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Equilibrium Real Exchange Rates and Misalignments in Large Emerging Markets: A Re-look through Panel Cointegrating Estimation

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Abstract

Equilibrium real exchange rates (ERERs) of a set of major emerging market economies (EMEs) are estimated in a panel cointegrating equation framework against trade weighted advanced economy (AE) currencies taking into account structural emerging market issues, and then used to derive misalignments of the RER. Since US as a dominant economy has considerable effect on EME monetary policy, we use weighted AE variables in order to avoid endogeneity when US data alone is used. We find robust support for the Balassa-Samuelson effect, whereby productivity appreciates RER. This is also seen to be a dominant factor, along with financial development. We find that dependency ratio appreciates ERER indicating excess demand possibly from increase in young dependent population, as well as future growth potential for these EMEs. Rise in fiscal expenditure and financial development, on average, have a depreciatory effect indicating improvements in long run supply conditions. Institutions are found to improve competitiveness in all EMEs in our sample, except Thailand. On average, Asian economies have more appreciated ERER indicating better fundamentals. Over 1995-2017 we find that EME RER followed a cyclical pattern closely linked to global events, with periods of appreciation followed by depreciation. Asian economies along with Brazil and Mexico can be grouped together in terms of RER movement. Russia and Turkey have edged on the side of under-valuation and followed a more random path. The absence of substantial prolonged under-valuation before the Global Financial Crisis implies it was not a sole cause of imbalances. Over-valuation indicates EMEs bore large post-crisis adjustment costs.

Keywords: Real exchange rate; fundamentals; emerging markets; misalignments; global imbalances; adjustment costs

JEL Code: C21, C22, C23, F31, F41, O5

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I. Introduction

Whether exchange rates are over- or under-valued in emerging market economies (EMEs) compared to advanced economies (AEs) is a topic of intense debate, especially in the context of the large Chinese current account surpluses (see Bergsten 2013, Bergsten and Gagnon 2012, Williamson 2011). Papers like Blanchard and Milesi-Ferretti (2012) point to global imbalances on the current account as a major cause of the 2008 Global Financial Crisis (GFC). Over-borrowing in AEs was able to finance unsustainable levels of private consumption that led to large current account deficits. Cheap exports from emerging markets with highly competitive exchange rates were alleged to have made this possible. Papers like Gourinchas and Obstfeld (2012), Cline (2005) find that the greater value of the assets of center economies like US makes it feasible to finance greater consumption and underline the need for currency revaluations in the under-valued economies. But financial innovations and cross border asset movements also affect exchange rates and current account balances. Over-leverage and under-regulation was also a major cause of the GFC. Inflows tend to appreciate currencies in destination EMEs. In the post GFC slowdown AEs were also depreciating their currencies through low interest rates and quantitative easing. Spillovers from an accommodative US monetary stance influence monetary conditions in peripheral economies [Buittron and Vesperoni 2015, Rey 2015]. This finding significantly challenged the existing consensus of EME currency manipulation and showed that further research was needed to understand the full circle of causality between EMEs and AEs. This paper re-addresses the debate based on new estimates of misalignment of real exchange rate[1] (RER) accounting for the role of structural variables in systematically important EMEs that are close to China in economic size and development. Sustained under-valuation of EME RERs would support the 'currency manipulation' thesis while fluctuations and over-valuation point towards capital flow surges.

We contribute to the existing literature in several ways. Rather than the widely used measure of bilateral RER against US, our estimates are based on a multilateral RER index against a basket of AEs using a weighing scheme that captures the changing trade shares between EMEs and AEs. This helps to avoid concern of endogeneity in the presence of dominant shares of US economy in global trade and financial flows. The weighing scheme also ensures that the multilateral RER correctly represents the changing EME-AE trade relations across the globe. We incorporate the weighing arrangement in the explanatory variables too that are differentials between EMEs and AEs in line with standard relative PPP theory. Most studies take large samples of either EMEs or a mix of AEs and EMEs (Curran and Velic 2019, Ricci et al. 2008) or focus solely on the Chinese RER (Adi and Du 2015, Yue 2015, Gan et al. 2013, You and Sarantis 2007, Coudert and Couharde 2007). Their growing impact in global markets motivates us to focus our analysis on a modest sample of the large EMEs with the highest economic development (in terms of per capita GDP) as well economic size (in terms

[1] RER, rather than the nominal exchange rate, is a key determinant of trade and domestic stabilization. Gourinchas and Obstfeld (2012) find appreciation in the RER along with domestic credit booms to be a good indicator of a subsequent crisis. Since trade is effectively determined both by the nominal exchange rate and the relative prices between nations, the focus on nominal currency values leaves the story incomplete.

of absolute GDP)[2]. Blanchard and Milesi-Ferretti (2012) note when several countries adopt the strategy of devaluation systemic distortions result. Our sample of EMEs is systemically important but structurally diverse enough in terms of geographic spread to lend robustness to the results. Figure 1 shows the nominal exchange rates of these EMEs. Except for Turkey and Mexico to some extent, there have been both falling and rising currency values. This underlines the need for robust estimates of RERs and of deviation from equilibrium. Rather than the commonly used approach of including both fundamentals like productivity as well as nominal variables like capital flows or interest differentials in the determination of equilibrium RER (ERER)[3], we focus on fundamentals and slow-moving structural variables. This behavioural cum structural equilibrium defines the ERER we estimate. We believe all these provide more precision to estimates of misalignment in RER due to short-term shocks.

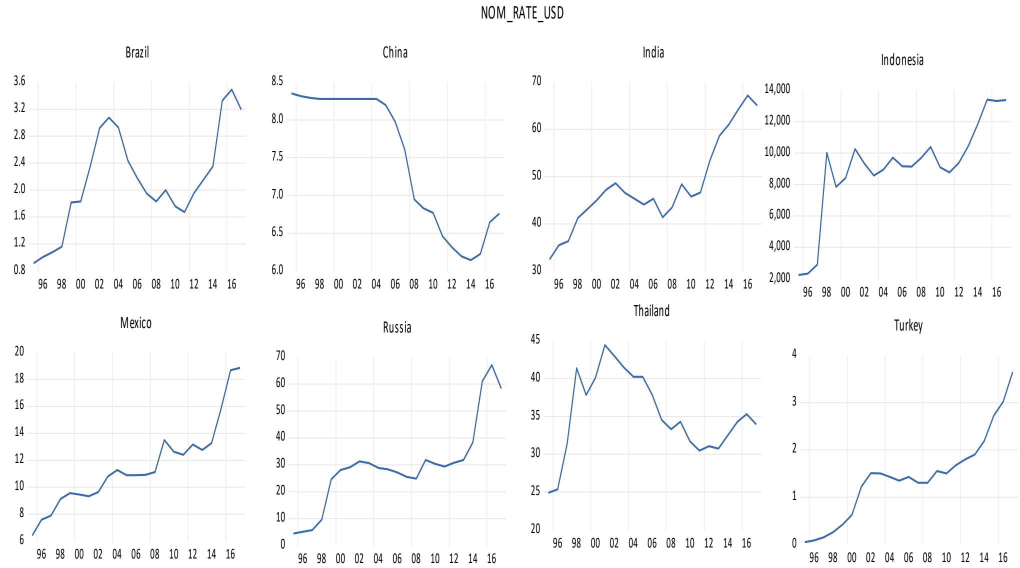

Figure 1. Movements in the nominal exchange rates of our selection of EMEs vis-à-vis the USD

Source: World Bank WDI.

The role of country characteristics has featured in a number of papers, for example, Curran and Velic (2019) and Cheung and Lai (2000) estimate the effect of country characteristics on the persistence of RER, and Hassan et al. (2016), Kim (2015), Ricci et al. (2008) estimate ERER based on country specific factors. The socio-economic-political differences across EMEs can affect wage/price structures. Dooley et al. (2004) find surplus labor in developing economies fuels imbalances through low real wages. According to the standard Solow model, population has important implications for both output and capital per capita. Again, Maggiori (2017) shows asymmetric risk-taking behavior as well as differential consumption levels between countries can reflect variations in the development of financial markets. High savings rate in EMEs, which have underdeveloped investment avenues, have also been a factor that contributed to rising surpluses. Its institutions are one of the crucial determinants of economic success in any country. The estimation of RER deviations from relative purchasing power parity (PPP) should abstract from these behavioral differences between nations e.g. factors, which build slowly over time like institutions, population characteristics or policy stances (which are 'real' variables as opposed to 'nominal' monetary policy often focused on) by including them in RER estimation. We account for the role of institutions through variables like financial

[2] Please see Appendix Section I for a brief discussion.
[3] For example, Gan et al. (2013) estimate the long run Chinese RER taking money supply as a fundamental.

development or fiscal procyclicality. As far as we are aware, the role of structural variables like population characteristics as well as institutions is previously unaddressed. The period of analysis from 1995 till 2017, extends the most recent long run estimates[4].

In the absence of a consensus on which approach is better[5], this paper uses both fully modified OLS (FMOLS) and dynamic OLS (DOLS) panel cointegrating equation approach to estimate ERER, which is suitable for dynamic panels where N < T. We apply a variety of panel unit root tests as well as panel cointegration tests as robustness checks on the data. The estimation exercise is also checked for robustness using different measures of RER or explanatory variables. Since this is a long run analysis, we do not go into sub-period wise estimation, but use intuitive methods to find out the deviations from ERER before and after the GFC.

