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RENMINBI IN REGIONAL INTEGRATION

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The Illusion of Precision and the Role of the Renminbi in Regional Integration

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Abstract

The debate on renminbi (RMB) revaluation has not subsided, despite the policy change announced by the Chinese authorities in July 2005. In this chapter, we show that the evidence of RMB undervaluation may not be as strong as it appears. Specifically, depending on the method used, the evidence ranges from slight overvaluation to undervaluation. Even in the case of undervaluation, the results are not significant in the statistical sense. We also note that China is playing an important economic role in Asia and has established a complex production and trade network with its neighboring economies, which complicates the calculation of the equilibrium exchange rate. Thus, a change in Chinese exchange rate policy in response to demands from foreign countries and short-run considerations may have undesirable effects on the economies of China and the Asian region.

Key words: exchange rate policy, regional integration, market integration, purchasing power parity, Balassa-Samuelson, currency misalignment.

JEL classification: F31, F41

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1. Introduction

On July 21, 2005, China announced a long-anticipated revision to its exchange rate regime.[1] Against a backdrop of rising protectionist sentiment in the United States and increasingly acrimonious mutual recriminations over the benefits and costs of an open international financial system, the move was warmly, albeit cautiously, welcomed. The wariness arises from the uncertainty surrounding the exact nature of the new exchange rate regime and how rapidly the Chinese authorities are willing to allow the currency, the renminbi (RMB), to appreciate. So far, the increase in the RMB's value against the dollar has been quite modest – on the order of a few percentage points.

The intensity of the debate regarding the degree of RMB misalignment reflects the increasing role of China in the international arena and its rapid pace of export growth and penetration into global markets. Much of the pressure for RMB revaluation is driven by China's rapidly growing trade surplus with the US (and more recently with the rest of the world) and its accumulation of foreign reserves. On the other hand, China's domestic problems and its role in the regional production process have received limited attention in the debate.

While the theme of the current study is not to evaluate arguments advanced for RMB revaluation, it should be noted that China's external balances have not – until quite recently – constituted a *prima facie* case for RMB undervaluation. Economic theory, for instance, suggests that the RMB value should be linked to the magnitude of the overall trade balance instead of to the size of a given bilateral trade balance. Yet in 2004, China's trade surplus relative to GDP was not particularly large compared with those recorded by, say, Japan and Germany. With respect to reserve accumulation, however, the recent Chinese experience has been quite phenomenal. Nonetheless, official reserve holdings might be deemed insufficient as concerns over China's contingent liabilities come to the fore. For instance, one recent study estimates that, in 2005, China's total nonperforming loan liability, a key component of China's contingent liability, stood at $900 billion, a figure higher than its reserve holdings.[2]

The extant discussion routinely stresses the impact of RMB valuation on global trade relationships and global trade imbalances. We, however, would like to emphasize the role of modern China in East Asia and, thus, the implications of China's foreign exchange policy for the region. In this regard, two observations are worth mentioning. First, the Asian economies have tended to link their currencies to the US dollar via either a *de facto* or *de jure* peg, even after the 1997 financial crisis. As has been observed on a number of occasions, the policymakers in these economies tend to favor a stable foreign exchange environment, often perceived to be conducive to capital inflows and economic growth.[3] To the extent that these currencies were stabilized at low values, the East Asian exchange rate regimes are

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[1]   We use the term "China" to refer to the People's Republic of China, exclusive of Hong Kong, SAR, Macao, SAR, and Taiwan, R.O.C, sometimes referred to as Chinese Taipei or Taipei, China.

[2]   Ernst & Young (2006). The subsequent retraction of this report by the company does not negate the fact that there are substantial amounts of nonperforming loans, the estimation of which is surrounded by considerable uncertainty.

[3]   See Calvo and Reinhart (2000) for an explication of the "fear of floating" phenomenon.

often viewed as part of a mercantilist approach to economic development (e.g., Dooley *et al*., 2003 and 2006). Second, the evolution of China's position in international and regional markets is closely related to the trend toward the globalization of production. Specifically, declining transportation costs and decreasing trade barriers have precipitated the internationalization of the production process, a phenomenon variously termed production fragmentation or vertical specialization (Arndt, 1997; Yi, 2003). Given these circumstances, China, with its incentive structure and its abundant labor, has grown into a key production/manufacturing hub for East Asia, mainly serving as the last segment in the international production chain. A by-product of the manufacturing relocation process is an upsurge in intra-regional trade between China and its neighboring economies.

The integration of China into the world economy has brought about substantial adjustment in production and trade in developing economies, especially those in East Asia. These economies, which beside their extensive production and trade linkages with China possess both real and financial sectors that are less sophisticated than those in developed countries, are very susceptible to the (adverse) effects of RMB exchange rate volatility. Thus, China's exchange rate policy has implications for both its domestic economy and that of the wider Asian region.

In this chapter, we step back from the debate about the merits of one exchange rate regime versus another [4] and, indeed, do not take a stand upon how large a revaluation – or devaluation – is necessary (although our conclusions will inform the debate over what the appropriate actions might be). Rather, we re-orient the discussion of currency misalignment back toward theory and empirics; in particular, we want to focus on the difficulty in defining and calculating the "equilibrium (real) exchange rate" in theory and on quantifying the uncertainty surrounding the measurement of the level of the equilibrium.

Why is such a re-assessment necessary? We think it is necessary to review the evidence and conclusions in the context of the various underlying premises. That is, like the story lines in *Rashomon*, each analyst seems to have a different interpretation of what constitutes misalignment.[5] At the heart of the differences are contrasting ideas about what constitutes an equilibrium condition, to what time frame the equilibrium pertains, and, consequently, what econometric method to implement. Even when there is agreement on the fundamental model, questions typically remain about the right variables to use.

The flux of exchange rate economics offers a hint of our main argument. Since Meese and Rogoff published their seminal piece on the difficulties inherent to empirical exchange rate modeling in 1983, a voluminous collection of studies echoing their conclusion has accumulated.[6] Given the lack of a commonly agreed theoretical model, assertions about the equilibrium (and disequilibrium) level of an exchange rate should be guided by numerous caveats. A hasty decision on RMB policy based on not well-founded

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[4] See among others, Eichengreen (2005), Goldstein (2004), Prasad *et al*. (2005), and Williamson (2005).

[5] For a review of the concepts of misalignment and the distinction between short-run and long-run disequilibria, see articles in Hinkle and Montiel (1999). As Frankel (2005) observes, there is a question about whether there is such a thing as an "equilibrium" exchange rate when there are two or more targets (e.g., internal *and* external equilibrium).

[6] Meese and Rogoff (1983). Cheung, Chinn, and Garcia Pascual (2005a, 2005b) present some recent evidence on this issue.

evidence can do more harm than benefit to China and to its trading partners, especially the developing economies in the region.

2. The Extant Literature

A couple of surveys of the RMB misalignment literature have compared the estimates of the degree to which the RMB is misaligned. GAO (2005) provides a comparison of the academic and policy literature, while Cairns (2005b) briefly surveys recent point estimates obtained by different analysts. Here, we review the literature to focus on primarily theoretical papers and their economic and econometric distinctions. Most of these papers fall into familiar categories, either relying upon some form of relative purchasing power parity (PPP) or cost competitiveness calculation, the modeling of deviations from absolute PPP, a composite model incorporating several channels of effects (sometimes called behavioral equilibrium exchange rate models), or flow equilibrium models. Table 1 provides a typology of these approaches, further disaggregated by the data dimension (cross section, time series or both).[7]

The relative PPP comparisons are the easiest to make, in terms of calculations. Bilateral real exchange rates are easy to calculate, and there are now a number of trade-weighted series that incorporate China. On the other hand, relative PPP in levels requires the cointegration of the price indices with the nominal exchange rate (or, equivalently, the stationarity of the real exchange rate),[8] but these conditions do not necessarily hold, regardless of the deflator adopted in empirical analyses. Wang (2004) reports interesting IMF estimates of unit labor cost deflated RMB. This series has appreciated in real terms since 1997; of course, this comparison, like all other comparisons based upon indices, depends upon selecting a year that is deemed to represent equilibrium. Selecting a year before 1992 would imply that the RMB has depreciated over time.

Bosworth (2004), Frankel (2005), Coudert and Couharde (2005), and Cairns (2005b) estimate the relationship between the deviation from absolute PPP and relative per capita income. All obtain similar results regarding the relationship between the two variables, although Coudert and Couharde fail to detect this link for the RMB.

Zhang (2001), Wang (2004), and Funke and Rahn (2005) implement what could broadly be described as behavioral equilibrium exchange rate (BEER) specifications.[9] These models incorporate a variety of channels through which the real exchange rate is affected. Since each author selects different variables to include, the implied misalignments will necessarily vary.

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[7]   Note that several authors rely upon multiple approaches.

[8]   For a technical discussion, see Chinn (2000a).

[9]   Also known as BEERs, a composite of exchange rate models.

