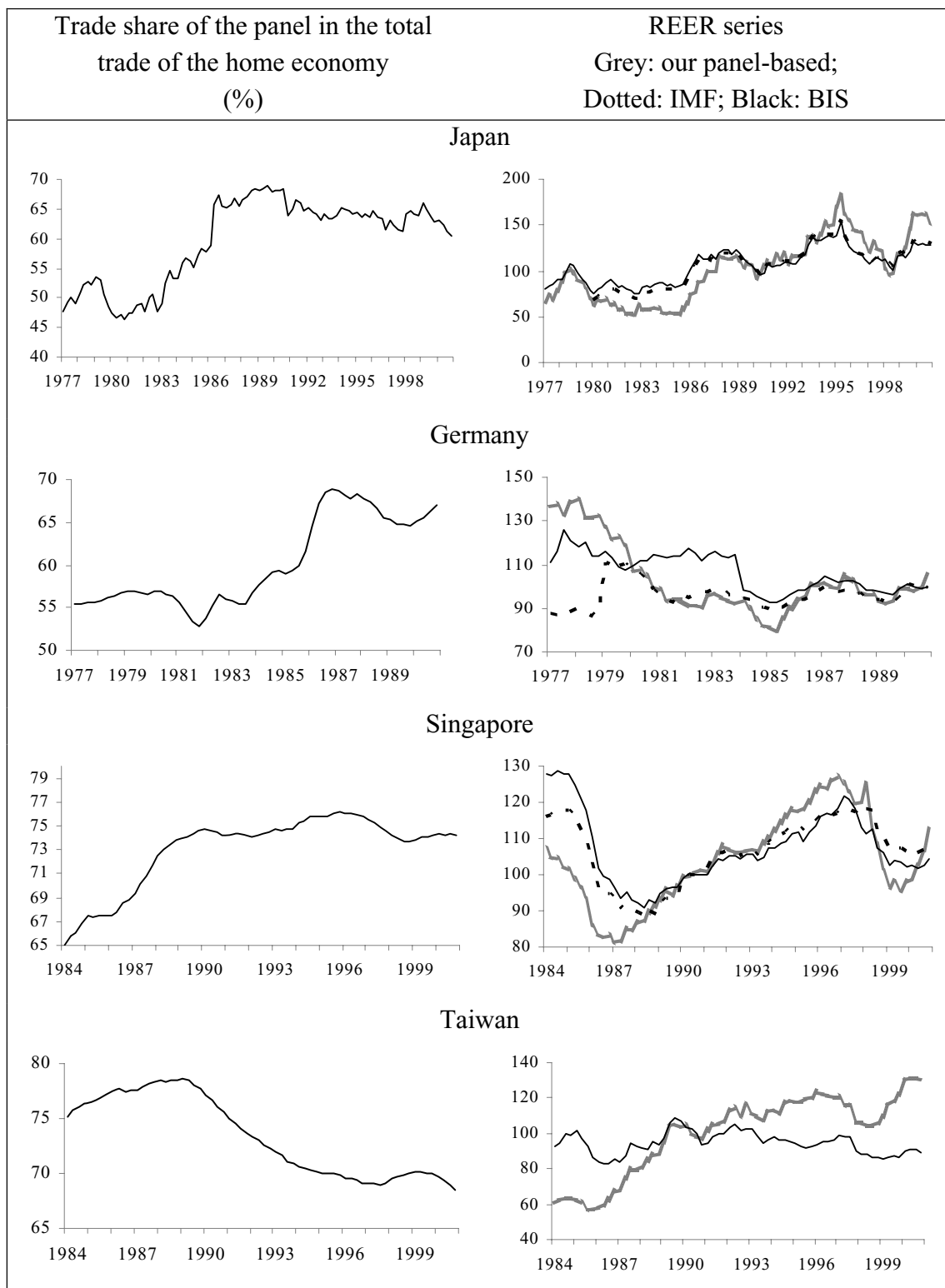
Data source: Singapore: IMF IFS in annual frequency; Taiwan: Datastream in quarterly frequency and some of the curves are taken as quarterly moving averages.