In our sample of systematically important EMEs although the weighted multilateral RER is found to be largely under-valued with respect to the efficient PPP value of 100, when structural characteristics like population or institutions are considered in a behavioral estimation of ERER, there have been periods of under and over-valuation both before and after the GFC. Under-valuation is less in Asian EMEs compared to the others. While half of the percentage appreciation in ERER is due to increase in relative productivity, improvement in institutions captured through financial development has an almost equal effect of depreciation. The higher the dependency rate in an EME, the more appreciated is its ERER. Government expenditure can have a positive depreciating impact on EME ERER. In seven out of eight EMEs in our sample ERER appreciates in years when these countries adopt procyclical fiscal policy indicating over-heating. However, the reverse holds true for Thailand where procyclical years are associated with depreciation. Over 1995-2017 misalignments in EME RER, from equilibrium corrected for structural characteristics, followed a cyclical pattern closely linked to global events with periods of appreciation followed by periods of depreciation. Asian economies of China, India, and Indonesia were experiencing a correction in their over-valuation a year or two before the GFC. This indicates that imbalances due to EME RER over-valuation may not be the sole cause of the GFC. Further research is required.

The remaining paper is divided into six sections. Section II discusses the relevant literature. Section III explains the data and variables. The estimation procedures and results are placed in Sections IV, while Section V calculates the misalignment in the RER for a comparative analysis, before Section VI concludes the study.

II. Literature review

The benchmark model of determination of ERER is PPP, which tests for stationarity in RER.

$RER = S\, P^*/P$, where S is the nominal exchange rate in terms of domestic currency per unit of foreign currency and P and P* are the domestic and foreign prices.

Under PPP, $\log RER = \log S + \log P^* - \log P = 0$ or, $\mathbf{q = s - (p - p^*) = 0}$ **(A)**

[4] Curran and Velic (2019) study real exchange rate persistence for 151 AEs and EMEs in terms of the half-life of RER from an initial shock over the time period 1973 to 2010.

[5] Kao and Chiang (1995) show that both FMOLS and DOLS have the same limiting distributions. However, on the basis of 10,000 Monte Carlo replications, they also show that DOLS and its t-statistic suffer from the least bias amongst OLS, FMOLS and DOLS estimators. However, the use of lagged variables in DOLS reduces the number of observations making FMOLS a better choice.

However, the evidence for PPP is weak (e.g. MacDonald (1996), Canzoneri et. al. (1996)). Rather than negating the PPP, it indicates the significance of other factors that create persistent deviations from PPP. It is found that in equation (A),

$$\mathbf{q = s - (p - p^*) = \varepsilon \neq 0} \qquad \textbf{(B)}$$

ε in (B) stands for factors that can explain the non-stationary movement of q. A cointegrating relationship can be defined between **q** and ε, yielding a reduced form estimation of ERER. Pioneering papers of this approach, also known as BEER (Behavioral Equilibrium Exchange Rate), include Edwards (1988) and Goldfajn and Valdés (1996).

Another approach that calculates ERER as one that satisfies both internal and external balances is known as Fundamental Equilibrium Exchange Rate (FEER)[6]. Edwards and Savastano (2000), Clark and MacDonald (1998) have useful surveys of the literature. The use of BEER is more common because of the objective nature of the estimation as compared to the subjectivity of the FEER approach where the balance is often difficult to define, especially for EMEs that may be growing faster yet have large unemployment. Wu (2016) argues that managed exchange rate regimes in developing countries often makes it difficult to estimate ERER in the macroeconomic balance approach and suggests an adjustment in the existing PPP approach by incorporating a Human Development Index. This paper follows the BEER approach in order to avoid the subjectivity bias as well as to include the impact of structural variables directly in the estimation of ERER.

In the variables that can explain persistent deviation from PPP, the literature takes productivity (Adi and Du 2015, Yue 2015, Ricci et al. 2008, Wang 2004, Chinn 2000, Canzoneri et al. 1996), terms of trade (Adi and Du 2015, Ricci et al. 2008, Edwards 1988), market frictions like trade barriers (Edwards 1988), government expenditure (Gan et al. 2013, Cheung and Lai 2000, Edwards 1988), demand side factors like GDP (Edwards 1988) or discount rate (Yue 2015), net foreign assets (Kim 2015, Ricci et al. 2008), interest rates (Adi and Du 2015) etc. The inclusion of productivity as a regressor is originally due to Balassa and Samuelson (1964) who showed international productivity differences affect the RER. Most of the studies find the B-S effect to be significant. Edwards (1988) over 1960 -1985 found that in the long run RER is significantly determined by fundamentals, while in the short run it is affected by both real and nominal factors. Following in that line, we focus on structural variables for estimation of a long run ERER. The estimation approach has varied from simple pooled regression (Edwards 1988), cross-sectional regressions (Curran and Velic 2019) to cointegration (Yue et. al 2015, Clark and MacDonald 1998) to panel cointegrating equations (Canzoneri et al. 1996, Ricci et al 2008[7]) to panel VAR (Kim 2015). A number of studies focus on the Chinese RER. For example, Yue et. al (2015) estimate the ERER in China using data over 1994-2012 and show recent moves by the Chinese Government to build a more market determined exchange rate system have reduced the overvaluation in the Chinese exchange rate and it has remained undervalued since 2010.

Curran and Velic (2019) apply a different approach by estimating how variables like inflation, trade openness, productivity, exchange rate volatility, government expenditure, financial integration,

[6] Pioneered by Williamson (1983), the Peterson Institute of International Economics semi-annually estimated FEER based misalignments from 2008 till 2017. These estimates are based on SMIM model of Cline (2008) and focusses on the changes in REER and nominal exchange rate required to bring the current account balance to a range of plus minus 3 per cent of GDP that is taken as the sustainable current account balance.

[7] DOLS with fixed effects is used with fundamentals like terms of trade, productivity differential, government consumption as share of GDP and net foreign assets to trade ratios and trade restrictions. They conduct their analysis over 1980-2004 for a mix of 48 industrialized nations and emerging markets.

geographical distance can determine the half-life of multilateral and bilateral RER. They do not distinguish between nominal and real variables when explaining the RER persistence. We deviate from this approach in two ways. Rather than studying the persistence, we try to find the distance of actual RER from an equilibrium which should throw light on the extent of external imbalances in EMEs. We estimate the equilibrium using only structural differences across the EMEs.

Financial development has been seen to play a fundamental role in economic growth[8]. Papers like Demirguc-Kunt et al. (2015) note the criticality of inclusive financial infrastructure in helping to alleviate poverty with greater access to savings and payment mechanisms. While financial integration has been addressed previously in Curran and Velic (2019), financial development is yet to be incorporated as a variable capturing institutions.

Another important structural variable specific to EMEs is fiscal procyclicality, which captures political interferences (Talvi and Vegh 2005). Fiscal indiscipline has been observed in many countries as one of the first causal factors of economic crises. Frankel et al. (2013) show that fiscal procyclicality is directly a product of institutional quality. Goyal and Sharma (2015) find that government expenditure at a disaggregated level can be a determining factor for the monetary conditions in an economy. Both financial under-development and fiscal procyclicality can help to capture the institutional problems of EMEs. As far as we are aware, these are new variables we introduce in this study.

There is some controversy regarding the choice of price index for calculation of RER. While most databases publish RER calculated based on Consumer Price Index CPI, Terra and Valladares (2010) report that WPI as an index is a better measure, because CPI generally puts more weight on commodities/services produced and consumed in the home country itself, e.g. non- tradables. This makes the RER deviate from PPP. The composition of price indices with exclusively tradable goods, such as the export unit value index, differs significantly across countries. WPI is more balanced. Hence this paper takes the WPI based RER to estimate ERER.

III. Data and methodology

We construct an index of multilateral weighted RER taking into account the changing trade shares between EMEs and AEs. RER is defined as the price of a basket of goods in foreign economy vis-a-vis the average price of the home country consumption basket, both expressed in domestic currency terms[9]. This index is then regressed on structural variables to estimate the ERER. Data over 1995 to 2017 is from the World Bank, the IMF, and the United Nations Comtrade database. The panel of eight EMEs were chosen on the basis of economic size and development. To get the widest geographic spread we choose economies from Latin America, Asia, Europe and Middle East. These are Brazil and Mexico (from Latin America), China, Indonesia, Thailand (East Asia), India (South Asia), Russia and Turkey (Eastern Europe and Middle East). Since Russia was previously a closed economy, our data begins from 1995.

Y variable: Weighted Multilateral RER

[8] See Levine (2004) for a survey on the functions of finance.
[9] An increase in RER implies AE prices rise relative to home country or EMEs, that is, a depreciation for the home country.

Weighted RER (WRER) of each EME is constructed as a weighted average of the bilateral RERs with respect to four major AEs: United States of America, United Kingdom, Japan and Australia. The AEs were chosen mainly keeping in mind a good geographical spread, trade and international importance, as well as economic size. The WRER, derived below, is our explained variable.

$$WRER_{it} = \sum_{j=1}^{4} Wijt \ \ RERijt$$

Where $RERijt$ is the bilateral RER of i^{th} EME with the j^{th} AE in year t, and j = USA, UK, Japan, Australia.

$RER_{ij} = S_{ij} (P_j / P_i)$ where S_{ij} is the cross nominal exchange rate between i^{th} EME and j^{th} AE currencies, P_j and P_i are WPI, following Terra and Valladares (2010). All price indices are with base 2010 so the nominal exchange rates are also indexed to base 2010=100.

w_{ijt} is the trade share of j^{th} AE defined as below:

w_{ijt} = Total trade (exports + imports) of i^{th} EME with j^{th} AE in t^{th} year/ Total trade of i^{th} EME with the World in t^{th} year.