Other approaches center on flow equilibria, considering savings and investment behavior and the resulting implied current account. The equilibrium exchange rate is derived from the implied medium-term current account using import and export elasticities. In the IMF's "macroeconomic approach", the "norms" are estimated, in the spirit of Chinn and Prasad (2003). Wang (2004) discusses the difficulties in using this approach for China but does not present estimates of misalignment based upon this framework. Coudert and Couharde (2005) implement a similar approach. Finally, the external balances approach relies upon assessments of the persistent components of the balance of payments condition (Goldstein, 2004; Bosworth, 2004). This last set of approaches is perhaps most useful for conducting short-term analyses. But the wide dispersion in implied misalignments reflects the difficulties in making judgments about what constitutes persistent capital flows. For instance, Prasad and Wei (2005), examining the composition of capital inflows into and out of China, argue that much of the reserve accumulation that has occurred in recent years is due to speculative inflow; hence, the degree of misalignment is small.

Moreover, such judgments based upon flow criteria must condition their conclusions on the existence of effective capital controls. This is an obvious – and widely acknowledged – point (e.g., Holtz-Eakin, 2005), but one that bears repeating and, indeed, is a point that we will return to at the end of this paper.

Two observations are of interest. First, as noted by Cairns (2005a), there is an interesting relationship between the particular approach adopted by a study and the degree of misalignment found.[10] Analyses implementing relative PPP and related approaches indicate the least misalignment. Those adopting approaches focusing on the external accounts (either the current account or the current account plus some persistent component of capital flows) yield estimates that are in the intermediate range. Finally, studies implementing an absolute PPP methodology result in the greatest degree of estimated undervaluation.

Second, while all these papers make reference to the difficulty of applying such approaches in the context of an economy ridden with capital controls, state-owned banks,[11] and large contingent liabilities, few have attempted a closer examination of these issues.

The current chapter, and its working paper version (denoted as CCF, 2005a, in Table 1), contributes to this literature using the Balassa-Samuelson approach (in which productivity differentials are used) and implementing panel analyses of the PPP-income relationship, augmented by variables motivated from the BEER and macroeconomic balance literature.

3.   A Simple Time Series Approach

Before turning to the more elaborate frameworks for evaluating the value of the RMB, let us consider an approach often used in the aftermath of the East Asian crisis of the mid-1990s, namely, indicators of exchange rate overvaluation that are measured as deviations from a trend. Adopting this approach in

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[10]   All the studies reviewed by Cairns imply undervaluation or no misalignment.

[11]   See Cheung, Chinn, and Fujii (2005b) for a description of how financial links between the rest of the world and China are mediated by capital controls and the banking system.

the case of China would not lead to a very satisfactory result. Consider first what a simple examination of the bilateral real exchange rate between the US and the RMB using this measurement would imply. Figure 1 depicts the official exchange rate series from 1986:1 to 2005:2, deflated by the CPIs of the US and China (higher values constitute a stronger Chinese currency vis-à-vis the dollar). In line with expectations, in the years since the East Asian crises, the RMB has experienced a downward decline in value. Indeed, over the entire sample period, the RMB has experienced a downward trend.

However, as is often the case with economies experiencing transitions from controlled to partially decontrolled capital accounts and from dual to unified exchange rate regimes, there is some dispute over what exchange rate measure to use. In the Chinese case, it could be argued that, with a portion of transactions taking place at swap rates, the 1994 "mega-devaluation" would actually be better described as a unification of different rates of exchange.[12]

The import of this difference can be gleaned from the fact that the imputed time trends then exhibit quite different behaviors and imply different results. Using the "adjusted" rate, one finds a modest undervaluation of 4.8% in the second quarter of 2005. Using the official rate would imply a slight, almost imperceptible, overvaluation of 1.4%.

A natural reaction would be to argue that simple bilateral comparisons are faulty. We would agree. However, appealing to trade-weighted exchange rates would not necessarily clarify matters. Figure 2 depicts the IMF's trade-weighted effective exchange rate index and a linear trend estimated over the available sample period 1980-2005. One finds that a simple trend (as used in the "early warning" literature) indicates that the RMB is 25% overvalued.

A cursory glance at the data indicates that a simple trend will not do. A test on residuals from recursive regression procedure applied to the constant plus trend suggests a break with maximal probability in the third quarter of 1986. Fitting a broken trend – admittedly an ad hoc procedure – provides a fairly good fit, as illustrated in Figure 3. In the second portion of the sample, the estimated trend is essentially zero, a result that is consistent with purchasing power parity.

Obviously, a more formal test for stationarity is necessary. Following the methodology outlined in Chinn (2000a), we test for cointegration of the nominal (trade-weighted) exchange rate and the relative price level.[13] We find that there is evidence for cointegration of these two variables, with the posited coefficients.[14] This means that we can use this trend line as a statistically valid indication of the mean value to which the real exchange rate series reverts.

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[12] See Fernald, Edison, and Loungani (1999) for a discussion in the context of whether the 1994 "devaluation" caused the 1997-98 currency crises.

[13] See Cheung and Lai (1993a) for a motivation for using the cointegration technique to investigate the stationarity of real exchange rates.

[14] See Appendix 2 for detailed results.

Interestingly, even here, the procedure indicates a very modest 2.1% undervaluation. These conclusions are not sensitive to the index. Using Deutsche Bank's PPI-deflated index, similar movements in the RMB are detected.

Before we move on to the next section, we should point out that the data in Figures 1 and 2 are indexes and do not give the exact exchange value of the underlying currencies. To be sure, the conclusion regarding overvaluation or undervaluation depends on how the trend line is drawn, which in turn depends on the starting point of the sample.

4. The Productivity Approach

The role of productivity is central to thinking about the evolution of the Chinese currency. The standard point of reference in thinking about the impact of productivity is the Balassa-Samuelson theory, which focuses on the differential between traded and nontraded sectors (Balassa, 1964; Samuelson, 1964). Interestingly, to our knowledge, nobody has attempted to estimate the link between sectoral productivity estimates and the real exchange rate for China, with the exception of Chinn (2000b).[15]

4.1 Nontradables, Productivity, and the Real Exchange Rate in Theory

Most investigations of the link between the relative price of nontradables and the real exchange rate rely upon the following construction. Let the log aggregate price index p be given as a weighted average of log price indices of traded (*T*) and nontraded (*N*) goods given by the relationship

$$p_t = (1 - \alpha)\, p_t^T + \alpha\, p_t^N, \tag{1}$$

where α is the share of nontraded goods in the price index. Suppose further that the foreign country's aggregate price index is similarly expressed by

$$p_t^* = (1 - \alpha^*)\, p_t^{T*} + \alpha^*\, p_t^{N*}. \tag{2}$$

Then, the real exchange rate is given by

$$q_t \equiv (s_t + p_t^* - p_t) + \kappa, \tag{3}$$

where s is the log of the domestic currency price of foreign currency and κ is a constant accounting for the fact that the price levels are indices. In other words, even though productivity is being accounted for, the very fact that we only have price and productivity indices means that we can only evaluate deviations from a relative PPP modified for productivity differentials.

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[15] Ceglowski and Golub (2005) do calculate relative unit labor costs. If one thought that unit labor costs should be equalized, this would provide a basis for a calculation of equilibrium exchange rates, based solely on the tradables (manufacturing) sector.

For $\alpha = \alpha^*$, the following holds:

$$q_t = (s_t + p_t^T - p_t^{T*}) - \alpha[(p_t^N - p_t^T) - (p_t^{N*} - p_t^{T*})] + \kappa. \qquad (4)$$

Although there are many alternative decompositions that can be undertaken, equation (4) is the most relevant, since most economic models make reference to the second term as the determinant of the real exchange rate, while the first is assumed to be zero by the application of purchasing power parity to traded goods.

In order to move away from accounting identities, one requires a model, such as the Balassa-Samuelson framework. The relative prices of nontradables and tradables will be determined solely by productivity differentials, under the stringent conditions that capital is perfectly mobile internationally and that factors of production are free to move between sectors. Substituting out for relative prices yields

$$q_t = (s_t + p_t^T - p_t^{T*}) - \alpha[(\theta^N / \theta^T)a_t^T - a_t^N] + \alpha[(\theta^{N*} / \theta^{T*})a_t^{T*} - a_t^{N*}] + \tilde{\kappa}, \qquad (5)$$

where a^i is total factor productivity in sector i ($i = N, T$) and the θs are parameters in the production functions.[16]

Most researchers have proceeded under the assumption that the first term is I(0). This implies cointegrating relationships of the forms

$$q_t = -\alpha(p_t^N - p_t^T) + \alpha(p_t^{N*} - p_t^{T*}) \qquad (6)$$

and

$$q_t = -\alpha[a_t^T - a_t^N] + \alpha[a_t^{T*} - a_t^{N*}] \qquad (7)$$

$$q_t = -\alpha[a_t^T - a_t^{T*}] + \alpha[a_t^N - a_t^{N*}], \qquad (7')$$

respectively (where the production functions in the tradable and nontradable sectors are assumed to be the same, so that the θs cancel out in equation (7) and the constants are suppressed). Equation (6) underpins the analysis by Funke and Rahn (2005). Equation (7') provides the basis for the empirical work in this section.[17]

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[16] Note that if the production functions have the same form in the two sectors, then the θs drop out.

