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How Robust are Estimates of Equilibrium Real Exchange Rates: The Case of China

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How Robust are Estimates of Equilibrium Real Exchange Rates: The Case of China [1]

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Abstract

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The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate.

Increased attention is being paid to assessments of the actual values of countries' real exchange rates relative to their "equilibrium" values as suggested by "fundamental" determining factors. This paper assesses the robustness of alternative approaches and models commonly used to derive equilibrium real exchange rate estimates. Using China's currency to illustrate this analysis, the variance in estimates raises serious questions regarding how robust the results are. The basic conclusion from the tests used here is that, at least for China, small changes in model specifications, explanatory variable definitions, and time periods used in estimation can lead to very substantial differences in equilibrium real exchange rate estimates. Thus, such estimates should be treated with great caution.

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I. INTRODUCTION

Increased attention is being paid to assessments of the actual values of countries' real exchange rates relative to their "equilibrium" values as suggested by "fundamental" determining factors. However, because of the methodological and empirical difficulties involved in establishing the equilibrium real exchange rate for a currency and/or estimating the deviation of the actual real exchange rate from its equilibrium level, it is not surprising that researchers have come up with a wide range of estimates. This has been particularly so in the case of attempts to estimate the equilibrium exchange rate for China's currency, the renminbi (Dunaway and Li, 2005). The variance in these estimates also raises serious questions regarding how robust equilibrium exchange rate estimates are. Various tests are presented in this paper to assess the robustness of alternative approaches and models commonly used to derive such estimates. The basic conclusion that can be drawn from these tests is that, at least for China, small changes in model specifications, explanatory variable definitions, and time periods for estimation can lead to very substantial differences in equilibrium real exchange rate estimates.

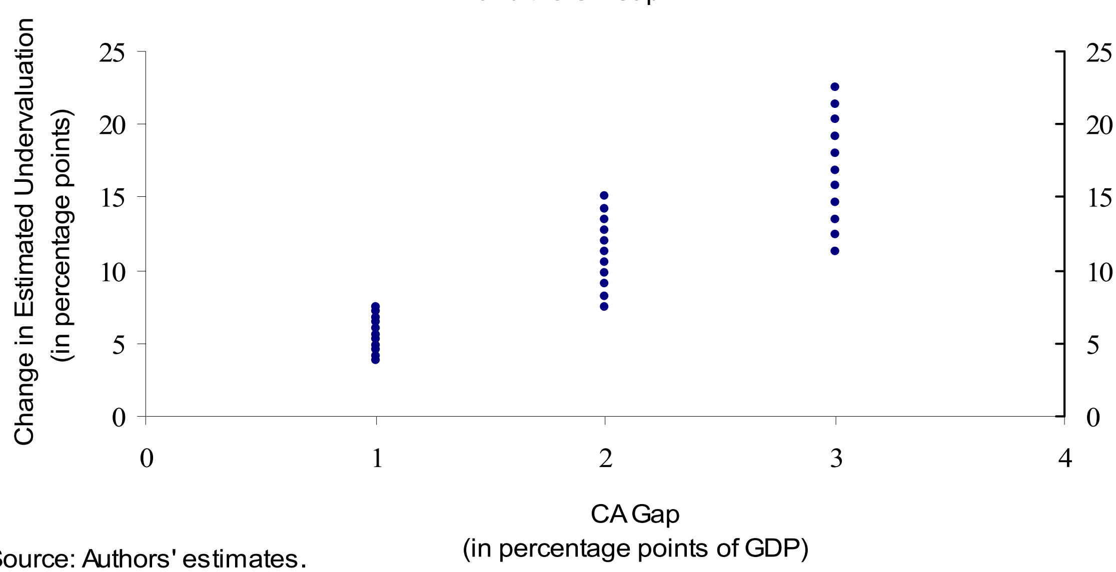
II. THE MACROECONOMIC BALANCE APPROACH

The macroeconomic balance approach generally involves assessing the change in the real effective exchange rate that is needed to close the gap between the actual or "underlying" current account balance of a country and its "equilibrium" level. This approach comprises three steps: (i) estimating the underlying current account balance, (ii) estimating the equilibrium current account balance, and (iii) estimating a trade model to calculate the exchange rate adjustment that is required to close the gap between the underlying and equilibrium current account balance (referred to here as the "CA gap"), with key parameters being the price elasticities estimated for exports and imports.