Appendix Section II Table A1 reports the averages of weights calculated from UN Comtrade database. Except Thailand, all the country weights are updated till 2017. Due to lack of data for Thailand, the trade weight for 2017 has been extrapolated using past average growth in trade shares. It is noteworthy that, except China, other economies have experienced a reduction in trade share with USA and UK over the period of analysis. Chinese trade share with Japan has declined, while trade shares with all of USA, UK and Australia has increased. Therefore, Chinese trade linkages with non-Asian AEs increased. The WPI based WRERs constructed for the eight EMEs have been shown in Appendix Section II Chart 2 along with CPI based RERs, as well as with PPP value of 100 for comparison purpose. Since the WPI series has been discontinued after 2015, we have substituted WPI for CPI for the years 2016 and 2017. The absence of WPI data for China compelled us to take the CPI based WRER in entirety for China. For the rest of the EMEs, it is seen that the WPI based RER has diverged from the CPI based RER, particularly in the 1990s and 2000s. Another important observation is that the constructed RERs show large diversions away from the PPP value of 100, indicating persistent deviations affecting ERERs. We aim to explain these deviations with the help of structural factors as discussed below.

X variables

Some of the variables are differentials while the others are specific to EMEs. The former mainly explain the movement in RER as being determined by the relative movement in the variables between the EMEs and the AEs. The variables specific to our EMEs are assumed to have influence on RER irrespective of their position in the AEs. Data for these are taken only from the EMEs. These are internal terms of trade (TOT_H), joint trade openness (OPEN_H) and a dummy capturing fiscal procyclicality (DUM_PROCY) in these countries. TOT_H is defined as ratio of price of tradables (P_T) and price of non-tradables (P_{NT})[10]. The Balassa Samuelson effect is theoretically based on dividing the economy into tradables and non-tradables sectoral productivities (for a mathematical approach see Chinn 2000). It shows that if the tradables productivity is rising faster than the non-tradables sector compared to foreign economies, this causes non-tradables prices to rise faster, leading to overall price

[10] Due to lack of adequate data points for China and Russia we substitute the tradables-non-tradables ratio with net barter terms of trade data (base 2010=100), which is defined as the ratio between export and import unit value index.

increase and appreciation of the domestic RER. So this entails two effects, one is the gap between the tradables and non-tradables sectors at home, e.g. the faster the rise in tradables productivity compared to non-tradables, the greater is the appreciation in RER, and the second is the differential between productivities at home and abroad. The faster home productivity grows relative to foreign productivity the higher the rate of appreciation. Under the law of one price, tradables are seen as equalized between EMEs and AEs in productivity and prices and hence, RER should be determined by the non-tradables productivity differential. However, in a world of trade barriers and absence of full pass-through to domestic prices, this might not hold in totality (Engel 1993 found large fluctuations in tradables prices across nations). The relative movement between the tradables and non-tradables becomes important here. Froot and Rogoff (1995) also underline the importance of the internal terms of trade for low income countries where income effects from large growth rates can rapidly change the structure of the relative price between tradables and non-tradables.

In the absence of sectoral productivity data, we take the price ratio between tradables and non-tradables (the internal terms of trade) as a proxy for the gap between productivities of the two sectors, which should capture the real world frictions. Hence, this is a key determinant of the RER for EMEs, whose trade share is too small to affect tradables prices. Joint trade openness (OPEN_H) is trade measured by the sum of exports and imports of goods and services as a share of gross domestic product. This reflects the extent of removal of trade barriers in the EME. The joint trade openness is taken only for EMEs which are in different stages of opening up to global integration, while AEs are assumed to have reached full integration.

Fiscal procyclicality results from weak governance institutions and proxies for them. We define fiscal pro-cyclicality as the simple ratio $(Y_{t+1} - Y_t)/(G_{t+1} - G_t)$ where Y and G are the cyclical components of real GDP and real government final consumption expenditure extracted using a Hodrick-Prescott filter. A positive ratio implies a procyclical fiscal policy, i.e. government expenses increase in good years and vice-versa. We take a dummy (DUM_PROCY), which is 1 whenever this ratio is positive and 0 otherwise (Chart 3 in Appendix Section II). Most of the chosen EMEs, especially Russia, had a loose fiscal policy according to this measure.

Differentials

The differentials have been constructed as a difference between EME and AE data, where the foreign counterpart of the differential is taken as a weighted average of AE data taking into account EME-AE trade shares changing over years and also across EMEs. This helps to add precision to the analysis. Since our equation is specified in the log-log form, the differentials are calculated on log transformed variables. However, ratios like joint openness or internal terms of trade are in levels.

The differentials for the i^{th} EME are explained below:

1) DL_PROD: Labour productivity differential. Labour productivity is calculated as GDP measured in 2010 Dollars divided by total labor force[11].
2) DL_DEP: Differential between the age dependency ratios. Age dependency ratio is defined as the share of dependent young (< 15) and old (> 64) population in the total working-age population (ages 15-64).
3) DL_FD: Differential between the indices of financial development.
4) DL_GOV: Government final consumption expenditure differential.

[11] Following OECD methodology and in line with their estimates.

For the differential in financial development, we use the index constructed by IMF and detailed in Svirydzenka (2016). The above paper compiles sub-indices for each of depth, access, efficiency for financial institutions and financial markets separately and compiles them into a final overall index for 183 countries. The indices have been extrapolated for 2017. While Curran and Velic (2019) take financial integration as a variable explaining RER persistence, the financial development index, which accounts for institutions as well, is a more comprehensive measure.

Expected coefficient signs for each of our variables and the rationale behind them are discussed in the Table 1 below:

Fundamental	**Expected sign of the coefficient**
Joint trade openness	With more open trade, both EME and AE prices are expected to converge. Depending on the level of EME prices compared to AE prices, RER can appreciate or depreciate with convergence in prices from increasing trade. So sign is **ambiguous**. The sign can potentially throw light on the nature of adjustment taking place in EME prices.
Internal terms of trade	With rapidly changing dynamics in the relative price of non-tradables, the sign of this coefficient depends on the pass-through of price of exportables into general price level. **Sign can be either way**. Literature also finds it **ambiguous** (Edwards et al. 1988).
Productivity differential	The Balassa and Samuelson (1964) effect predicts a country with rising productivity will experience higher prices. Rising labour productivities in tradables in poorer economies may pull up wages in traditional non-tradable sectors and hence increase overall price levels in EMEs. So with higher productivity differential, RER in EMEs should fall in value meaning appreciate. Coefficient sign is expected to be **negative,** according to the definition of RER in this paper**.**
Dependency differential	A higher dependency ratio indicates lower GDP per capita as per Solow model. But this may also imply future growth potential if the population less than 15 years leads the increase in dependency. If the latter holds true, a growing dependency differential should mean growing output requirement in the EMEs. This could mean higher output and prices. An appreciated RER can be expected. But if the increase in dependency come from increase in ageing population, this could mean a stagnating GDP and hence lower prices, which could depreciate the RER. Hence, sign is **ambiguous** and depends on the nature of the variable.
Financial development differential	With better institutions, growth in financial services may lead to expansion in supply and hence lower overall prices. Coefficient sign is expected to be positive in this channel. However, with better integrated financial markets, this may also lead to appreciation through increased capital flows. Thus, sign is **ambiguous.**
Government expenditure differential	According to the textbook Mundell Fleming model, a relatively lower government expenditure should be matched by depreciation in RER, if there is full employment. Hence, coefficient should be negative. Under excess capacity, or if G creates capacity in the long-run, the opposite should hold. Hence, coefficient could be positive. Thus, sign is **ambiguous.**

Table 1. Variables used as regressors and rationale behind their signs

We plot the movements in these variables in Appendix Section II Chart 4 across the eight EMEs which helps to understand temporal dynamics in these variables. The few most interesting points are:

i) Amongst the Asian economies, the rise in productivity has been highest for China, especially in the post 2000 period. There were large increases in productivity of Brazil, Russia and Turkey, but a levelling off can be seen post 2014 or after the Euro debt crisis. The productivity differential in Asian economies like China, India, Indonesia and Thailand slowly moving from the negative range to zero lends support to the growth convergence thesis. Only the productivity differential of Mexico is diverging away towards negative figures since 2014 (Appendix Section II. Chart. 4a). ii) The ITT has reached similar level in the EMEs indicating some convergence in relative prices. However, the long term trends indicate large changes in the ITT (Appendix II. Chart. 4b). iii) Contrary to general belief of higher trade integration, the openness ratio has actually come down in most EMEs mainly from the mid-2000s. Only Mexico shows a steady increase in openness over the entire period. Interestingly, for Indonesia and Russia, trade openness did not take off ever since the Asian Financial crisis years. No singular pattern emerges for Turkey. iv) EME dependency ratio is higher than AE dependency in all cases. However, the difference in dependency ratio is coming down in recent years e.g. post 2010, except in the case of Russia where it has gone up since 2015.This might be indicative of longer working years in the absence of social security / pension schemes in these EMEs. This issue posits scope for future research using larger datasets and also disaggregating the source of changes in dependency.