[17] Both equations have been exploited extensively. Equation (6) has been examined by Kakkar and Ogaki (1999) for several exchange rates. Equation (7) has been estimated by Hsieh (1982), Marston (1990), and most recently Choudhri and Khan (2004) and Lee and Tang (forthcoming).

4.2 Econometric Specification, Data, and Results

The cointegrating relationship is identified using dynamic OLS (DOLS; Stock and Watson, 1993). One lead and one lag of the right hand side variables are included. In a simple two-variable cointegrating relationship, the estimated regression equation is

$$q = \beta_0 + \beta_1 x + \sum_{i=-1}^{+1} \gamma_i \Delta x_{t+i} + u_t. \tag{8}$$

Although this approach presupposes that there is only one long-run relationship, this requirement is not problematic, as in these extended samples at most one cointegrating vector is usually detected.[18] A deterministic trend is also allowed in equation (8).

We take the two countries to be the US and China. In principle, it would be preferable to consider China vs. the rest of the world. However, data considerations, plus the fact that the misalignment debate revolves around the US-China nexus, motivate us to adopt this perspective.

The data issues present the largest challenges. The straightforward calculations involve the exchange rate and the US variables, although, even in the former instance, there are some calculations. For reasons discussed in Section 1, we do not rely upon the official exchange rate in the years directly leading up to 1994. Rather, the real RMB/USD rate is measured using the nominal exchange rate, which is then "adjusted," following Fernald *et al*. (1999), as described above, and then deflated by the respective CPIs. US data are derived from the Bureau of Labor Statistics and the Groningen Growth and Development Center.

Once one has to determine the appropriate Chinese productivity numbers, one enters a data quagmire. As is well known, even deciding upon the appropriate estimate of Chinese GDP can be a contentious matter (see Rossi, 2005). As demonstrated in Young's (2003) dissection of Chinese data, small changes in assumptions regarding the validity of the output numbers and the deflators can radically alter the implied output per worker and total factor productivity series substantially. Hence, all the estimates provided in this section should be viewed as heroic in nature.

Forging ahead, we follow the method adopted in Chinn (2000b). Average labor productivity, obtained by dividing real output in sector i by labor employment in the same sector, is used as the proxy for sectoral total factor productivity.[19] The tradables sector is proxied by the manufacturing sector, while the nontradables is proxied by the "other" sector. This latter sector is defined as those sectors besides mining, manufacturing, and agriculture.

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[18]   Application of the Johansen maximum likelihood procedure indicates evidence of cointegration at the 5% marginal significance level, using asymptotic critical values. The procedure is implemented by including two lags of the first differences (i.e., a VAR (3) in levels). The cointegration result holds irrespective of whether or not a deterministic trend is allowed for in the cointegrating vector.

[19]   Unfortunately, we could not obtain long enough series of sector-specific deflators, so we used the aggregate GDP deflator reported in Holz (2005) to deflate the sectoral output reported in the ADB's *Indicators of Developing Asian and Pacific Countries*. The employment figures are also drawn from this source.

Two limitations of the data should be stressed. First, since these labor employment statistics are not adjusted for part-time workers, the constructed sectoral productivity data are cross-checked using the manufacturing productivity reported by the World Bank's *World Development Indicators* for several countries. The productivity figures from these two sources match quite well. Further, these series also match quite well for both manufacturing vs. tradables and "other" vs. nontradables. These outcomes serve to improve one's confidence that the proxies used are not implausible.

Second, the proxy variable is labor productivity, rather than TFP as suggested by the model. Canzoneri *et al*. (1996) have argued that use of labor productivity is to be preferred because it is less likely to be tainted by misestimates of the capital stock. In any event, there is little possibility of circumventing this problem. To our knowledge, almost all calculations of East Asian total factor productivity over long spans of time have been conducted on an economy-wide basis, with a few exceptions, including Young (1995, 2003).

In addition to the productivity series calculated in the described manner, we also relied upon a productivity series obtained via a careful analysis of the state-owned enterprise (SOE) and township and village enterprise (TVE) output and employment figures reported by Szirmai *et al*. (2005). The two Chinese manufacturing productivity series, in logs, normalized to 1986=0, are shown in Figure 4. The productivity growth rates are 9.5% and 7.1%, respectively, over the 1987-2003 period. These are more rapid than the US manufacturing growth rate of 4.6% over the same period. Figure 5 depicts the Chinese "other" productivity series, which grows at a rate of 5.0% (compared to 2.0% for the US).

The DOLS results for estimations over the 1988-2002 period are reported in Table 2.[20] The estimates based upon productivity numbers calculated using output and employment figures are reported in columns [1]-[4], while those based upon the manufacturing estimates from Szirmai *et al*. (2005) are reported in columns [5]-[8].

In column [1], estimates from the most basic specification, corresponding to equation (7'), indicate that each one percent increase in Chinese manufacturing productivity over US productivity results in a half percentage point appreciation in the RMB against the dollar, in real terms. Increases in nontraded sector productivity depreciate the RMB, in line with the theoretical prediction. However, the point estimate is somewhat large; in general, when the productivity coefficients in the tradable and nontradable sectors are similar, the coefficient should be about equal to the share of nontradables in the aggregate price index. On the other hand, the standard error is so large that the ± 1 standard error bands encompass plausible values of α.

In column [2], the specification is augmented by a time trend. The point estimate for the coefficient on traded sector productivity is now larger in absolute value; however, neither the nontradables term nor the time trend itself is statistically significant, casting doubt on the relevance of this specification. Constraining the coefficients on tradables and nontradables productivity to be the same yields a

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[20] Since the DOLS procedure here uses one lead and lag of the right hand side variables, the sample is truncated to 2002 even when 2003 data is available. The levels observations for 2003 and 2004 are *not* used in the estimation procedure.

deterioration in the fit (the adjusted-R^2 declines, while the standard error of regression increases). Augmenting the constrained specification with a time trend produces estimates that are correctly signed and ascribes a large portion of the secular movement in the RMB – 3.5% per year – to the time trend. This is certainly an undesirable result for prediction purposes, since the time trend is a proxy for our ignorance.

Using the Szirmai *et al*. (2005) manufacturing numbers produces interesting results. In column [5], the coefficients are correctly signed, albeit somewhat large in absolute value. Interestingly, the point estimates are not sensitive to the inclusion of a time trend (column [6]). Constraining the coefficients on tradable and nontradable productivity to be equal yields plausible estimates of α. Including a time trend, as in column [8], produces more imprecisely estimated coefficients, while leaving the time trend insignificant.

For reasons already alluded to, one may be dubious about these results. An additional reason for skepticism is that the sample is quite short; using the DOLS approach results in a sample of only 15 observations. An obvious question is why we do not extend the sample backward.

Two reasons guide our sample choice. First, the data are available on a more or less consistent basis over this time period. Second, and perhaps of even greater importance, it is not clear whether extending the data back in time would be appropriate. The end of the second phase of economic liberalization, which severed the link between firm management and the government's economic plan objectives, roughly coincides with the beginning of the sample.

The data can be extended backward in time. Splicing data utilized in Chinn (2000b) to the series discussed above, the DOLS regressions can be re-estimated over the 1980-2004 period. This produces a sample of 22 observations (or 25, if simple OLS is implemented). The results are surprisingly similar to those reported in the first two columns of Table 2. The elasticity of the real exchange rate with respect to the intercountry traded sector productivity differential for the extended data set is -0.50, versus -0.56 for the truncated data used in Table 2, while the nontraded differential has an implausibly large impact of 2.2, versus the truncated data set's 1.1. The pattern of estimates persists even with the inclusion of a time trend.[21]

To sum up, it appears that, regardless of the measure of manufacturing productivity used, the coefficient estimates point in the directions predicted by the Balassa-Samuelson hypothesis.

4.3   Implied RMB Misalignment

In order to assess whether the RMB is misaligned, we take the long-run coefficients from columns [1] and [5] of Table 2 and generate long-run predicted values. One difficulty in conducting the assessment for the recent period is that the sectoral output and employment data are available only up to 2003.

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[21]   However, the results are *not* similar if the coefficients on the traded and nontraded sectors are constrained to be equal and opposite. The impact of productivity differentials disappears in this longer sample, unless a time trend is included. The sensitivity of the results to the inclusion of time trends is another reason to focus on the shorter sample.

Indeed, the estimated manufacturing labor productivity data from Szirmai *et al*. (2005) extends only up to 2002. We assume that, for the latter, the productivity growth rates in 2003 and 2004 are the same as the 2002 rate of 9.1%, while, for the former, the 2004 rate equals the 2003 rate of 4.8%.

Figure 6 depicts the results (higher values of the exchange rate imply weaker values of the RMB against the USD). Using the estimated productivity data, the RMB is only about 6.1% undervalued in 2004. Interestingly, the greatest degree of undervaluation is in 1993 (about 30%), and it *drops* in 1994 (to 16%), despite that year's "devaluation". Using the Szirmai *et al*. (2005) data, the 2004 undervaluation is negligible, at about 1.4%.