Depending on how the estimates are made in each of these three steps, estimates of the needed adjustment in the real effective exchange rate (REER) can vary widely. Small estimation errors in each of these steps can easily be compounded. Assessing a country's underlying current account balance requires adjusting for where the economy may be in its business cycle and lagged effects of past exchange rate movements, both of which are difficult to estimate precisely. Estimation of the equilibrium current account balance can be complicated by rapid structural changes in an economy. There are also problems specific to the approach adopted to try to measure the equilibrium current account balance. In general, three approaches are followed: (i) setting the equilibrium current account balance to a level that offsets "normal" (or autonomous) capital inflows (Goldstein, 2004), (ii) calibrating the current account balance that will stabilize the net foreign assets (NFA) of a country at a specified level (judged in some way to be sustainable), and (iii) deriving the equilibrium current account balance from estimates of savings and investment using panel data (Chinn and Prasad, 2003). Choice of sample period, equation specification, and variable definition can lead to large variations in the estimated equilibrium current account balance. Even when authors have used the same methodology and relatively similar specifications, estimates have varied substantially. For example, Wang (2004) estimated China's equilibrium current account balance to be 3.1 percent of GDP, while Coudert and Couharde (2005) estimated it to be around -1.5 percent of GDP.

The robustness of equilibrium real effective exchange rate estimates from the macroeconomic balance approach was tested. In Goldstein (2004), the CA gap was estimated to be roughly 4 percent of GDP, and the real undervaluation of the renminbi was estimated to be 15–30 percent. Coudert and Couharde (2005) also find a CA gap of 4 percent of GDP, and their estimated undervaluation is 23 percent. In contrast, Wang (2004) finds a smaller CA gap of 1 percent of GDP, suggesting a small undervaluation.[2] These studies come up with different estimates of undervaluation, in part because they also use different price elasticities for exports and imports.[3] Figure 1 illustrates how much (in terms of percentage points) an estimate of undervaluation can change for every one-percentage point error in the CA gap and every 5 percent error in the estimate of trade price elasticities.[4] It suggests that, over a 3 percentage point range of error in the estimate of the CA gap (which is roughly equivalent to the differences in the studies cited above) and allowing for potential errors in the estimates of trade elasticities (up to 50 percent), the undervaluation of the renminbi could change by up to 23 percentage points.

Figure 1. Sensitivity of Undervaluation Estimates to Changes in Trade Elasticities and the CA Gap



Source: Authors' estimates.

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[2] Wang (2004) also finds a 1 percent of GDP negative CA gap, suggesting an overvaluation of the renminbi.

[3] A direct comparison of the trade elasticities in each of the three studies is not possible because the trade models used are not explicitly described.

[4] For the price elasticities, ten 5-percent steps are shown, representing export or import price elasticities that deviate by 0-50 percent, so if the estimated elasticity was 1, then the variations experimented will range from 1-1.5.

III. The Extended PPP Approach: Single-Country Estimates

The extended PPP approach is based on the assumption that purchasing power parity holds in the long run, but factors may act to prevent the actual exchange rate from converging to its PPP-determined level in the short to medium term. Taking into account the predicted influence of these factors, an equilibrium exchange rate can be calculated. In estimating an equation, this approach is subject to the usual problems with single-country data analysis, such as short time series, independent variable selection and specifications, the choice of sample period, and the estimation technique employed.

A single-country extended PPP equation is usually specified as follows:

$$\log(\text{REER}_t) = \alpha_0 + \alpha_1 * \log(\text{Relprod}_t) + \alpha_2 * \text{NFAratio}_t + \alpha_3 * \text{OTHER}_t + \varepsilon_t \qquad (1)$$