IV. Estimation

Testing for unit roots

We start by assessing the order of integration of the data through panel unit root testing. We apply the Levin, Lin and Chu (2002) (LLC), Im, Pesaran and Shin (1997) (IPS), and Chang (2000) panel unit root tests. In the LLC (2003) procedure, we test the null of $\rho = 0$ in the equation below for heterogeneous panels:

$$y_{i,t} = (\rho + 1)\, y_{i,\, t-1} + \alpha_{o\, i} + \delta_{o\, i} t + \varepsilon_{i,t}\ , \quad i = 1, 2, \ldots 8, \quad t = 1, 2, \ldots 23 \qquad (1)$$

Here α stands for intercept and δ captures trend effect. The LLC test statistics is $S_n = 1/\sqrt{n} \sum Zi$ where Zi corresponds to the t-ratio in the ADF regression for the i^{th} individual. LLC introduces heteroscedasticity and serial correlation in limiting distributions of the Dickey Fuller statistic (as both T and N increase) allowing for individual and time specific fixed effects. However, IPS has good small sample properties in heterogeneous dynamic panels, and is more appropriate for panel with T > N, which is the case in this study. While the null hypothesis in LLC considers non-stationarity for all i against stationarity for all i, IPS assumes away the common stationarity assumption in the alternative. IPS uses averaged t-bar statistic from individual t statistics in the cross-sectional regressions given by equation (1). However, both these tests do not address the presence of cross-sectional dependence which is addressed in Chang (2000) using instrumental variables in the usual ADF regressions in equation (1). Since the data is a dynamic panel with strong trade and historical dependencies[12], we stress on the unit root evidence from the Chang test. This test also followed the null hypothesis of non-stationarity for all i against stationarity for some. Below we report the results of the panel unit root testing.

[12] Cross-sectional dependence was checked and found to be significant in all variables (see Table A2 in Appendix Section III).

	LLC				IPS				Chang			
	(intercept)		(intercept and trend)		(intercept)		(intercept and trend)		(intercept)		(intercept and trend)	
	Statistic	p-values	Statistic	p-values	Statistic	p-values	Statistic	p-values	Statistic	p-values	Statistic	p-values
WRER												
Level	1.20	***0.89***	-0.80	***0.21***	1.66	***0.95***	-1.82	***0.03***	0.64	***0.74***	-1.02	***0.15***
First diff	-4.01	***0.00***	-2.34	***0.01***	-3.69	***0.00***	-2.18	***0.01***	-4.10	***0.00***	-6.57	***0.00***
TOT_H												
Level	-1.30	***0.10***	4.79	***1.00***	-0.26	***0.40***	2.50	***0.99***	-0.83	***0.20***	-1.03	***0.15***
First diff	-0.36	***0.36***	-2.56	***0.01***	-1.32	***0.09***	-1.42	***0.08***	-3.99	***0.00***	-6.27	***0.00***
OPEN_H												
Level	-1.42	***0.08***	-3.19	***0.00***	-0.38	***0.35***	-3.99	***0.00***	-0.60	***0.27***	-1.89	***0.03***
First diff	-4.93	***0.00***	-3.50	***0.00***	-5.64	***0.00***	-4.86	***0.00***	-3.19	***0.00***	-5.44	***0.00***
DL_PROD												
Level	0.02	***0.51***	-0.80	***0.21***	1.71	***0.96***	-1.33	***0.09***	0.04	***0.52***	-0.51	***0.31***
First diff	-3.70	***0.00***	-1.19	***0.12***	-3.08	***0.00***	-1.20	***0.12***	-1.75	***0.04***	-4.64	***0.00***
DL_DEP												
Level	-1.42	***0.08***	1.26	***0.90***	-1.03	***0.15***	0.70	***0.76***	-1.18	***0.12***	-1.34	***0.09***
First diff	-0.56	***0.29***	-0.26	***0.40***	-1.53	***0.06***	-0.48	***0.31***	-2.84	***0.00***	-4.79	***0.00***
DL_FD												
Level	-0.33	***0.37***	0.38	***0.65***	1.94	***0.97***	0.14	***0.55***	0.89	***0.81***	0.09	***0.53***
First diff	-2.03	***0.02***	-1.67	***0.05***	-3.40	***0.00***	-2.41	***0.01***	-4.63	***0.00***	-8.09	***0.00***
DL_GOV												
Level	-1.34	***0.09***	-2.74	***0.00***	1.12	***0.87***	-1.59	***0.06***	-0.91	***0.18***	-1.10	***0.14***
First diff	-3.80	***0.00***	-1.62	***0.05***	-3.34	***0.00***	-2.07	***0.02***	-3.20	***0.00***	-3.70	***0.00***

Table 2. Results of panel unit root tests

Note: Each specification includes maximum lag of 2.

The WPI based weighted RER, internal terms of trade and openness index as well as the differentials show I(1) process[13]. We also test for non-stationarity in the home and foreign country variables individually. However, finding that individual series are stationary, we go forward with the composite differentials in the estimation taking log RER as the dependent variable. Since RER is found to be non-stationary it implies PPP did not hold over our time period 1995-2017.

Panel cointegration test

Before estimation, cointegration needs to be checked. In general, the main problem is to estimate a model with K regressors of the form of (2) below:

$$y_{i,t} = \alpha_i + \delta_t + \sum_{k=1 \text{ to } K} \beta_{ik} X_{i,t,k} + e_{i,t}\ ,\ i = 1 \text{ to } N\ ,\ t = 1 \text{ to } T \qquad (2)$$

α_i and δ_t are the individual-specific and time-specific effects. Cointegration would mean that the error term $e_{i,t}$ in (2) is stationary. The equilibrium long run relationship is represented by the β_i vector. Panel cointegration tests have mainly changed the asymptotics of Dickey-Fuller statistics as an extension to the Engle-Granger residual testing approach. Pedroni (1999) provides the most accepted residual based panel cointegration tests. It constructs the modified asymptotics of Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) or Phillip and Perron Z statistics from the auxiliary regression

[13] Except the ratios of TOT_H and OPEN_H, all variables had been log transformed wherever needed.

of the estimated residuals ê from (2). In effect, the null of no cointegration amounts to testing for the presence of unit root in the errors $e_{i,t}$, or the null of $\Upsilon_i = 1$ in the equation (3) below separately for each member:

$$\hat{e}_{i,t} = \Upsilon_i \hat{e}_{i,t-1} + \sum_{j=1 \text{ to } p} \mu_j \Delta \hat{e}_{i,t-j} + \acute{u}_{i,t\ p} \quad (3)$$

Pedroni (1999) takes the ordering of the X variables on an a-priori basis, modifying the PP or ADF statistics making them suitable for panel data, and assuming the existence of a single cointegrating vector that can vary across members. We also use the Kao (1999) residual based test of panel cointegration.

Cointegrating equation estimation

Although consistent, the panel OLS estimator of β_i in equation (2) leads the asymptotics wrong in the presence of non-spherical disturbances arising from endogeneity. The correlated disturbance in the X matrix and the equation (2) is corrected using the long-run covariance matrix estimators of the disturbances in the cointegrating equation and another equation capturing the residuals in the X matrix. Phillips and Hansen (1990) in their fully modified OLS estimate the long run covariances of residual terms by the Kernel method. Pedroni (2001) shows heterogeneity in panel datasets can alter asymptotics of Phillips and Hansen (1990) estimators. They provide the asymptotics for a modified estimator e.g. FMOLS using long run covariance matrix for heterogeneous panels. Since our motive is to capture the changes in the dynamics between members of a panel, we use this model which allows cross-section specific deterministic effects.

For the construction of the modified OLS estimator, non-stationarity of the Y and X variables is required. Using difference stationarity in X, the residuals in X are defined as:

$$\mathbf{\Delta X_i = U_i}, \text{ or alternatively, } x_{it} = x_{it-1} + u_{it} \quad (4)$$

The construction of either FMOLS or DOLS depends on the defining the innovation vector ξ_i of Z_i, where $Z_i = (Y_i, X_i)'$ is defined such that:

$$Z_{it} = \rho_i Z_{it-1} + \xi_{it} \quad (5)$$

Pedroni (2001) proposes Newey-West estimator for Ω_i, the asymptotic long run covariance matrix of ξ_i. Using Cholesky decomposition of Ω_i and normalization, Pedroni constructs the FMOLS estimator which has an asymptotically standard normal distribution.

Kao and Chiang (1995) modify the estimator of β_i in (2) in a different approach by defining the residuals in (2) as a weighted sum of the innovations in (4). Following Saikkonen (1991), and based on the assumption that $\{c_{ij}\}$ are absolutely summable, they define the residual e_{it} as:

$$e_{it} = \sum_{j=-\infty \text{ to } \infty} c_{ij} u_{it+j} + \vartheta_{it} \quad (6)$$

They correct the endogeneity in the cointegrating equation, by taking the leads and lags of the differenced regressors into the set of equations defined by equation (2). Truncating the leads and lags of differenced regressors, and defining a new innovation vector $\dot{\vartheta}_{it}$, the dynamic OLS (DOLS) equation can be written as:

$$y_{it} = \alpha_i + \beta x'_{it} + \sum_{j=-q \text{ to } q} c_{ij} \Delta X_{it+j} + \dot{\vartheta}_{it} \quad (7)$$

However, the results in Kao and Chiang (1995) as well as Pedroni (2001) are based on the assumption that {**X** $_{i,t}$**}** are not cointegrated between themselves.

Results

Both the Pedroni (1999) and Kao (1999) test the null of no cointegration. Pedroni (2001) shows that group mean estimators perform better with small samples than panel estimators. So we give more weight to the results from group mean estimators. All tests are performed on the basis of SIC. Since the Kao (1999) test allows only fixed effects, only intercept is included in equation (2) for the Kao test.