These counter-intuitive results suggest that something may be missing from this approach. This framework assumes that the relative prices of tradable and nontradable goods are determined solely by the relative production prices. This assumption, in turn, relies upon the assumption of homothetic preferences across different per capita income levels. But this is unlikely to be the case; hence, relative prices might be changing for reasons apart from differing productivity trends. In fact, the argument that much of the spectacular growth in Chinese income is due to labor reallocation rather than to rapid sectoral productivity growth is consistent with this view.[22]

Another difficulty with this approach is that it relies upon the relationship holding over the sample period. If the entire sample period were one in which the Chinese economy were *adjusting* toward a condition under which the Balassa-Samuelson hypothesis would hold–without actually achieving that condition– then this approach would be inappropriate. This is not a difficulty specific to the current approach. It also occurs in cases in which one is empirically validating purchasing power parity in levels but using price indices. The limitation of such approaches, based upon indices, motivates the use of measurements with which price levels can directly be compared.

5. Real Exchange Rate and Income Regression

In this section, we appeal to cross-country time-series evidence on the determinants of the real exchange rate, where the real exchange rate is measured in such a way that one can identify deviations from absolute purchasing power parity.

We conduct the analysis in the following manner. First, we will appeal to the well-known cross-sectional relationship between the relative price level and relative per capita income levels to determine whether the Chinese currency is undervalued. Obviously, this approach is not novel; it has been implemented recently by Coudert and Couharde (2005) and Frankel (2005). However, we will expand this approach along several directions. First, we augment the approach by incorporating the time series dimension.[23] Second, we explicitly characterize the uncertainty surrounding our determinations of currency misalignment.

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[22] This argument is most closely associated with Young (2003), as well as Brandt *et al*. (2005).

[23] Coudert and Couharde (2005) implement the absolute PPP regression on a cross-section, while their panel estimation relies upon estimating the relationship between the relative price level to relative tradables to nontradables price indices.

Frankel (2005) exploits the well-known relationship, noted in Summers and Heston (1991), between the real exchange rate and per capita income, as recorded in the Penn World Tables. When the real exchange value of a currency is expressed as the price in common currency terms ("international dollars") relative to the US price level, there is a positive, monotonic relationship to the relative per capita income.

We amass a large data set encompassing up to 158 countries, over the 1975-2003 period. (Because some data are missing, the panel is unbalanced.) Most of the data are drawn from the World Bank's *World Development Indicators* (*WDI*) and the Penn World Tables (Summers and Heston, 1991). Since the PWT data end with 2000, we update the sample using the *WDI* data up to 2003. Greater detail on the data used in this subsection and elsewhere is reported in Appendix 1.

We estimate the relationship using a pooled time-series cross-section regression, where all variables are expressed in terms relative to the US. The results are reported in Table 3, for cases in which we measure relative per capita income in terms of either market rates or PPP based exchange rates. Furthermore, to examine the robustness of the results with respect to different specifications, we report not only the pooled time-series cross-section estimates (our preferred specification) but also fixed effects and random effects models.[24]

In all cases, the elasticity of the price level with respect to relative per capita income is always around 0.22-0.33, which compares favorably with Frankel's (2005) 1990 and 2000 year cross-section estimates of 0.38 and 0.32, respectively.[25] Interestingly, the elasticity estimate does not appear to be sensitive to measurements of per capita income. In Tables 4 and 5, the actual and resulting predicted and standard error bands are reported.

We make two observations about these misalignment estimates. First, the RMB has been persistently undervalued by this criterion since the mid-1980s, even in 1997 and 1998, when China was lauded for its refusal to devalue its currency despite the threat to its competitive position.

Second, and perhaps most importantly, in 2003, the RMB was more than one standard error – but less than two standard errors – away from the predicted value, which in the present context is interpreted as the "equilibrium" value. In other words, by the standard statistical criterion that applied economists commonly appeal to, the RMB is not undervalued (as of 2003) in a statistically significant sense. Note that this uncertainty relies upon an agreement that we have identified *the* correct model; uncertainty regarding the true specification would add another layer of uncertainty.

Figures 7 and 8 provide a graphical depiction of the actual vs. predicted values (for USD and PPP based per capita incomes), the prediction intervals, and how the RMB fits into the more general relationship.

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[24]   Since the price levels being used are comparable across countries, in principle there is no need to incorporate currency-specific constants as in fixed effects or random effects regressions. In addition, fixed effects estimates are biased in the presence of serial correlation, which is obviously present in the data.

[25]   In addition to the obvious difference in the sample, our estimates differ from Frankel's in that we measure each country's (logged) real GDP per capita in terms relative to the US rather than in absolute terms. Hence, the resulting coefficient estimates are not necessarily directly comparable.

The wide dispersion of observations in the scatter plots should give pause to those who would make strong statements regarding the exact degree of misalignment.

It is interesting to consider the path that the RMB has traced out in these graphs. It starts out the samples as overvalued, and over the next three decades it moves toward the predicted equilibrium value and then overshoots, so that, by 2003, it is substantially undervalued – by between 47% and 54% in level terms (greater in log terms) by these point estimates.

Notice that the deviations from the conditional mean are persistent; this has an important implication for interpreting the degree of uncertainty surrounding these measures of misalignment. This suggests that deviations from the PPP-relative income relationship identified by the regression are persistent, or exhibit serial correlation. Frankel (2005) makes a similar observation, noting that half of the deviation of the RMB from the 1990 conditional mean exists in 2000. We estimate the autoregressive coefficient in our sample at approximately 0.74 to 0.84 (based on USD and PPP based per capita income figures, respectively) on an annual basis. A simple, *ad hoc* adjustment based upon the latter estimate suggests that the standard error of the regression should be adjusted upward by a factor equal to $[1/(1-\hat{\rho}^2)]^{0.5} \approx 2$. Figure 9 depicts the same data as presented in Figure 8, but with the standard errors adjusted to account for the serial correlation. In this case, the actual value of the RMB is always within one standard error prediction interval surrounding the equilibrium value.

6. Implications for Foreign Exchange Policy

The key rationale for undertaking this study was our strongly held conviction that many strong policy recommendations were being made on the basis of weak empirical evidence or vague theoretical underpinnings. In particular, we think that there needs to be some humility in recognizing the limitations of our knowledge regarding the appropriate model and the true nature of the relevant data.

In this study, contrary to the standard approach, we have documented the extent of our ignorance. The results should give one pause for thought. It may be that the Chinese currency is twenty to forty percent undervalued, as suggested by the macroeconomic balance approach. But that degree of misalignment pertains to a view of what constitutes equilibrium that obtains when the current account balance offsets the normal level of capital inflows as judged by some usually arbitrary criterion. The normal level, in turn, pertains to specific macroeconomic conditions that might – or might not – persist.

The biggest uncertainty pertains to shocks that are difficult to model but could nonetheless induce large changes to the equilibrium value of the exchange rate–namely, the shocks that could spring from contingent liabilities and loopholes of capital controls. The mere act of quickly revaluing – or of moving to a relatively free float – might in itself change the equilibrium exchange rate if it triggers corporate defaults or causes changes in the balance sheets of unhedged firms. The end of capital controls, either by fiat or by slow erosion, might also alter the equilibrium exchange rate.

It is also important to note that the regime of currency stability has up to this point served China well. The refusal of China to accede to competitive devaluation in the wake of the 1997 financial crisis helped

facilitate the recovery of the other East Asian economies. During the same period, the intensity of integration between China and its neighboring economies, as measured by intra-regional trade and financial transactions, was probably encouraged by the stable value of the RMB.

Thus, one natural concern is whether the Chinese economy, given its fragile financial systems and hidden domestic economic problems, is capable of handling a floating RMB exchange rate without incurring a substantial domestic economic backlash which would cause substantial repercussions for the regional and even the global economies. Even though some people perceive China to be a market economy, the reality is that China is still intrinsically a transitional economy with a relatively primitive and inefficient banking and financial sector. It is still in the early stage of devising and developing a prudential legal and regulatory framework that promotes governance and financial stability. It is highly questionable whether the current Chinese economy can withstand the potential financial instability induced by full foreign exchange flexibility. A volatile RMB exchange rate would most likely impede China's economic progress.

We also believe that China's Asian trading partners would suffer more from its economic slowdown than they would benefit from a stronger RMB. A volatile RMB is likely to impose extra costs on the integration between China and its neighboring economies and hinder the cooperation between these economies. With a growing role in an uncertain world, China's foreign exchange policy can have unexpected (instead of expected) effects on the world in general and to other regional economies in particular. Thus, in designing her exchange rate policy, China should not only consider the policy's short-term and long-term impacts on the Chinese economy but also take into account the policy's implications for the region.

That being said, we do believe that China should pursue a policy of gradually allowing the RMB to appreciate. Both the macroeconomic balance and real exchange rate-income models suggest some undervaluation. One can think of these two models as bracketing the short run and the long run. The productivity-based model is perhaps relevant to the idea of competitiveness over time, and even here there is some doubt. So the implied direction of change is dependent upon the horizon.