Figure 3. Main macro indicators – China



Data source: IMF IFS for the period 1999-2008 in annual frequency; 2009 data are from China Statistics Abstracts 2010.

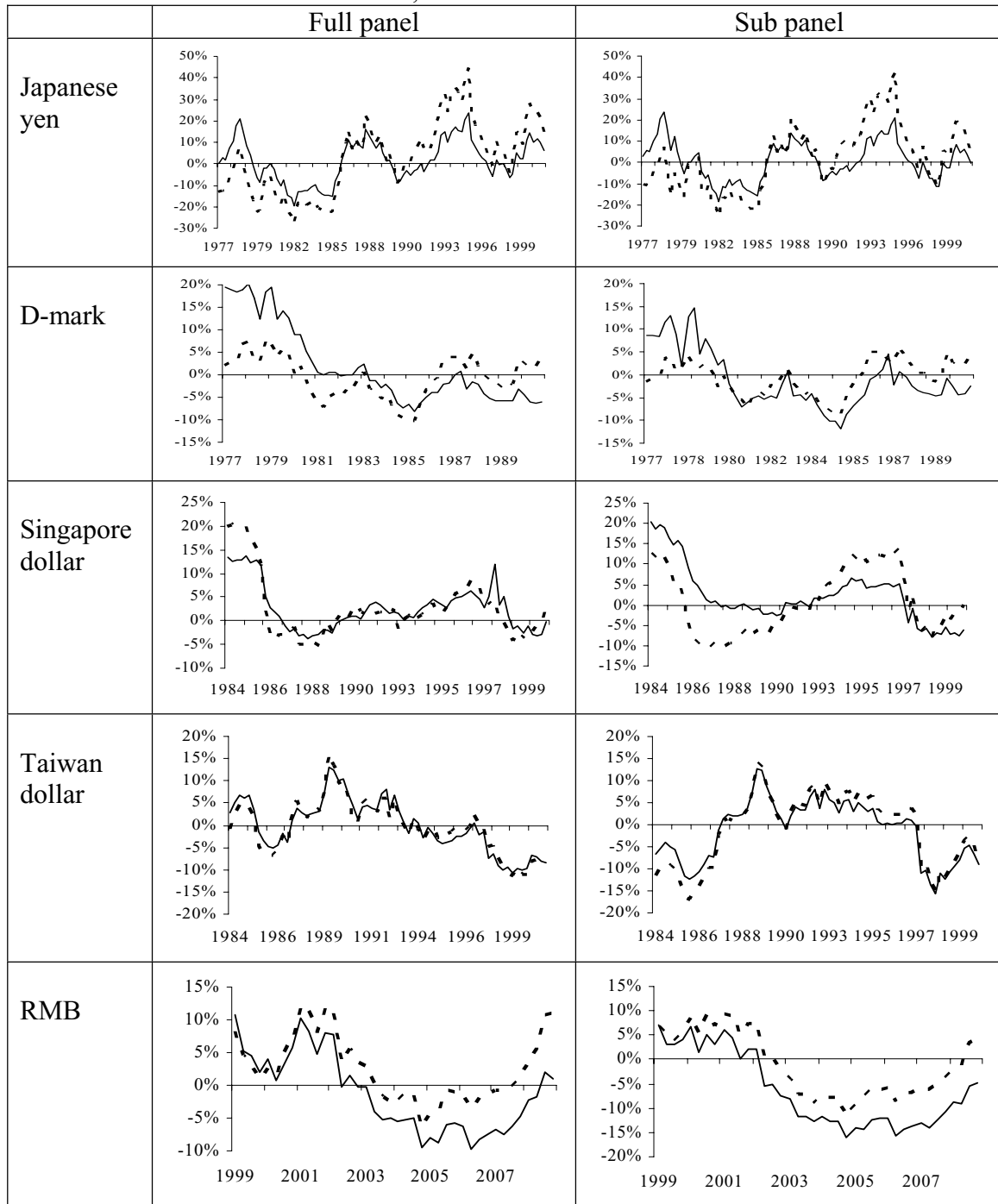
Figure 4. Trade shares of the panels and REER series



Data source: IMF IFS, BIS and Datastream. There is no Taiwan dollar REER from the IMF source.