Since both the FMOLS and DOLS procedures require the regressors not to be individually cointegrated amongst each other, bivariate testing between pairs of independent variables was necessary. All the regressors were found to be individually non-cointegrated, except in the case of the differential in government expenditure DL_GOV, which was found to be cointegrated with two variables DL_DEP and DL_FD. So we cannot include DL_GOV and {DL_DEP, DL_FD}in the same regression. We also tested if the differential between the trends[14] of government expenditure of home and foreign economies could show non-cointegration with DL_DEP or DL_FD. However, this too showed cointegration. Since we capture the role of governance through procyclicality in fiscal policy that we take as a deterministic variable in the cointegrating equations and also because we want to keep the maximum number of structural factors in the estimation, we estimate the multivariate cointegrating relationship with the other five variables e.g. TOT_H, OPEN_H, DL_PROD, DL_DEP, DL_FD (Case A). We estimate a second model with DL_GOV (excluding DL_DEP and DL_FD) only to see the nature of the coefficient of the variable of fiscal expenditure. But this model (Case B) is not used to determine the equilibrium relationship.

The ADF statistics of the multivariate tests and their p-values are reported in Appendix Section III Table A3. Both cases A and B support existence of cointegration at a high level of significance. We go ahead with estimation of both FMOLS and DOLS for these 2 cases[15]. Table 3 summarizes the coefficients estimates.

The regression is specified by the set of equations:

$$WRER_{it} = X'_{it}\beta_i + D_1'_{it}\surd_i + e_{1\ it,} \tag{8}$$

$$X_{it} = D_1'_{it}\Gamma_1 + D_2'_{it}\Gamma_2 + u_{1\ it} \tag{9}$$

$$\Delta X_{it} = e_{2\ it} \tag{10}$$

where (1, -β) defines the cointegrating vector, X is matrix of the regressors TOT_H, OPEN_H, DL_PROD, DL_DEP, DL_FD, DL_GOV (the last 3 included only in select cases) and D_1 is the matrix of deterministic variables, including fixed effects[16], trend and also the dummy of procyclicality (DUM_PROCY: 1 for years showing fiscal procyclicality, 0 otherwise). The trend was included in the equation because of the long run nature of the data. D_2 is the matrix of deterministic variables (intercept and trend and time dummies) in the regressor's equation (9). The choice of deterministic terms was made on the basis of the goodness of fit. The expansion of the cointegrating vector $X'_{it}\,\beta$ in

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[14] Calculated using HP filter.

[15] Pairwise correlation coefficients were also checked for the two sets of regressors and they were found to be small enough to allow us to proceed with estimation.

[16] Hausman test rejected random effects for the panel data.

the two cases is given in Appendix Section III. The long-run covariance matrix is estimated using (non-pre-whitened) kernel approach with a Bartlett kernel and Newey-West fixed bandwidth.

For the case of DOLS, equation (8) includes additional differenced and differenced- lagged regressors in the matrix D_1. This forced us to lose two observations for each cross-section. So the DOLS estimates start from 1997 giving us a total of 21 observations. In the DOLS, we have refrained from using the dummy for procyclicality in the equation because of the problem of differencing. Each estimation has pooled estimates. For the case of DOLS estimation, the paucity of data constrained us from including more than the first lag of the differenced regressors.

The consistency of the coefficients across the estimations provides a check for robustness of the results. Robust residual graphs in Chart 5 corresponding to each estimation are reported in Appendix Section III. We use the cases 1 B and 2 B not to estimate the ERER but to study how government expenditure affects our dependent variable WRER. The interpretations on the cointegrating relationship as based on Cases 1 A and 2 A are given below.

	Panel FMOLS				**Panel DOLS**			
	Case 1 A		Case 1B		Case 2A		Case 2B	
	Coefficients and t-stats	p-values	Coefficients and t-stats	p-values	Coefficient estimates	p-values	Coefficient estimates	p-values
EME specific variables								
Internal terms of trade (Home) **TOT_H**	-0.45	0.00	-0.27	0.03	-0.29	0.03	-0.43	0.00
	(-3.87)		(-2.23)		(-2.19)		(-3.44)	
Openness ratio **OPEN_H**	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
	(3.63)		(4.22)		(4.39)		(4.29)	
Differentials								
Productivity **DL_PROD**	-0.56	0.00	-0.51	0.00	-0.56	0.00	-0.46	0.00
	(-10.44)		(-11.16)		(-11.02)		(-11.30)	
Dependency **DL_DEP**	-0.33	0.06			-0.17	0.29		
	(-1.92)				(-1.07)			
Financial **DL_FD**	0.52	0.00			0.52	0.00		
	(4.97)				(5.68)			
Government expenditure **DL_GOV**			0.12	0.02			0.11	0.06
			(2.46)				(1.88)	
Adjusted R square	0.88		0.87		0.95		0.93	
Periods included	22		22		21		21	
Observations	176		176		168		168	

Table 3. FMOLS and DOLS estimates of long run cointegrating relationship

EME specific co-variates

We hypothesized in Table 1 that the direction of the signs of internal terms of trade and openness index could be ambiguous. Although we find a statistically significant negative (appreciation) impact of TOT_H on domestic WRER, quantitatively negative 0.3 (DOLS) translates to a muted pass-through of tradables prices to general price level in EMEs. However, the FMOLS estimates show a higher impact of around negative 0.45. This is to be expected if tradables include food items. We do not find any major impact of the increasing trade integration of EMEs with the rest of the world as the coefficient of OPEN_H is negligible although significant. This suggests these economies still do not have much market power to exert on international relative prices. However, positive coefficients indicate that with greater integration EME prices decline, supporting the benefits of trade thesis. With the decline in trade openness in the last few years (except Mexico and Turkey) as charted in Appendix Section II Chart 4.c., this also indicates that the domestic RER might appreciate.

Differentials

Productivity differential

We find that productivity is a very important factor in determining the ERER. The negative coefficient of productivity difference supports the Balassa effect at a high level of significance. It shows an increase in productivity in EMEs relative to the developed economies, leads to an appreciation in WRER. The value of the coefficient is negative 0.56 and is the same for both FMOLS and DOLS estimations. It gives the long run elasticity of WRER with respect to an increase in productivity differential. This implies that the weighted multilateral RER appreciates by around half of the percentage increase in productivity of EMEs over AEs.

Age dependency differential

A negative relationship holds possibly reflecting an excess demand scenario. As the dependency ratio of the EMEs increase, prices rise in response to excess of demand over supplied output and hence, lead to an appreciation in WRER. As hypothesized in Table 1 this should be the case when the increase in dependency is from increasing young non-working population. The dependency ratio differential, however, becomes insignificant in the DOLS specification.

Financial development differential

This coefficient is positive as expected. It indicates that with improvement in domestic financial infrastructure, WRER depreciates i.e. domestic EME goods become cheaper with respect to the chosen AEs. The impact of this variable is significant and as high as the BS effect, only less by 4 basis points. This also proves that financial development can have a strong positive impact on the competitiveness of the EMEs in international trade as against AEs. The coefficients are same for both the FMOLS and DOLS estimations. While rising relative productivity and wages tend to appreciate the ERER there are other improvements taking place, which tend to depreciate it. This also shows that EMEs should focus on building institutions to increase their competitiveness.

Government expenditure differential

In Cases 1B and 2B, we study the coefficient of government expenditure differential. We find **a significant and unambiguous positive impact of government expenditure differential on WRER**, suggesting excess capacity, or that government expenditure tends to improve long-run conditions of supply.

Next Table 4 tabulates the fixed effects in increasing order with the topmost country having the smallest value of RER, or the least competitive RER. The corresponding trend coefficients are also reported. We get some interesting comparative results, which hold for both the FMOLS and DOLS estimations.

Fixed effects are smaller for Asian EMES, implying they, on average, have less competitive RERs, compared to the countries from Latin America or Eastern Europe. However, in Table 4 we can also see that amongst the Asian countries only Thailand shows a negative trend across the models. This implies the Thai RER has been appreciating, while the rest of the Asian members have depreciated starting from comparatively higher relative prices. The non-Asian nations show exactly opposite trends. The DOLS estimates show that the non-Asian economies indicate a path of correction or appreciation from highly depreciated value over the period of analysis. FMOLS confirms the trend appreciation for Mexico and Brazil.

	FMOLS				**DOLS**	
	Case 1A				Case 2A	
	Fixed effects	Trend	Procyclicality dummy		Fixed effects	Trend
China	3.60	0.03	-0.03	**China**	3.22	0.02
India	3.80	0.02	-0.04	**India**	3.25	0.02
Thailand	3.81	-0.01	0.01	**Thailand**	3.27	-0.02
Indonesia	3.83	0.03	0.00	**Indonesia**	3.34	0.03
Mexico	4.67	-0.01	-0.02	**Mexico**	4.29	-0.02
Russia	4.90	0.01	0.06	**Russia**	4.61	-0.01
Brazil	5.05	-0.01	0.02	**Brazil**	4.69	-0.02
Turkey	5.42	0.00	0.00	**Turkey**	4.86	-0.01

Table 4. Cross-sectional deterministic effects

The position of China and India does not vary much across the models. Both the countries, on average, are experiencing trend RER depreciation, although FMOLS shows that China experiences a higher depreciation starting from a lower value of WRER compared to India. The DOLS shows that China and India are almost on equal footing. The highest trend depreciation has been registered by China and Indonesia.

The dummy for procyclicality, which takes the value of 1 for years with ‘bad’ fiscal policy, shows how the RER moves away from the equilibrium in those years. Negative coefficients for China, India and Mexico show that they experience appreciation in years of procyclical fiscal policy, suggesting pricing pressures. This also indicates that good institutions in fiscal sector can improve the competitiveness in these EMEs. Amongst the Asian countries, Thailand shows RER depreciation in years of procyclical fiscal policy. The non-Asian nations, except Mexico, experience RER depreciation in procyclical years, highest depreciation of 0.6 being in Russia, which may be due to foreign investor exit on perceived fiscal risks.