Nonetheless, in order to get to the medium run and the long run, one has to get through the short run. The rapid accumulation of foreign exchange reserves in 2005 – in contrast to that in the earlier years – can be attributed to a burgeoning current account surplus that has placed strains on the Chinese economy. With the fragile banking system having difficulties with assimilating this reserve accumulation, it makes sense for Chinese policymakers, *in their own interests*, to slow the pace of acquisition of dollar assets. The actual value of the RMB-USD exchange rate is not itself so crucial in this respect.

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Table 1. Studies of the Equilibrium Exchange Rate of the Renminbi

	Relative PPP, Competitiveness	Absolute PPP-Income Relationship	Balassa-Samuelson (with productivity)	BEER	Macroeconomic Balance/External Balance
Time Series	Wang (2004) CCF (2005a)	Bosworth (2004)	CCF (2005a)	Zhang (2001) Wang (2004) Funke & Rahn (2005)	Bosworth (2004) Goldstein (2004) Wang (2004)
Cross Section		Coudert & Couharde (2005) Frankel (2005)			
Panel		Cairns (2005b) CCF (2005a)		CCF (2005a)	Coudert & Couharde (2005)

Notes: Relative PPP indicates that the real exchange rate is calculated using price or cost indices and that no determinants are accounted for. Absolute PPP indicates the use of comparable price deflators to calculate the real exchange rate. Balassa-Samuelson (with productivity) indicates that the real exchange rate (calculated using price indices) is modeled as a function of sectoral productivity levels. BEER indicates composite models using net foreign assets, relative tradable to nontradable price ratios, trade openness, or other variables. Macroeconomic Balance indicates cases where the equilibrium real exchange rate is implicit in a "normal" current account (or combination of current account and persistent capital inflows, for the External Balance approach).

Table 2. Balassa-Samuelson Model of Real Exchange Rate of Renminbi, 1988-03

	Pred.	Official Deflator	Official Deflator	Official[a/] Deflator	Official[a/] Deflator	Szirmai Mfg.	Szirmai Mfg.	Szirmai Mfg.[a/]	Szirmai Mfg.[a/]
		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Mfg. prod.	(-)	-0.556	-0.921	-0.275	-0.987	-1.322	-1.204[†]	-0.512	-1.145
		[0.184]	[0.231]	[0.088]	[0.224]	[0.550]	[0.616]	[0.242]	[0.735]
Other prod.	(+)	1.122	1.087	0.275	0.987	1.788	1.882	0.512	1.145
		[0.516]	[0.527]	[0.088]	[0.224]	[0.748]	[0.724]	[0.242]	[0.735]
Trend			0.028		0.035		-0.007		0.010
			[0.022]		[0.009]		[0.014]		[0.008]
Adjusted R^2		0.77	0.76	0.71	0.8	0.79	0.76	0.73	0.73
N		15	15	15	15	15	15	15	15
SER		0.049	0.049	0.054	0.046	0.047	0.050	0.053	0.052

Notes: "Official Deflator" refers to estimates obtained using productivity figures calculated using official deflator as reported by Holz (2005); "Szirmai" refers to estimates obtained using manufacturing productivity numbers reported in Szirmai *et al*. (2005). All estimates use estimated effective exchange rate as described in Fernald *et al*. (1999). Estimates obtained using dynamic OLS (DOLS) with one lead and lag of the right hand side variables. "Mfg." ("Other") productivity is the differential labor productivity in the manufacturing (other) sectors. "Pred." is the predicted sign according to the Balassa-Samuelson hypothesis. SER is the standard error of regression. N is the number of observations.

[a/] Manufacturing and Other productivity are constrained to have equal and opposite signs.

Table 3. Panel Estimation Results of the Absolute PPP Plus (Ln(price)=c+b1*Ln(GDPpc)+u)

	USD-based GDP per capita				PPP-based GDP per capita			
	Pooled OLS	Between	Fixed effects (within)	Random effects	Pooled OLS	Between	Fixed effects (within)	Random effects
GDP p.c.	0.245***	0.252***	0.330***	0.276***	0.294***	0.297***	0.217***	0.250***
	(0.003)	(0.016)	(0.032)	(0.012)	(0.006)	(0.028)	(0.032)	(0.017)
Constant	-0.023**	-0.041	-	0.026	-0.140***	-0.183***	-	-0.272***
	(0.009)	(0.052)		(0.043)	(0.012)	(0.064)		(0.044)
Adjusted R^2	0.483	0.601	0.752	0.483	0.338	0.399	0.745	0.338
F-test for Homo. C			27.871***				40.466***	
Hausman Chisq(1)				3.277*				1.410
N	3880				3880			

Notes: Unbalanced panel of 174 countries x 29 years (1975-2003). ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively. Heteroskedasticity-robust standard errors are in parentheses. N is the number of observations.

Table 4. Actual and predicted price levels for China by panel (pooled OLS): USD-based GDP per capita

Year	Actual	Predicted	+2 std. err.	+1 std. err.	-1 std. err.	-2 std. err.
1975	-0.245	-1.249	-0.452	-0.851	-1.647	-2.046
1976	-0.344	-1.267	-0.470	-0.869	-1.666	-2.064
1977	-0.354	-1.261	-0.464	-0.863	-1.660	-2.058
1978	-0.308	-1.248	-0.451	-0.850	-1.647	-2.045
1979	-0.272	-1.239	-0.442	-0.840	-1.637	-2.035
1980	-0.287	-1.220	-0.423	-0.822	-1.619	-2.017
1981	-0.486	-1.215	-0.418	-0.816	-1.613	-2.011
1982	-0.661	-1.190	-0.393	-0.791	-1.588	-1.986
1983	-0.716	-1.176	-0.380	-0.778	-1.575	-1.973
1984	-0.872	-1.160	-0.363	-0.761	-1.558	-1.957
1985	-1.041	-1.140	-0.343	-0.741	-1.538	-1.936
1986	-1.174	-1.129	-0.332	-0.730	-1.527	-1.925
1987	-1.233	-1.111	-0.315	-0.713	-1.510	-1.908
1988	-1.161	-1.097	-0.300	-0.698	-1.495	-1.894
1989	-1.114	-1.097	-0.300	-0.699	-1.495	-1.894
1990	-1.331	-1.093	-0.296	-0.695	-1.491	-1.890
1991	-1.406	-1.071	-0.274	-0.673	-1.469	-1.868
1992	-1.385	-1.046	-0.249	-0.648	-1.445	-1.843
1993	-1.313	-1.021	-0.224	-0.623	-1.420	-1.818
1994	-1.555	-1.002	-0.205	-0.603	-1.400	-1.798
1995	-1.443	-0.983	-0.186	-0.585	-1.381	-1.780
1996	-1.399	-0.969	-0.173	-0.571	-1.367	-1.766
1997	-1.405	-0.959	-0.162	-0.561	-1.357	-1.756
1998	-1.453	-0.950	-0.153	-0.552	-1.348	-1.747
1999	-1.490	-0.944	-0.147	-0.545	-1.342	-1.740
2000	-1.510	-0.933	-0.136	-0.534	-1.331	-1.729
2001	-1.522	-0.915	-0.119	-0.517	-1.313	-1.712
2002	-1.530	-0.900	-0.103	-0.502	-1.298	-1.697
2003	-1.517	-0.885	-0.088	-0.487	-1.283	-1.682

Notes: Values in log terms. Based upon Table 3, USD pooled estimates.

Table 5. Actual and predicted price levels for China by panel (pooled OLS): PPP-adjusted GDP per capita

Year	Actual	Predicted	+2 std. err.	+1 std. err.	-1 std. err.	-2 std. err.
1975	-0.245	-1.176	-0.274	-0.725	-1.627	-2.078
1976	-0.344	-1.199	-0.297	-0.748	-1.649	-2.100
1977	-0.354	-1.190	-0.289	-0.740	-1.641	-2.092
1978	-0.308	-1.175	-0.274	-0.724	-1.626	-2.077
1979	-0.272	-1.164	-0.263	-0.713	-1.615	-2.066
1980	-0.287	-1.141	-0.240	-0.691	-1.592	-2.043
1981	-0.486	-1.134	-0.232	-0.683	-1.584	-2.035
1982	-0.661	-1.101	-0.200	-0.650	-1.552	-2.003
1983	-0.716	-1.090	-0.188	-0.639	-1.541	-1.991
1984	-0.872	-1.068	-0.167	-0.617	-1.519	-1.969
1985	-1.041	-1.044	-0.143	-0.593	-1.495	-1.946
1986	-1.174	-1.033	-0.131	-0.582	-1.483	-1.934
1987	-1.233	-1.010	-0.109	-0.560	-1.461	-1.912
1988	-1.161	-0.990	-0.089	-0.539	-1.441	-1.891
1989	-1.114	-0.994	-0.092	-0.543	-1.444	-1.895
1990	-1.331	-0.991	-0.089	-0.540	-1.441	-1.892
1991	-1.406	-0.964	-0.063	-0.514	-1.415	-1.866
1992	-1.385	-0.935	-0.034	-0.485	-1.386	-1.837
1993	-1.313	-0.906	-0.005	-0.455	-1.357	-1.807
1994	-1.555	-0.883	0.019	-0.432	-1.333	-1.784
1995	-1.443	-0.854	0.048	-0.403	-1.304	-1.755
1996	-1.399	-0.837	0.064	-0.386	-1.288	-1.738
1997	-1.405	-0.825	0.076	-0.374	-1.275	-1.726
1998	-1.453	-0.810	0.091	-0.359	-1.261	-1.711
1999	-1.490	-0.802	0.099	-0.351	-1.253	-1.703
2000	-1.510	-0.786	0.115	-0.336	-1.237	-1.688
2001	-1.522	-0.765	0.136	-0.315	-1.216	-1.667
2002	-1.530	-0.750	0.151	-0.299	-1.201	-1.651
2003	-1.517	-0.735	0.166	-0.285	-1.186	-1.636

Notes: Values in log terms. Based upon Table 3, PPP pooled estimates.