Figure 5. REER misalignment series

Solid: GDP-based version; dotted: RPI-based version



Note: For the RMB misalignment series, the full panel consists of 22 trading partners and the sub-panel 7 partners covering the US and the Euro-zone countries from the full panel (see Qin and He, 2010).

Table 1. A sample of previous estimates of exchange rate misalignments

Study	Data	Misalignment estimates	Approach
Japanese Yen			
Song (1997)	1975-91 quarterly	REER (graph): Overvalued during 1980-2 for over 10%; undervalued around 5% during 1984-5; slightly overvalued 1986-9; undervalued about 10% in 1990.	NATREX model
Clark and McDonald (1998)	1960-96 annual	REER (graph and table): Undervalued slightly 1983-6; 10-17% undervaluation in 1990.	BEER
Isard and Mussa (1998)	Not specified	REER (table): 35% undervalued in 1985; 31% overvalued in 1995.	MBF (IMF)
Jeong and Mazier (2003)	1981-2000 annual	REER & bilateral rate to US\$ (graph): Undervalued during 1980-9, around 20% in REER and 35% in bilateral rate to US\$ in 1985.	FEER
Miyagawa et al. (2004)	1980-2000 annual	Nominal bilateral rate to US\$ (table): Undervalued around 10-200+% during 1980-5; overvalued around 10-50% during 1987-2000, except 1990.	PPP
Bénassy-Quéré et al. (2009)	1980-2004 quarterly	REER (graph and table): Undervalued above 20% during 1980-5; overvalued 1986-2001 except 1990 and 1997-8; 1988Q1: overvalued around 17-20% in REER or 21-24% in real bilateral rate to US\$	BEER and panel cointegration
Deutsche Mark			
Clark and McDonald (1998)	1960-96 annual	REER (graph and table): Undervalued up to 20% during 1973-80; slightly overvalued during 1981-8; 2% undervaluation in 1990.	BEER
Stein (1997)	1975-93 quarterly	REER (graph): Slightly overvalued during 1982-3; undervalued up to 5% during 1984-90 except for a brief overvaluation around 1988.	NATREX model
Isard and Mussa (1998)	Not specified	REER (table): 6% undervalued in 1985	MBF (IMF)
Fischer & Sauernheimer (2002)	1973-98 quarterly	REER (graph): Overvalued in late 1970s up to 10%; slightly undervalued around 1981 and 1985-6; overvalued from 1987 to early 1990s reaching 20% in 1990.	NATREX model

Singapore Dollar			
Montiel (1997)	1960-94 annual	REER: Undervalued up to 5% during 1980-5 and 1990-1; overvalued up to around 10% during 1986-89 and 1992-93.	BEER
Chinn (2000)	1970-97 monthly	Bilateral real rate to US\$ (graph and table): Undervalued in the 1990s except around 1991 and 1996; about 6% undervalued in May 1997.	PPP / BEER
Rajan and Siregar (2002)	1984-2000 quarterly	REER (graph): Undervalued during 1984-9 and 1993-8, with misalignment of less than 5%.	NATREX
MacDonald (2004)	1983-2003 quarterly	REER (graph): Overvalued up to about 8% during 1984-5 and 1997; mildly undervalued during 1986-7; clearly undervalued during 1998-2001.	BEER

Taiwan Dollar			
Chinn (2000)	1970-97 monthly	Bilateral real rate to Japanese yen and US\$ (graph and table): Overvalued up to 20% during 1990-3, and undervalued up to 20% during 1993-6 to the yen. Undervalued by 9% May 1997 to the US\$.	PPP / BEER
Miyagawa et al. (2004)	1980-2000 annual	Nominal bilateral rate to US\$ (table): Undervalued during 1980-96, from over 400% in 1981 to 3% in 1993; undervalued again after the East Asian crisis up to over 30% in 2000.	PPP

Note: NATREX stands for 'Natural real exchange rate', BEER for 'behavioural equilibrium exchange rate', FEER for 'fundamental equilibrium exchange rate', MBF for 'macroeconomic balanced framework' and PPP for 'purchasing power parity'.