Robustness checks

The estimation was re-conducted with the CPI-based RER. Both productivity and financial development are found to be robust in their impact as well as significance. The coefficient of productivity differential is found to be almost same for Cases 1A and 2A at negative 0.57 (for FMOLS) and negative 0.54 (for DOLS) with a 0 per cent level of significance. Interestingly, financial development differential remains significant but its impact is reduced to the range of 0.13 (FMOLS) to 0.09 (DOLS). Both internal terms of trade and dependency differential show no impact on the CPI based RER, while the coefficient of openness is similar to earlier estimation. Case B regressions sustain the long run elasticity of around 50 percent for productivity, but find no impact of DL_GOV on CPI-based RER. The WPI based RER includes a higher share of manufacturing in its computation and hence, is able to capture the influence from structural variables like population characteristics and government activity with greater precision, thus validating the hypothesis in this paper that WPI is a better measure when constructing the RER.

Since the DOLS estimation could not include the procyclicality dummy, we also compare the coefficient estimates between FMOLS and DOLS by running the FMOLS regressions without the dummy and found negligible changes quantitatively in the coefficients of the structural variables.

Following Hamilton (2017) who points to disadvantages of the HP filter leading to spurious estimates, we construct a second measure of fiscal procyclicality from cycles extracted through the Hamilton filter[17] (DUM_PROCY_HAM). The dummy is constructed similar to fiscal procyclicality dummy (DUM_PROCY) detailed in Section III. Cases 1A and 1B show negligible changes in the coefficients, except a 10 percentage point decrease in the LR elasticity of dependency differential. The appreciating impact of fiscal procyclicality ("bad" fiscal policy), which was found for China, India and Mexico with the Hodrick-Prescott filter based DUM_PROCY (Table 4 above) is now found in Brazil, Indonesia and Russia too. India, however, now shows a strong depreciatory impact in "bad" fiscal years in contrast to earlier estimate of appreciation. Thus the impact of good institutions (proxied by "good" fiscal years) in improving EME competiveness is robust to a change in the measure of fiscal procyclicality. The positive impact of fiscal procyclicality continues to hold for Thailand, while Turkey shows no impact from this variable as in earlier case.

Following Frankel et. al (2013), we calculate the correlations between cycles[18] of real government expenditure and real GDP for these countries over 1995 and 2017. These are tabulated below:

	Correlation
Brazil	0.88
Russia	0.67
Indonesia	0.59
India	0.57
China	0.38
Mexico	0.31
Turkey	0.12
Thailand	-0.03

Table 5. Correlations between real government expenditure and output cycles

The robustness check with DUM_PROCY_HAM provides unambiguous evidence for RER depreciation in Thailand in response to "bad" fiscal policy. It can be seen in Table 5, amongst the eight EMEs only Thailand, on average, has fiscal counter-cyclicality or "good" fiscal policy which is another evidence in support of its appreciated RER.

[17] This method takes the trend component as the fitted values from regression of the series on four lagged values of itself back-shifted by two years and a constant. In the case of annual data, this means regressing government expenditure and GDP on their second, third, fourth and fifth lags. The lack of data on government expenditure prior to 1994 for China forced us to take the annual HP estimates of cycles through 1995-98.

[18] Cycles have been extracted using Hodrick-Prescott Filter.

V. Calculating misalignments

In Section IV, we estimate long run ERER under the assumption that structural characteristics of EMEs might cause it to move away from the PPP predicted value of unity. The significant impact of the variables considered in the estimation exercise corroborates the hypothesis. While the estimated cointegrating relationship gives the influence of the chosen variables on the DGP of WRER, the short run equilibrium RER can be calculated using the cointegrating vector coefficients as well as the deterministic coefficients on the actual data for each year. The model specification is in log-linear form as below:

$$log\ ERER = (\alpha_1 *TOT\_H + \alpha_2 *OPEN\_H + \alpha_3 *DL\_PROD + \alpha_4 *DL\_DEP + \alpha_5 *DL\_FD + \alpha_6 *DL\_GOV) + D_i \surd_i^{\prime}$$

where D_i is the matrix of deterministic variables like intercept, linear trend, dummy on procyclicality (and lagged regressors for DOLS). $D_i \surd_i^{\prime}$ is calculated for each EME separately using cross-section specific coefficients while the cointegrating equation provides pooled coefficients for all the cross sections.

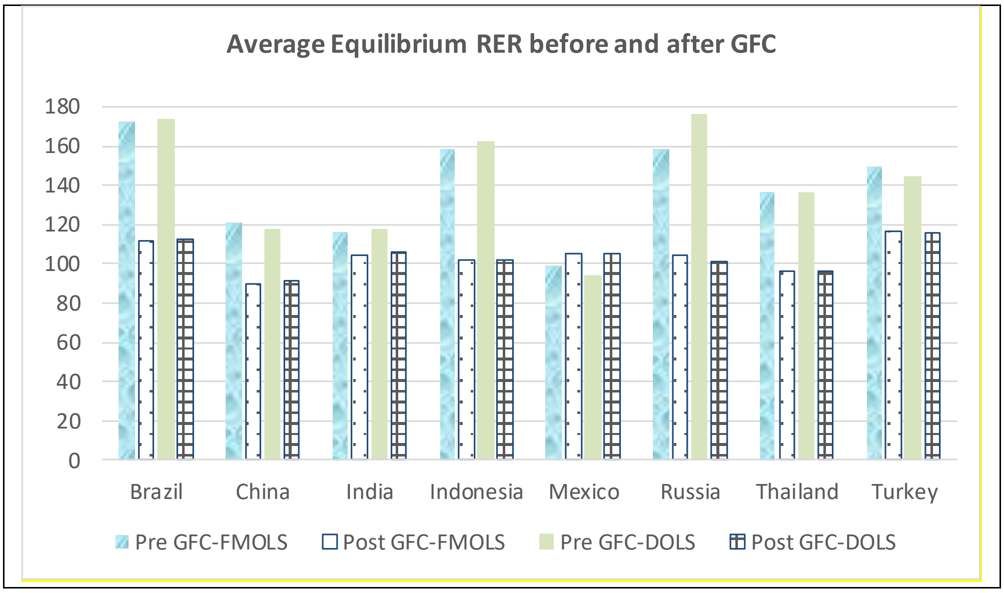

Figure 2. Average ERER

Note: Pre GFC: 1995 (1997 for DOLS) to 2007. Post GFC: 2008 to 2017

ERER estimates can be obtained after taking the antilog of the above estimated log values. The ERERs, thus estimated, were averaged dividing the entire span into pre- and post- GFC periods and have been plotted in the bar graph below. There is a clear distinction in the ERER between the two periods. We can see that, on average, the equilibrium RER in the post-GFC period has fallen in value suggesting rise in EME relative prices as well as fundamental driven appreciation, the exception being the case of Mexico. Incidentally, it is the only country in our set of EMEs that has registered a decline in relative productivity since 2010 and this might be the reason behind its depreciating ERER. In the pre GFC period, China, India and Mexico had the strongest ERERs. China and India have further gained in strength in the post crisis period. It can also be seen there has been a definite convergence in the EME ERERs in the post GFC period. However, the Asian markets still have the strongest ERER in the period following the GFC. Brazil and Turkey show the weakest ERER and indicate weak fundamentals. It can also be seen, that the average ERER estimates from the FMOLS and DOLS are close, except for Russia in the pre GFC period.