where REER is the measure for the real effective exchange rate for the home country; Relprod is productivity of the home country relative to the rest of the world; NFAratio is the ratio of home country net foreign assets to some appropriate scalar; and OTHER represent a collection of different variables that have been used in previous studies. Generally in studies for developing countries, REER is defined based on relative CPIs adjusted for exchange rates. This is done primarily because CPIs are the most readily available price indexes for these countries, and not because such measures are good proxies for competitiveness. Relprod is often proxied by the ratio of the consumer price to the producer price index for the home country relative to the CPI/PPI ratio for the country's major trading partners (Wang, 2004; and Coudert and Couharde, 2005). The presumption is that this ratio proxies changes in the relative price of tradables to nontradables, as the PPI consists of mostly tradables while the CPI consists mostly of nontradables, and that there is a relatively close link between changes in this ratio and changes in relative productivity. However, there are several reasons to believe that there is not such a close link in the case of China, as well as in many other countries.[5] Alternatively, Relprod can be measured directly by the ratio of GDP per worker in the home country relative to that of its major trading partners (Lee and others; 2005; and Cheung, Chinn, and Fujii, 2005). The NFAratio is meant to capture the influence of capital flows on the equilibrium real exchange rate. Empirically, it is often measured as the ratio of net foreign assets to GDP (NFA/GDP) (Wang, 2004) or to exports (NFA/X) (Lee, 2005). The OTHER variables typically used in previous studies include such things as the terms of trade and a measure of external openness (usually defined as the ratio of total trade to GDP).

To illustrate the sensitivity of estimates of equilibrium real exchange rates to changes in the specification of explanatory variables and which ones are included, a simple extended PPP

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[5] In China's case, elements of the CPI, such as utility prices, are still under government control, housing costs are imputed based on prices in rental markets that are not fully developed, there is mismeasurement of price increases because adequate adjustments for improvements in quality, especially for durable goods, are not made. Liberalization of price controls in China have affected the CPI and the PPI by different amounts and at different times, with the resulting changes in the ratio of the two price series potentially being misinterpreted as changes in productivity.

equation for China was estimated with Relprod and NFAratio as the explanatory variables. This "baseline" equation was estimated over the period 1980–2002. In the equation, Relprod was specified as the ratio of real GDP per worker for China relative to real GDP per worker for its major trading partners, and the NFAratio was specified as net foreign assets relative to GDP. The difference between the actual and the "equilibrium" real effective exchange rate was calculated based on an out-of-sample forecast for 2005. Table 1 shows how this difference (an estimated undervaluation in the case of China) changes as the specification of variables and which variables are included in the equation changes. When the relative productivity variable is measured by the ratio of CPI/PPI instead of by relative GDP per worker, the estimated undervaluation of the real exchange rate declines by almost 24 percentage points. This reflects a sharp rise in the relative GDP per worker variable during the out-of-sample period 2003–05, while the relative CPI/PPI variable was more stable. Replacing the NFA-to-GDP ratio by the ratio of NFA to exports reduces estimated undervaluation by about 6 percentage points. Making these two changes in explanatory variable specification together, reduces the estimate of undervaluation by close to 38 percentage points. Adding additional explanatory variables also tends to reduce the estimated undervaluation. Inclusion of a terms-of-trade variable (TOT) reduces it by 4 percentage points, while adding an openness variable reduces it by about 31 percentage points because the share of total trade in GDP soared from 43 percent in 2002 to 64 percent in 2005.

Table 1. Sensitivity of Extended PPP Single Country Estimates to Changes in Explanatory Variables

	Change in Estimated Undervaluation Relative to Baseline (- less under valuation; in percentage points)
(1) Replace GDP/workers with CPI/PPI	-23.5
(2) Replace NFA/GDP with NFA/EXP	-6.3
(3) Combine (1) and (2)	-37.9
(4) Add TOT	-4.1
(5) Add Openness	-30.8

Baseline equation: $\log(\text{REERt}) = \alpha_0 + \alpha_1 \log(\text{GDP/Worker}_t) + \alpha_2\, \text{NFA/GDP}_t + \varepsilon_t$

IV. The Extended PPP Approach: Panel Data Estimates

Often the extended PPP model is estimated using data for a panel of countries. This is done at times to overcome problems with short time series for dependent and explanatory variables, especially in the case of developing countries. It is also often done in order to derive equilibrium real exchange rate estimates that are consistent on a multilateral basis. For a panel regression to provide "reasonable" estimates for the equilibrium real exchange rate for any given country, there has to be a rather high degree of similarity across countries in terms of both the variables that explain the real exchange rate and their relative importance.