Table 2. Key estimation results of model (1)

	The upper equation of (1)		The lower equation of (1)	
Conditioning variables	$\ln(GDP_{it})$	NFA_{it}	$\ln(RPI_{it})$	NFA_{it}
Japanese yen; sample period: 1977Q1-2000Q4; full panel				
DOLS	0.3365	-0.0001	1.4666	-0.0003
s.d.	0.0075	0.0001	0.0656	0.0001
\bar{R}^2	0.9974		0.9952	
Japanese yen; sample period: 1977Q1-2000Q4; sub panel				
DOLS	0.3528	0.0005	1.9462	0.0008
s.d.	0.0082	0.0002	0.0743	0.0003
\bar{R}^2	0.9985		0.9973	
D-mark; sample period: 1977Q1-1990Q4; full panel				
DOLS	0.3658	-0.0006	0.9167	-0.0003
s.d.	0.0231	0.0001	0.0904	0.0001
\bar{R}^2	0.9980		0.9978	
D-mark; sample period: 1977Q1-1990Q4; sub panel				
DOLS	0.0679	-0.0011	1.329	-0.0002
s.d.	0.0385	0.0003	0.0964	0.0002
\bar{R}^2	0.9984		0.999	
Singapore dollar; sample period: 1984Q1-2000Q4; full panel				
DOLS	0.2969	-0.000006	0.5399	-0.0001
s.d.	0.0121	0.0001	0.0419	0.0001
\bar{R}^2	0.9983		0.9974	
Singapore dollar; sample period: 1984Q1-2000Q4; sub panel				
DOLS	0.2827	-0.0003	0.1932	-0.0002
s.d.	0.0189	0.0002	0.0677	0.0002
\bar{R}^2	0.9975		0.9965	
Taiwan dollar; sample period 1984Q1-2000Q4; full panel				
DOLS	0.2556	-0.00004	0.7264	-0.00008
s.d.	0.0118	0.00006	0.0412	0.00007
\bar{R}^2	0.9987		0.9983	
Taiwan dollar; sample period 1984Q1-2000Q4; sub panel				
DOLS	0.1458	0.0003	0.2285	0.0003
s.d.	0.0177	0.0003	0.0685	0.0004
\bar{R}^2	0.9985		0.9979	

Note: s.d. stands for standard deviations.

Table 3. Granger non-causality tests: misalignments m_{1t} and m_{2t} versus inflation:

Panel	m_{1t}		m_{2t}	
	$m_{1t} \rightarrow$	$\rightarrow m_{1t}$	$m_{2t} \rightarrow$	$\rightarrow m_{2t}$
Japan (full)	4.6268 [0.0009]	0.7205 [0.610]	3.8844 [0.0033]	1.3919 [0.2362]
(sub panel)	3.6965 [0.0046]	0.4844 [0.7869]	2.1445 [0.0685]	0.8379 [0.5267]
Germany (full)	3.1223 [0.0243]	2.0273 [0.1075]	3.8990 [0.0087]	1.0235 [0.4060]
(sub panel)	2.7111 [0.0423]	1.7842 [0.1495]	4.1545 [0.0062]	1.1376 [0.3516]
Singapore (full)	2.6896 [0.0404]	3.0114 [0.0256]	4.1441 [0.0053]	0.7951 [0.5335]
(sub panel)	2.7288 [0.0382]	1.7920 [0.1436]	5.0468 [0.0015]	1.0700 [0.3802]
Taiwan (full)	0.5614 [0.7290]	1.0330 [0.3986]	0.5077 [0.7691]	1.3789 [0.2532]
(sub panel)	1.2995 [0.2785]	0.7206 [0.5816]	0.9662 [0.4471]	0.9670 [0.4430]
China (full)	3.3776 [0.0230]	1.0765 [0.3876]	1.7282 [0.1729]	1.1148 [0.3700]
(sub panel)	4.0518 [0.0106]	0.8606 [0.6000]	2.7041 [0.0515]	0.6813 [0.6110]

Note: The signs $m_{it} \rightarrow$ and $\rightarrow m_{it}$ indicate respectively whether misalignment G-causes inflation and whether inflation G-causes misalignment; statistics in brackets are probability values; Japan and Taiwan 5 lags; Germany, Singapore and China 4 lags.

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