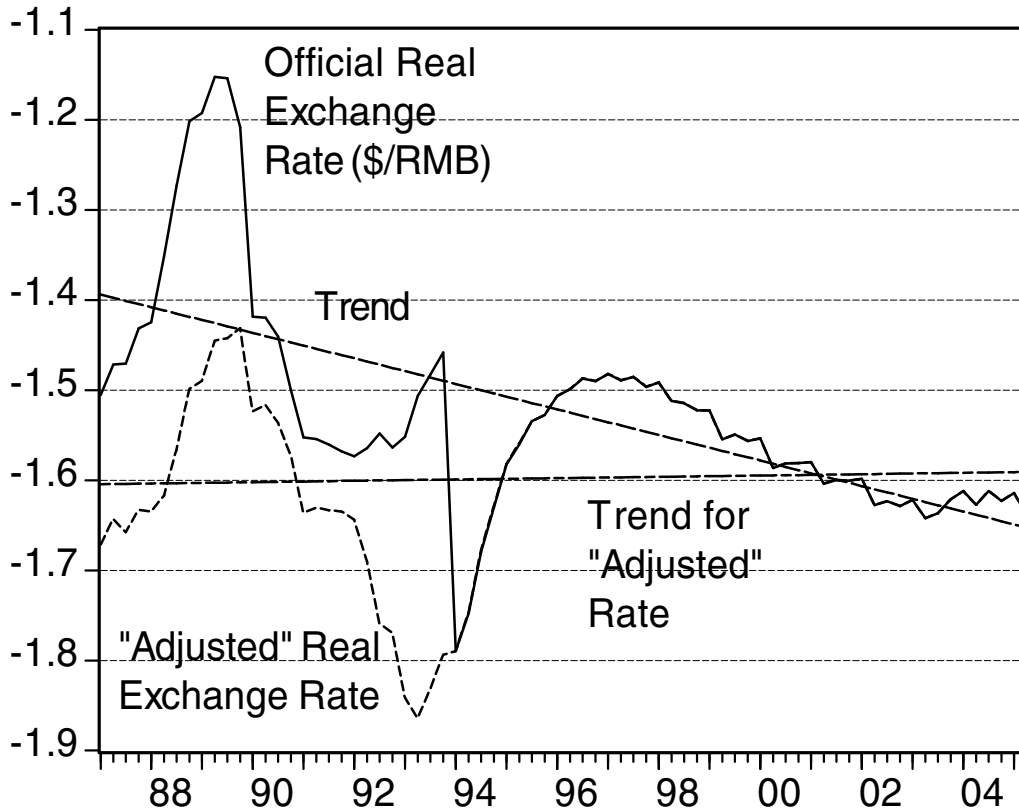**Figure 1. Real USD/RMB Exchange Rate, in logs (Official and "Adjusted") and Trends**

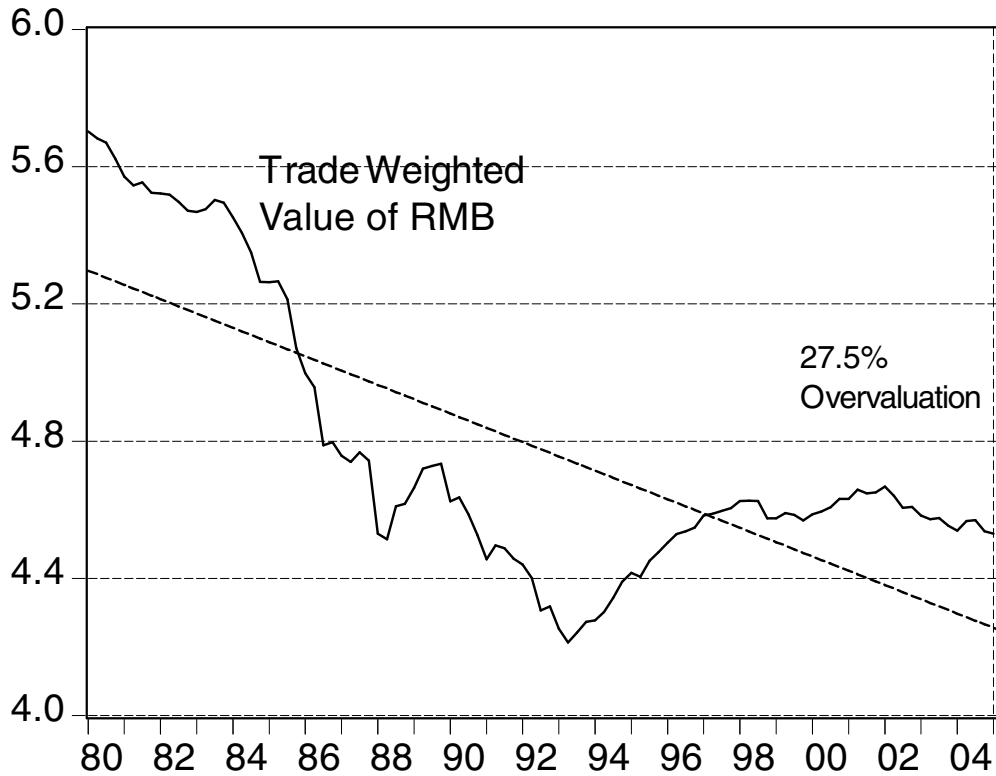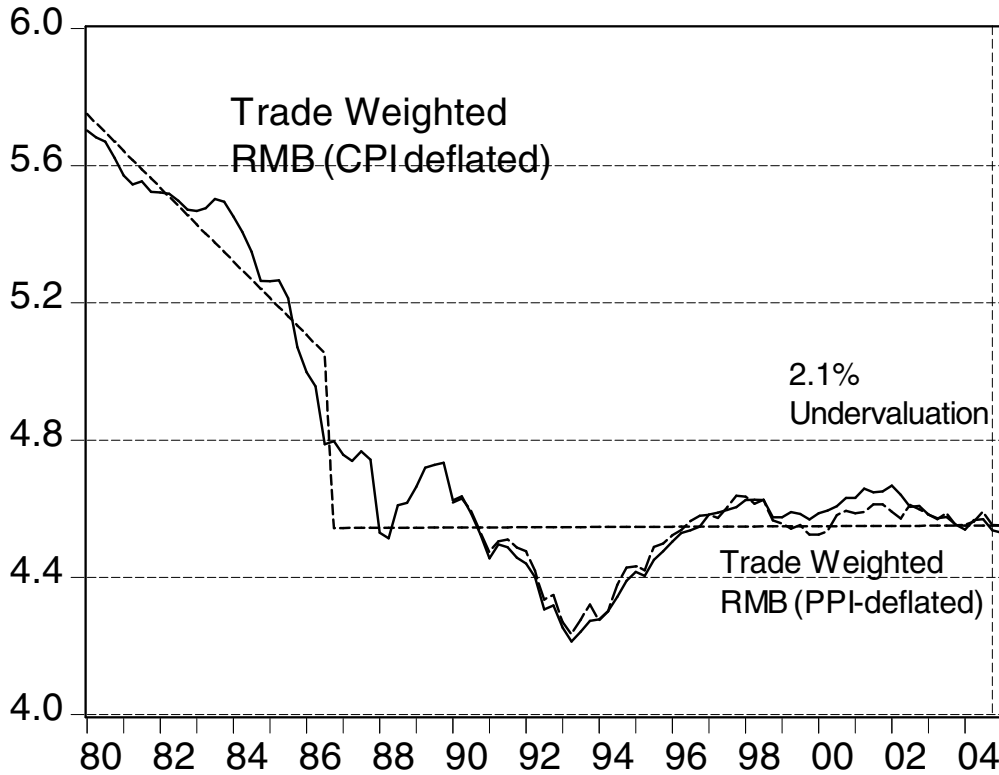**Figure 2. Real Trade-Weighted Value of RMB, in logs, and Trend**

Figure 3. Real Trade-Weighted Indices of RMB, in logs, and Segmented Trend.