The sensitivity of estimates of China's equilibrium real exchange rate derived from a panel regression is tested by randomly varying the countries included in the panel and the sample period for the estimation, as well as by changing the specifications of the explanatory variables. A panel of 11 economies in the Asia-Pacific region was used to estimate a standard extended PPP model.[6] The general form of the estimated equation is:

$$\log(REER_{it}) = \alpha_{0i} + \alpha_{1}*\log(Relprod_{it}) + \alpha_{2}*NFAratio_{it} + \alpha_{3}*\log(TOT_{it}) + \alpha_{4}*O_{it} + \acute{\varepsilon}_{it} \quad (2)$$

For a "baseline" equation, Relprod was specified as the ratio of real GDP per worker for each economy in the panel relative to real GDP per worker for its major trading partners, and the NFAratio was specified as net foreign assets relative to exports.[7] The sample period for the equation was 1980–2002. For the baseline equation, the difference between China's actual and the predicted "equilibrium" real effective exchange rate was calculated based on an out-of-sample forecast for 2005.

The sensitivity tests suggest that estimates of China's real equilibrium exchange rate can vary widely (Figure 2).

- Randomly dropping one country from the 11-country panel changes the estimate of the deviation of the actual real exchange rate from its predicted equilibrium level by 6−43 percentage points relative to the baseline estimate (Test 1 in Figure 2).

- When the sample period for the equation is randomly changed, the estimated deviations in China's real exchange rate relative to the baseline estimate vary by 11−47 percentage points (Test 2).[8]

- Changing the proxy for relative productivity from relative GDP per worker to relative CPI/PPI leads to estimated deviation in China's real exchange rate relative to the baseline estimate of up to about 25 percentage points (Test 3).

- Estimated deviations in China's real exchange rate relative to the baseline estimate are as much as 37 percentage points when the NFAratio is changed from NFA to exports to NFA to GDP (Test 4).

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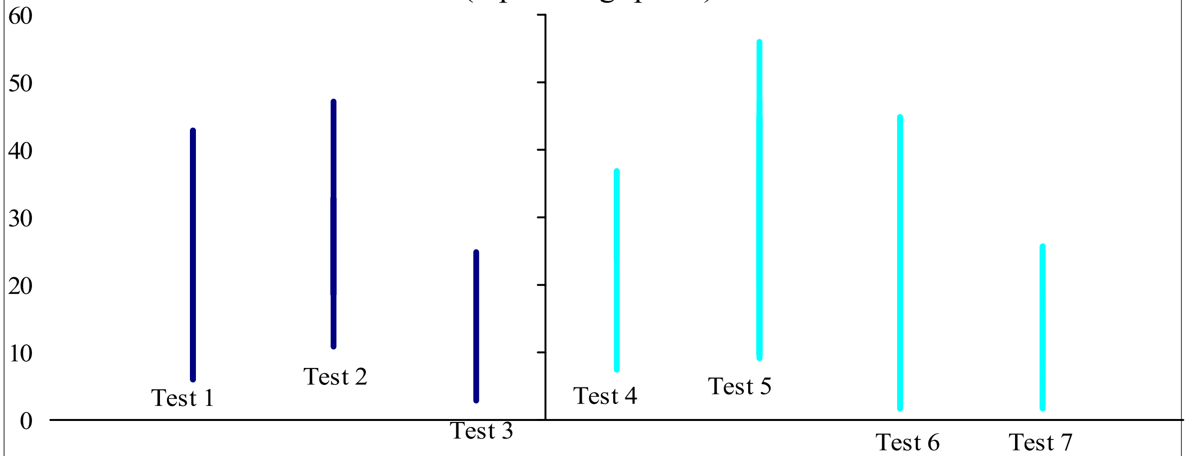
[6] The 11 Asia-Pacific economies included in the panel are Australia, China, Hong Kong SAR, India, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, and Taiwan POC.

[7] This specification of the equation and the explanatory variables broadly follows that used in Lee and others (2005).

[8] Panel regressions were estimated for randomly selected five-year periods using data for 1994-2002. 1994 is selected as the beginning year because of a major regime shift in China's exchange rate. In that year, China's official exchange rate was devalued and unified with the exchange rate at China's foreign exchange swap centers.