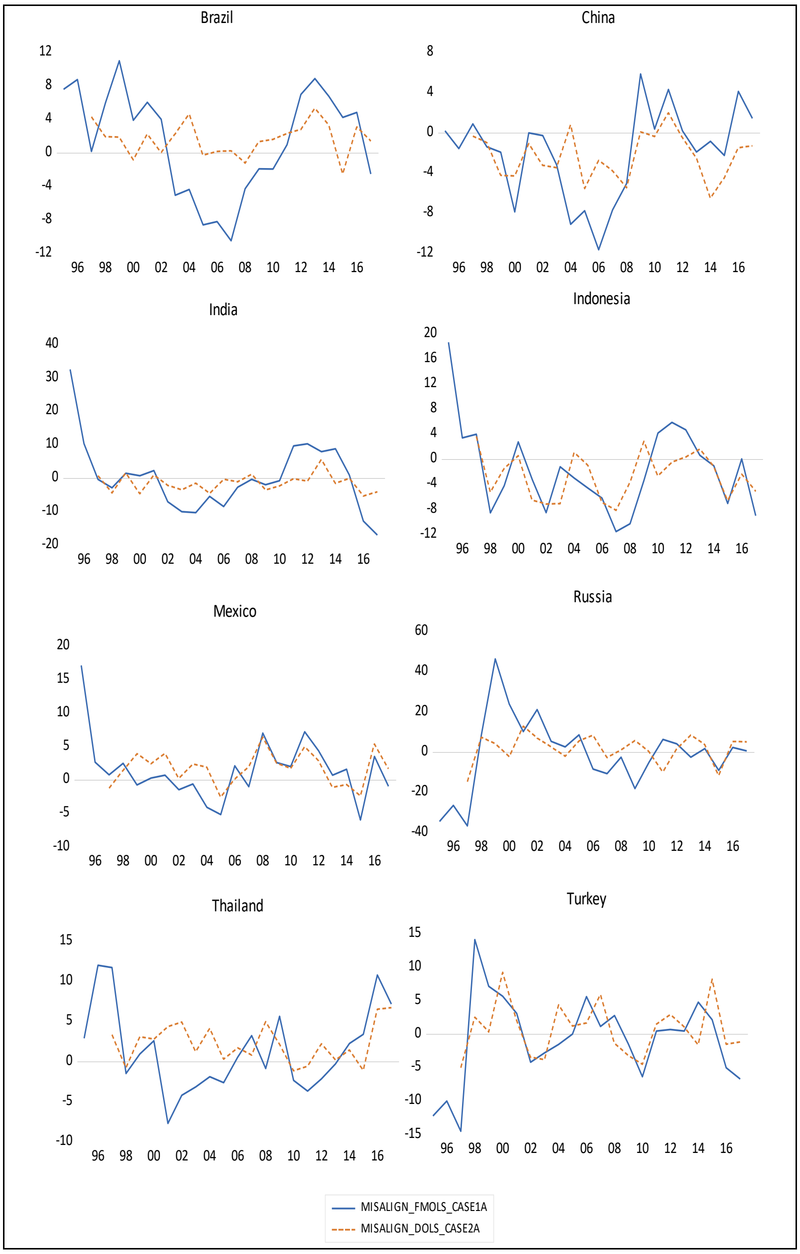

Figure 3. Misalignments

Source: Authors' calculations

We then calculate the yearly misalignments as the percentage deviation of actual RER from estimated ERER. A negative misalignment means that RER has been over-valued for a country in that year and vice-versa for a positive value. The misalignments calculated from the two models FMOLS and DOLS are charted in Figure 3.

Misalignment percentage = [Actual RER (WRER)/ Equilibrium RER (ERER) – 1] * 100

The misalignments as calculated from DOLS are significantly smaller than those calculated from FMOLS. However, for all countries, the DOLS and the FMOLS both predict corrections in the same direction, during the post-crisis period, giving evidence that global factors had affected the EMEs in broadly similar ways. In the analysis of misalignments, it is critical to study the inflection points since it gives a picture of when exchange rate policy changed. Next, we study these changes.

Pre GFC period

Periods of over-valuation are seen to have more inertia in the Asian nations. This is especially true for China, India and Indonesia. All the EMEs, except China, Russia and Turkey, begin with under-valued RER in 1995-96. Since the DOLS estimates start from 1997, we depend on the FMOLS estimates for the initial misalignments before 1997. RER under-valuation is corrected around 1997-98 for Brazil, India, Indonesia, Mexico, Thailand suggesting adjustment after the Asian financial crisis years. The sharp correction in Brazil ERER during 1995-97 coincides with the period of appreciation after the pegging of the Real to the US Dollar in 1994 as a measure to control hyperinflation preceding this period.

The 2000s, till the 2007-08 GFC, were a period of generally overvalued RERs for Brazil, China, India and Indonesia, with years of correction in between. Indonesia had its RER on the side of overvaluation for the largest time from 1998 till 2008-09 and both DOLS and FMOLS give very close misalignment estimates. Between 2004 and 2008, the Chinese RER shows over-valuation to the extent of negative 5 per cent (DOLS)[19], Indian RER between 2002 and 2007 was overvalued with maximum overvaluation of negative 4 per cent (DOLS). The period of overvaluation 2005-2008 was less for Brazil with the RER being undervalued till 2003 (the DOLS estimates show still more undervaluation till 2005).

It is seen that in the years preceding the peak of Global Financial Crisis the correction in over-valuation had already started e.g. China (2006-07), India (2005-06), and Indonesia (2007). So just before the crisis, these economies possibly reflected a trend of short term depreciation in their RERs, which was, in effect, correctional movement in their RERs.

Although over-valuation has been lesser in the case of Mexico (between 2004 and 2006), the correction towards equilibrium came earlier in 2005. The DOLS estimates for Mexico show that its RER was undervalued for most of the pre-crisis years. Russia and Turkey are departures, since in these two nations, the Asian Financial Crisis shifts the RER from over-valuation to undervaluation. Both Russia and Turkey show undervalued RER for most of the pre-crisis period. The Russian undervaluation continued after the GFC (DOLS). It is only after the 2014 Russian financial crisis that Russian RER has appreciated and moved into the zone of over-valuation in the year 201520.

The 2000s, thus, show a decline in competitiveness for the Asian EMEs with RER becoming over-valued at some point or the other. This was the period of large capital inflows to EMEs. Both periods of over-valuation and under-valuation show inertia, with consecutive ups and downs before the final adjustment towards the other side of the equilibrium. Our results negate the belief that EME exchange rates were undervalued. After the inclusion of structural factors and weighing over a set of AEs, EME RER was more on the side of over-valuation, especially so for the Asian economies.

[19] FMOLS estimates show overvaluation to the extent of minus 11 per cent.
[20] Result supported by both FMOLS and DOLS.

Post GFC period

With the GFC, the RER starts moving upwards coinciding with risk-off capital outflows from EMEs. Mexico (2006), Thailand (2007) and India and China (2008) were the first economies to start the upward movement in RER, while Indonesia and Russia joined in around 2010 and Brazil was much later in 2011. This suggests global events affect the RER. For Russia, Turkey and Mexico, phases of undervaluation are more common. Surprisingly, amongst these eight EMEs, the year 2013 (tapering announcements) was a year of undervalued RER for all, except China, where the misalignment was negative 2.5 per cent. This also shows the gaining strength of Chinese currency and investments compared to other EMEs.

In the post GFC years, RER misalignment dipped below the zero boundary in several years. This was the period of QE undertaken by AEs, which shows that EMEs bore a part of post crisis spillovers.

The trend is similar in the case of China (2012), India (2009), Indonesia (2010) and Mexico (2013). Turkey and Russia have also seen RER over-valuation from 2014-15 onwards. Brazil has only responded in 2015. It is to be noted that the range of negative misalignment is considerably less in the RER of India than in China. The Mexican and Indian RER have been very near the equilibrium for most of the years by DOLS estimates. However, recently in 2016, Indian RER has taken a downward turn towards increased over-valuation.

It can be seen in Appendix II Chart 2, the constructed multilateral RER of most EMEs was mostly undervalued with respect to the PPP value of 100 in the pre-GFC period and corrected itself afterwards post the GFC. In contrast, after including structural variables and institutions, the deviations of constructed RER from the equilibrium (which is different from the PPP value) are seen to be both on the side of over- and under- valuations both before and after the crisis.

Figure 4 summarizes the RER misalignments through boxplots over the period 1995-2015. It can be seen that for both the models, the Asian EMEs, were more on the side of over-valuation. While the DOLS shows that in China, India, Indonesia median RER is below equilibrium, or over-valued, FMOLS includes Thailand in this group. The misalignments estimated through DOLS show that, on average, there has been more undervaluation in the economies of Mexico, Brazil, Russia and Turkey.

Next, we contrast our findings with some existing estimates, which suggest the Chinese exchange rate was undervalued during the period 2006-07 (Cline and Williamson 2013). Our findings suggest that RER in China was actually overvalued in this year. The inclusion of structural characteristics of EMEs in the determination of RER possibly leads to this deviation from existing estimates. Cline and Williamson (2009) suggests that China needed to depreciate by 21.2 per cent in 2009 to reduce its current account surplus to a sustainable level. Our results show that if we consider the structural factors the scenario is quite different. In 2009, China was very near to the equilibrium. After 2012, China remained consistently overvalued for most of the years. This is in sharp contrast to the Cline and Williamson estimates of under-valuations in Chinese RER till 2014. While the Cline and Williamson estimates are based on a FEER model, and this paper is based on BEER and cannot be compared, the findings indicate that inclusion of structural characteristics of EMEs can substantially reduce the estimated misalignments in EME RER. Sato et al. (2010), who use supply side factors, find between 2005 and 2008 Chinese RER was actually over-valued, similar to our results.