Sources: IMF, Deutsche Bank, and author's calculations

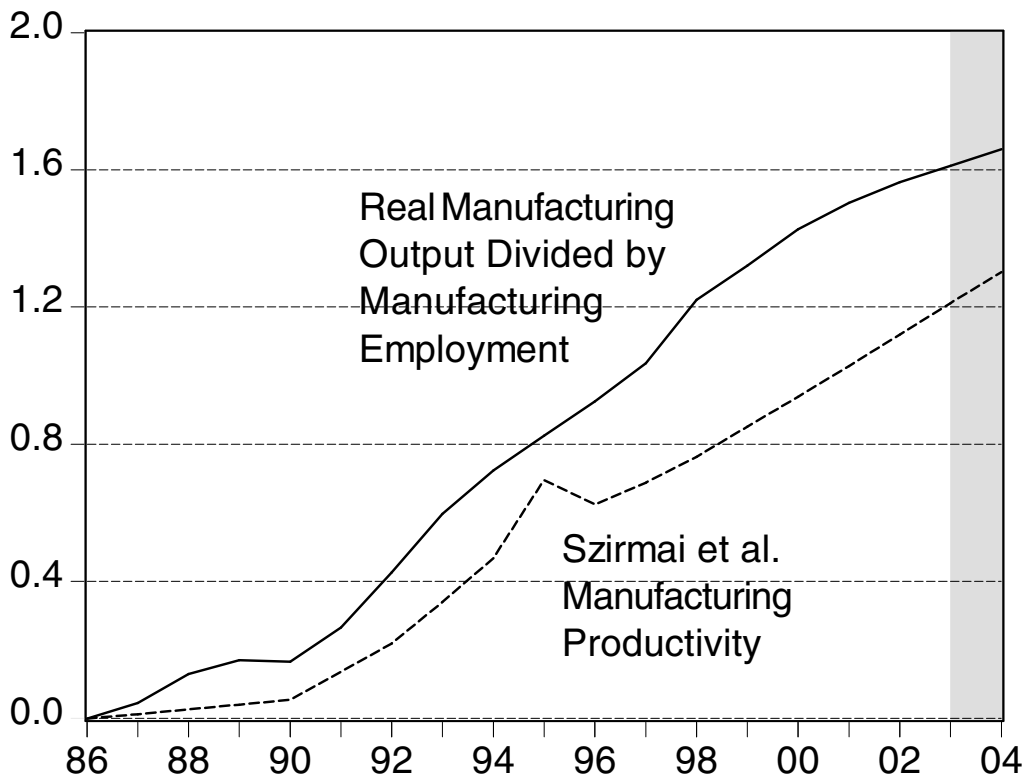**Figure 4: Measures of Chinese Manufacturing Productivity, in logs, normalized to 1986=0**

Figure 5. The Measure of "Other" Productivity, in logs, normalized to 1986=0

Figure 6. Real Bilateral ("Adjusted") Exchange Rate and Predicted Long Run Rate, in logs, based upon Estimated Productivity and Szirmai *et al*. (2005) Manufacturing Productivity
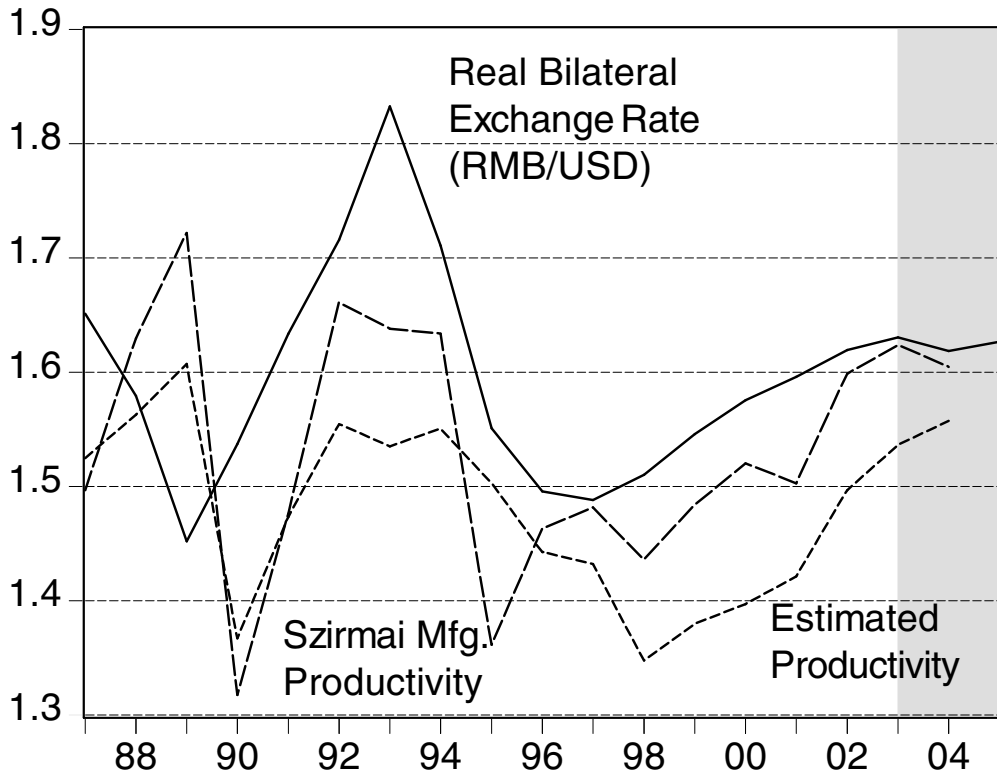
Figure 7. Scatter Plot of Relative Price Level against Relative Per Capita Income (in USD), Conditional Mean, and Prediction Intervals
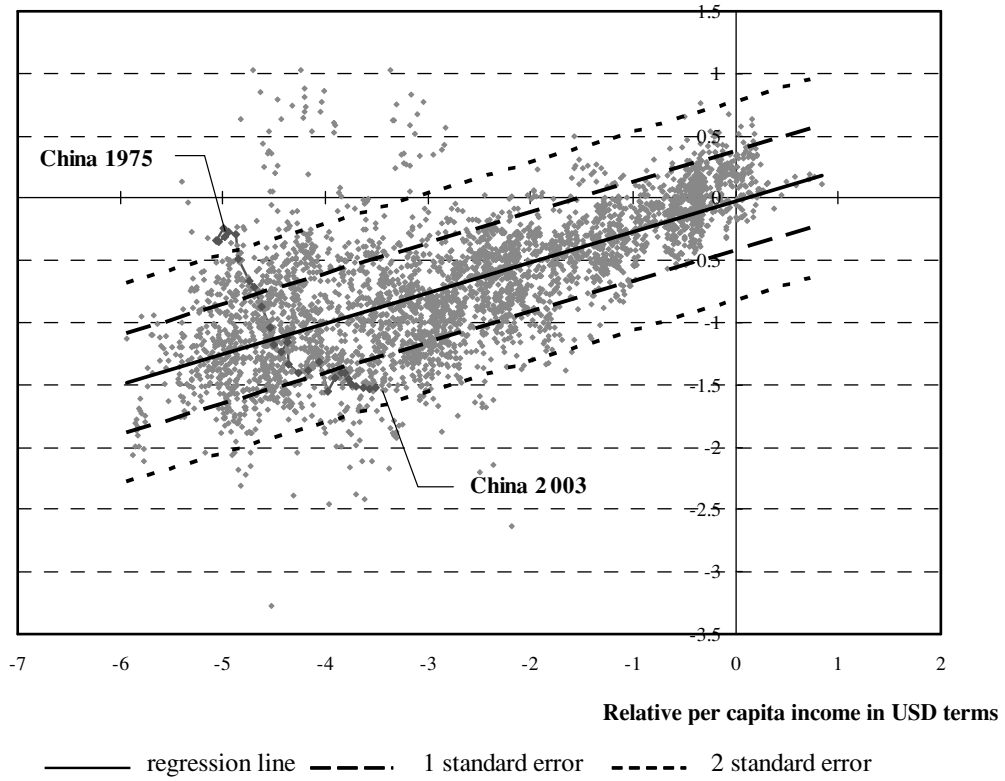
Figure 8. Scatter Plot of Relative Price Level against Relative Per Capita Income (in PPP terms), Conditional Mean, and Prediction Intervals