Figure 2: Deviations from Baseline Panel Estimate
(in percentage points)



Test 1– random changes in country sample.
Test 2– random changes in the estimation period.
Test 3– changing the proxy for Relprod.
Test 4– changing the proxy for NFAratio.
Test 5– allowing the coefficient for Relprod to vary across countries.
Test 6– allowing the coefficient for NFAratio to vary across countries.
Test 7– allowing the coefficient for TOT to vary across countries.
Source: WEO database, Information Notice System, International Financial Statistics, CEIC database, and authors' estimates.

Other tests suggest that estimated coefficients for the explanatory variables exhibit significant cross-country variations. Using a panel data model with homogenous slopes to estimate an equilibrium real exchange rate relationship involves making an assumption that only the intercept term (α_{0i} in equation 2) differs across countries, while the rest of the equation's coefficients are the same for all of the economies in the panel. A seemingly unrelated regressions model was used to test the validity of this assumption. Estimated results for this type of model show that the coefficients for the relative productivity, NFA-to-export ratio, and terms of trade variables differ significantly across selected economies in the panel, and accordingly, the estimated deviation of China's real exchange rate relative to the baseline estimate differs by up to 50 percentage points (Tests 5, 6, and 7 in Figure 2).[9]

As demonstrated by Haque, Pesaran, and Sharma (1999), ignoring differences in coefficients across countries can lead to misleading inferences about the key determinants of any particular economic relationship.[10] In this instance, assuming common coefficients in order to

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[9] Pooled mean group estimates using a dynamic heterogeneous panel in Pesaran, Shin, and Smith, (1999), which also allows for country-specific effects to vary, confirmed cross-country variation in the estimated coefficients.

[10] Appendix I describes the methodological difficulties of dealing with slope heterogeneity in dynamic panel data models.

use panel data analysis could lead to serious errors in the estimates of equilibrium real effective exchange rates.

V. Concluding Remarks

As the analysis presented here illustrates, there are serious questions regarding the robustness of estimates of equilibrium real exchange rates across the various methodologies typically used. Relatively small changes in the specifications of equations, definitions of variables, or time periods for estimation can lead to very large differences in equilibrium real exchange rate estimates. Moreover, the results presented here point to a conclusion that equilibrium real exchange rates may not be well explained by panel regressions. Large and relatively similar deviations in the difference between the actual and the equilibrium estimates of the real exchange rate in the case of China's currency suggest that there is a lack of commonality across economies in both the variables which explain the real exchange rate and in their coefficients. Tests using a seemingly unrelated regressions model confirm this view. All of these results indicate that estimates of a country's equilibrium real exchange rate need to be treated with a great deal of caution.

APPENDIX. METHODOLOGICAL DIFFICULTIES OF DEALING WITH SLOPE HETEROGENEITY IN DYNAMIC PANEL DATA MODELS

This appendix describes the methodological difficulties which arise when one tries to address slope heterogeneity in dynamic panel data models. As noted in the main text, panel data models are often used in order to derive equilibrium real exchange rate estimates that are consistent on a multilateral basis. These models assume a high degree of similarity across countries in terms of both the variables that explain the real exchange rate and their relative importance.

A dynamic panel data model is usually specified as follows:

$$y_{it} = \mu_i + \lambda_i y_{i,t-1} + \beta_i x_{it} + u_{it}, \quad u_{it} \sim iid\ (0, \sigma_i^2), \quad i = 1, 2, ..., N; \ t = 1, 2, ..., T \qquad (1)$$