Relative price level

Relative per capita income in PPP terms

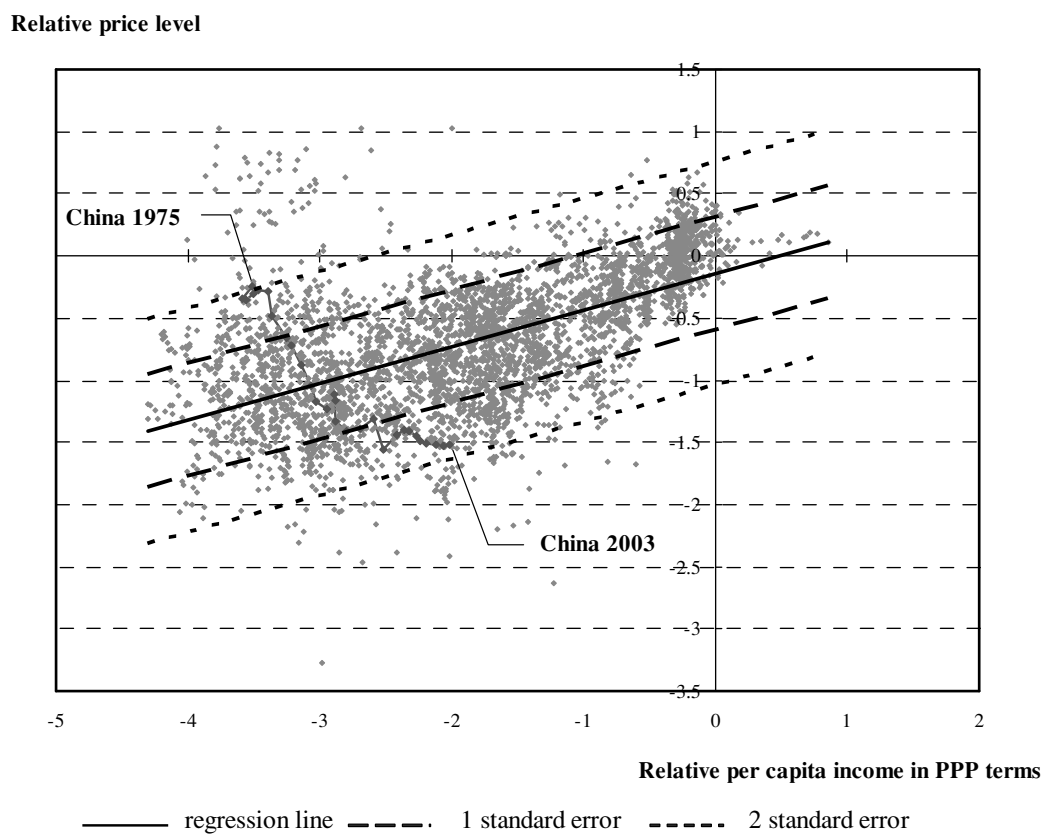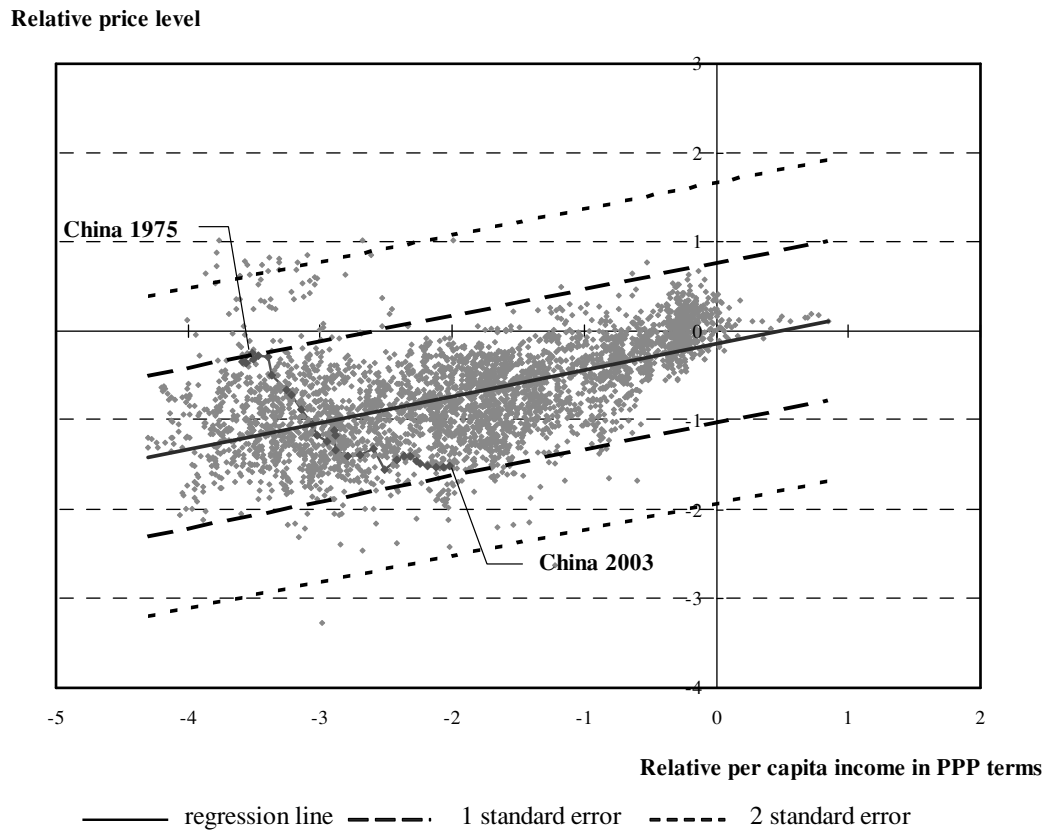——— regression line — — — 1 standard error - - - - 2 standard error

Figure 9. Scatter Plot of Relative Price Level against Relative Per Capita Income (in PPP terms), Conditional Mean, and Serial Correlation Adjusted Prediction Intervals

Relative price level

China 1975

China 2003

Relative per capita income in PPP terms

—— regression line – – – 1 standard error - - - - - 2 standard error

Appendix 1. Data and Sources

For Section 1

The nominal Renminbi exchange rate is the bilateral period average, expressed against the US$ (in $/f.c.u.), obtained from the IMF's *International Financial Statistics*, and from Hali Edison, for the "adjusted" exchange rates (Fernald *et al*., 1999). The CPIs are drawn from the CEIC database, extrapolated for 2004 and 2005 by using the CPI growth rates reported in *IFS*. The CPI-deflated trade-weighted exchange rate is drawn from IFS, while the PPI deflated series was provided by Michael Spencer at Deutsche Bank.

For Section 3

The nominal Renminbi exchange rate source is described in Section 1. Tradables and nontradables are proxied by manufacturing and by "other" (which includes mostly services, construction, and transportation), respectively.

For the United States, labor productivity in manufacturing: BLS (Foreign Labor Statistics website) "International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends, Supplementary Tables, 1950 - 2003".

http://www.bls.gov/fls/prodsupptabletoc.htm. US productivity in 2004 calculated from output and hours from BLS website, accessed 21 August. Labor productivity in "other" for 1979-2002 from 60-Industry Database (latest update February 2005).

http://www.ggdc.net/dseries/60-industry.shtml from Groningen Growth and Development Center. 1995 chained value added data and employment numbers for all industries above SIC 3. Productivity growth rate for 2003-04 set at the 2002 rate.

For China, the basic productivity data is calculated as the ratio of nominal sectoral output to sectoral employment, as reported in the Asian Development Bank's *Key Indicators of Developing Asian and Pacific Countries*. The Chinese real output series are obtained by deflating using the GDP price deflator (base year 2000), as reported in Holz (2005). The alternative manufacturing productivity index is drawn from Szirmai *et al*. (2005). 2003 data assumes 2002 productivity growth continues. 2004 figures for all Chinese data are extrapolated from 2003 growth rates.

Some additional results are also reported using a 1980-2004 sample. These results are based upon spliced series, where 1980-85 data on Chinese productivity is drawn from the database used in Chinn (2000b). Manufacturing productivity is that reported by the World Bank's *World Development Indicators*, while "Other" productivity is generated in the method described using data from the ADB and the ILO. The effective exchange rate is assumed to equal the official over the 1980-86 period.

For Section 4

The data for macroeconomic aggregates are mostly drawn from the World Bank's *World Development Indicators*. These include demographic variables, per capita income and government deficits. Relative price levels and per capita income are drawn from the Penn World Tables (Summers and Heston, 1991), as drawn from http://pwt.econ.upenn.edu/. Financial development indicators, including lending, stock and bond market capitalization, are drawn from the Beck *et al*. (2000). The capital controls index is from Chinn and Ito (forthcoming). The (inverse) corruption index is drawn from the *International Country Risk Guide*. Data for Taiwan are drawn from the Central Bank of China, ICSEAD, and ADB, *Key Indicators of Developing Asian and Pacific Countries*.

Appendix 2. Relative Purchasing Power Parity Tests

	Bilateral		Trade Weighted	
Panel A: Johansen Cointegration Tests				
k	3	3	2	2
#,#[#,#]	1,1[1,1]	2,2[2,2]	1,0[0,0]	2,0[2,0]
Spec.	w/o	w/trend	w/o	w/trend
β_1	1	1	1	1
β_2	1.503***	1.455***	0.765*	0.828
	(0.125)	(0.118)	(0.168)	(0.162)
Panel B: Horvath-Watson Cointegration Tests				
Wald	12.556		11.427	
Smpl	1987:4-2005:2	1987:4-2005:2	1987:1-2005:1	1987:1-2005:1
N	71	71	73	73

Notes: Panel A: k is lag in VAR specification. #,#[#,#] is the number of cointegrating vectors according to a likelihood ratio test on the trace, maximal eigenvalue statistic, using asymptotic [finite sample] critical values. Spec. indicates whether a deterministic trend is assumed to be in the data ("w/trend"), or not ("w/o"). Finite sample critical values are from Cheung and Lai (1993b). β_i are cointegrating vector coefficients. *(**)[***] denotes significance at the 10%(5%)[1%] MSL for the null hypothesis of $\beta_2 = 1$. Panel B: Wald is the Wald test statistic for the joint null that the reversion coefficients in the VECM representation are zero. Critical values are 9.72 (11.62)[15.41], from Horvath and Watson (1995). Smpl is sample, N is the number of observations.