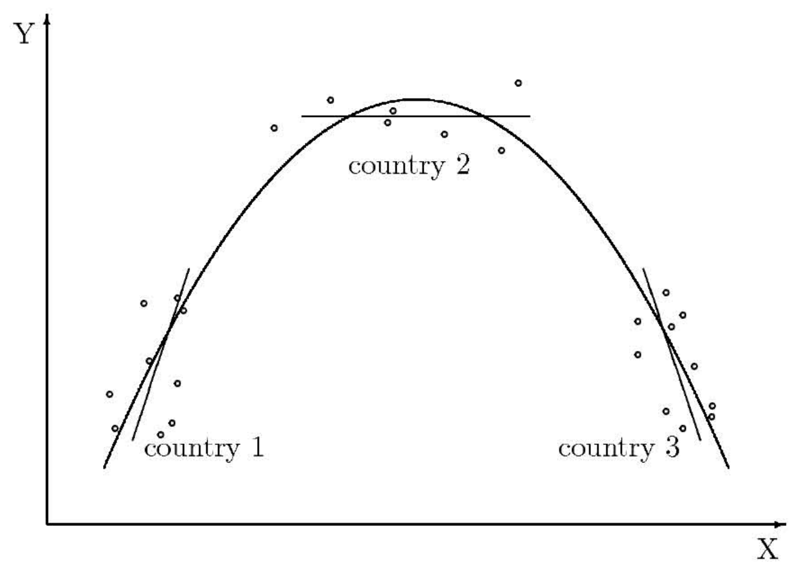
One source of bias of fixed effects panel data estimators (which assume that the coefficients and error variances are the same across countries) is because they generate a correlation between the explanatory variables and the error term as well as serial correlation in the disturbances, and hence introduces a bias in the fixed-effects estimator, even for sufficiently large T and N (equations 2 and 3 below). Specifically, the fixed-effects estimator in (2) will be inconsistent even if both T and N are allowed to increase without bounds due to the non-zero correlation between v_{it} and $y_{i,\,t-1}$.

$$y_{it} = \mu_i + \lambda y_{i,t-1} + \beta x_{it} + v_{it} \qquad (2)$$

$$v_{it} = \eta_i x_{it} + u_{it} \qquad (3)$$

Now a fundamental problem arises in dynamic panel data modeling in the general case where both λ_i and β_i are allowed to vary across countries. Various estimators provide an asymptotically valid distribution theory for making inferences about the average of the slope coefficients, nevertheless they do not fully resolve the problems associated with dynamic panel data modeling due to slope heterogeneity.

Figure A.1. Fixed-Effects Regression under Heterogeneous Slopes



Pesaran and Smith (1995) proposed the mean group (MG) estimator, obtained by estimating the coefficients of each cross-sectional unit separately by ordinary least squares (OLS) and then by taking an arithmetic average of them. The MG estimators of λ and β (which are denoted as λ_{MG} and β_{MG}) are given by:

$$\hat{\lambda}_{MG} = \frac{1}{N}\sum_{i=1}^{N}\hat{\lambda}_i, \quad \hat{\beta}_{MG} = \frac{1}{N}\sum_{i=1}^{N}\hat{\beta}_i \tag{4}$$

where λ_i and β_i are the OLS estimates from individual group (country) regressions. The variance-covariance matrix of the MG estimators can then be consistently estimated by:

$$\widehat{Cov}(\hat{\boldsymbol{\delta}}_{MG}) = \frac{\sum_{i=1}^{N}(\hat{\boldsymbol{\delta}}_i - \hat{\boldsymbol{\delta}}_{MG})(\hat{\boldsymbol{\delta}}_i - \hat{\boldsymbol{\delta}}_{MG})'}{N(N-1)} \tag{5}$$

where $\delta_{MG} = (\lambda_{MG}, \beta_{MG})$. When the slopes differ randomly across countries (Figure A.1), the Swamy estimator (also known as the "empirical Bayes" estimator) computed as weighted averages of λ_i and β_i or the Bayes estimator proposed by Hsiao, Pesaran, and Tahmiscioglu (1999) can be used. The three estimators; namely the mean group, the Swamy, and the Bayes estimators are asymptotically equivalent and have a standard asymptotic normal distribution for large N and large T. However, these models generally do not take into account the fact that certain parameters may be similar across countries. On the other hand, the traditional pooled estimators, such as the fixed and random-effects panel estimators, stand at the other extreme and (with the possible exception of intercepts) assume that the coefficients and error variances are the same across countries.

An intermediate panel data estimator which allows the short-run coefficients and error variances to differ across countries, but imposes the equality of the long-run coefficients across countries, proposed by Pesaran, Shin, and Smith (1999), is the pooled mean group (PMG) estimator as it involves pooling and averaging. However, even the PMG estimator does not solve the problem of modeling equilibrium real exchange on a multilateral basis, since its asymptotic distribution of this estimator partly relies on the assumption that long-run relationship between the real exchange rate and its underlying determinants such as productivity growth (Balassa-Samuelson effect) are the same across countries.

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