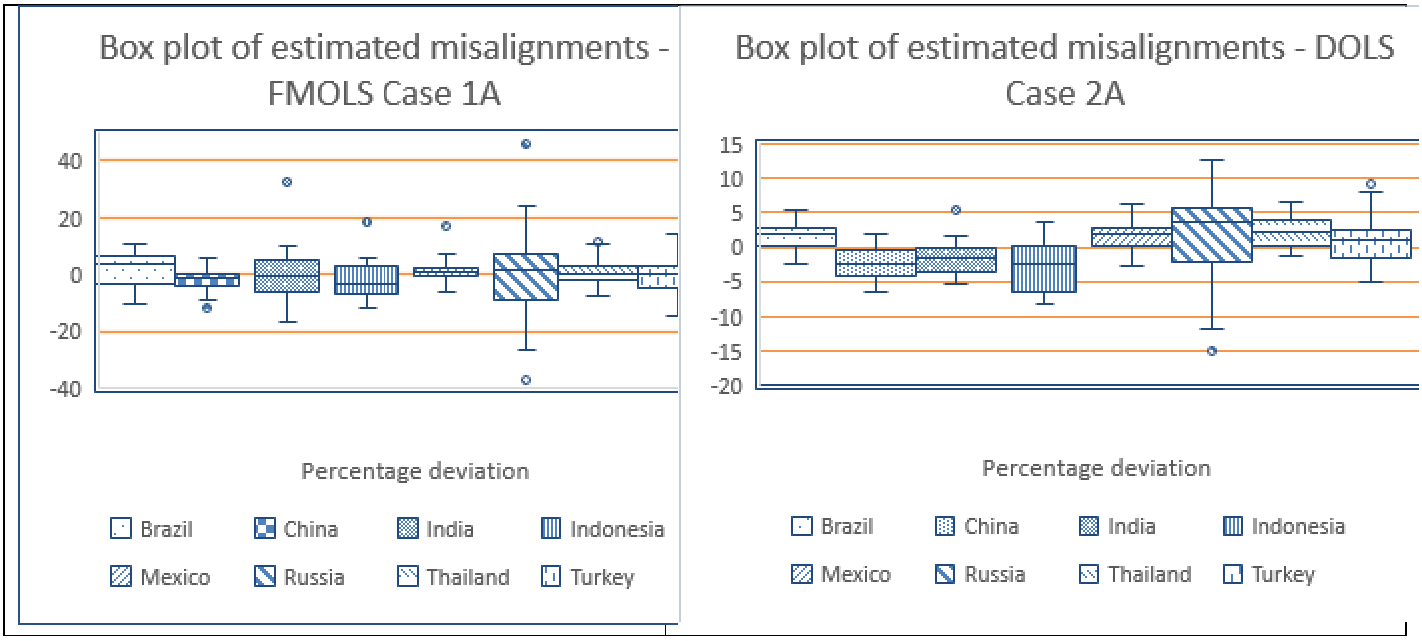

Figure 4. Boxplot of estimated misalignments

During the taper tantrum episode of 2013, we find that there was undervaluation in the RER in economies of Brazil, India, Indonesia, Russia, and Turkey, the maximum being 8.3 per cent in Russia. This was also a crisis period for Russia. This is indicative of the downward pressure on EME exchange rates in the face of tapering announcements. We find that Brazil, Mexico and Thailand RERs were consistently undervalued during this period while FEER estimates find them to be overvalued, or at equilibrium for most of this period. Our results show major ups and downs in Russia, in contrast to FEER estimates indicative of Russia at the equilibrium. Our results support the fall in Ruble during the Russian financial crisis of 2014 which, largely resulted from falling prices of oil exports and international sanctions on Russia. We find more years of overvaluation in India, Indonesia and China in the post-GFC period.

VI. Conclusions

Although a constructed measure of weighted multilateral EME RER has largely been seen to be under-valued with respect to the benchmark purchasing power parity RER of 100 especially in the pre-GFC period, when structural factors are taken into account the undervaluation is found not to hold for all years. This shows that a behavioral modelling of ERER can successfully explain some of the under-valuations observed in REERs used in policy. Under-valuation is less in Asian EMEs compared to the others in the present study conducted with eight key EMEs against a basket of AEs with good geographical spread. We see a need for future research on why Asia behaves considerably differently from non-Asian emerging markets.

Amongst the structural variables, productivity is found to have a strong impact on the RER supporting the Balassa Samuelson effect. If an EME experiences rise in each of productivity, relative price of tradables or dependency, its ERER appreciates. On the other hand, rise in fiscal expenditure and financial development, on average, lead to depreciating RER. Thus while demand factors/fundamentals appreciate RER there are supply-side improvements that depreciate it. The depreciatory impact of government expenditure on RER is in line with Kim (2015), which finds the same effect with AEs. However, Ricci et al (2008) found an appreciating impact of government expenditure on RER, although they did not include the post GFC years. The long run impact of aggregate productivity financial development is found to be robust across a variety of estimations.

We also find that EMEs experience a decline in competitiveness in years of procyclical or “bad” fiscal policy. Only Thailand experiences greater competitiveness in such years. However, on average Thailand is found to follow a counter-cyclical fiscal policy indicating more evidence for RER appreciation in Thailand. While institutions captured through financial development is seen to improve competitiveness of EME RER in general, political institutions captured through the inclination to follow fiscal rules is also found to increase competitiveness in most EMEs. Thus EMEs should focus on building institutions in order to increase their competitiveness in global markets.

The RER corrected for fundamentals is found to follow a cyclical pattern linked closely to global events. Asian economies along with Brazil and Mexico can be grouped together in terms of comparable RER movement. Russia and Turkey have edged on the side of under-valuation and followed a more chaotic path. Asian markets along with Mexico are possibly leading the cycles, with Brazil following with a definite lag. The finding that RER has both episodes of over and under-valuation means that EMEs have responded well to the possibility of retaliation. China, India and Indonesia had at least a few years of over-valuation in their RER in the pre GFC years. China RER remained over-valued in the face of taper tantrums of 2013, while most of the other EMEs suffered from depreciation.

That EME RER was over-valued in the years before the GFC and following it shows EMEs bore the brunt of post GFC adjustment costs. This implies it was not imbalances so much as financial innovation that was responsible for the GFC. More research is required on GFC adjustment costs.

The ERER moves both ways. This shows RER misalignments, which also move in both directions, are not just a nominal adjustment, but can strongly be taken as a fundamental driven phenomenon. Much of the RER competitiveness can be explained through supply-side improvements. This paper finds global events like the East-Asian Financial crisis, GFC and QE, influence the RER with turning points happening post such events. Amongst Asian markets, Thailand seems to lead. The cyclical pattern of RER as well as the link with global events in the presence of significant influence of fundamentals can be explored further. RER over-valuations have been commonly found in the years preceding many crises (Catao, 2018). We find that in the case of GFC too, RER was over-valued at least to some extent between 2000 and 2007 especially for Asian emerging markets. Even though the GFC resulted in depreciatory impact on RER, in the recent years, we find a trend of rising RER as misalignments move downward towards over-valuation, particularly for China, India and Indonesia. Hence, it would pay for exchange rate policies in these countries to be more cautious.

Future research could investigate what part of the adjustment dominates - the nominal adjustment through exchange rate or the real adjustment through the impact of fundamentals. The impact of structural variables like population and institutions on the persistence of multilateral exchange rates can be studied further. Non-linearity in the data and their impact on the findings of this study is kept as an agenda for future research, as is the falling dependencyfound in most EMEs using disaggregated datasets.

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References

(1) Adi, A. A., Du, J., 2015. Estimate of Equilibrium Real Exchange Rate and Misalignment of Chinese Yuan Vis-a-Vis US Dollar. Academic Journal of Economic Studies. 1(3), pp. 148–165. September 2015. ISSN 2393-4913, ISSN On-line 2457-5836.

(2) Balassa, B., 1964. The Purchasing-Power Parity Doctrine: A Reappraisal. Journal of Political Economy. 72(6), pp. 584-596.

(3) Blanchard, O.J., Milesi-Ferretti, G.M., 2012. (Why) Should Current Account Balances Be Reduced? IMF Economic Review 60, pp. 139–150.

(4) Bergsten, C. F., 2013. Currency Wars, The Economy of the United States and Reform of the International Monetary System. Stavros Niarchos Foundation Lecture. https://piie.com/sites/default/files/publications/papers/bergsten201305.pdf

(5) Bergsten, C. F., Gagnon, J. E., 2012. Currency Manipulation, the US Economy, and the Global Economic Order. Peterson Institute of International Economics. Policy Brief number PB12-25.

(6) Osorio Buitron, C., Vesperoni, E., 2015. Big Players Out of Synch: Spillovers Implications of US and Euro Area Shocks. IMF Working Papers, 15(215), 1. doi:10.5089/9781513558448.001

(7) Canzoneri, M. B., Cumby R. E., Diba, B, 1996. Relative Labor Productivity and The Real Exchange Rate in The Long Run: Evidence for A Panel of OECD Countries. NBER Working Paper 5676.

(8) Catão, L. 2018. Real Exchange Rates: What Money Can Buy. Finance & Development. International Monetary Fund. https://www.imf.org/external/pubs/ft/fandd/basics/realex.htm

(9) Chang, Y., 2000. Nonlinear IV Unit Root Tests in Panels with Cross Sectional Dependency. Department of Economics. Rice University.

(10) Chinn, M.D., 2000. The Usual Suspects? Productivity and Demand Shocks and Asia-Pacific Real Exchange Rates. Review of International Economics, 8(1), pp.20–43. Available at: http://dx.doi.org/10.1111/1467-9396.00203.

(11) Cheung, Y.-W. & Lai, K.S., 2000. On cross-country differences in the persistence of real exchange rates. Journal of International Economics, 50(2), pp.375–397. Available at: http://dx.doi.org/10.1016/s0022-1996(98)00079-8.

(12) Clark, P, MacDonald, R, 1998. Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs. IMF Working Paper. Available at SSRN: http://ssrn.com/abstract=882342

(13) Cline, W.R., 2005. The United States as a Debtor Nation. Institute for International Economics. ISBN 0-88132-399-3.

(14) Cline, W.R., Williamson, J., 2009. Estimates of Fundamental Equilibrium Exchange Rates. Policy Brief. Peterson Institute of International Economics. PB09-10. https://piie.com/sites/default/files/publications/pb/pb09-10.pdf

(15) Cline, W.R., Williamson, J., 2013. Estimates of Fundamental Equilibrium Exchange Rates, May 2013. Policy Brief. Peterson Institute of International Economics. PB13-15. https://piie.com/sites/default/files/publications/pb/pb13-15.pdf

(16) Coudert, V. & Couharde, C., 2008. Real Equilibrium Exchange Rate in China. Is the Renminbi Undervalued? Exchange Rates and Macroeconomic Dynamics, Applied Econometrics Association Series. Palgrave Macmillan, London. pp. 94–112. Available at: http://dx.doi.org/10.1057/9780230582699_4.

(17) Curran, M., Velic, A., 2019. Real Exchange Rate Persistence and Country Characteristics: A Global Analysis. Journal of International Money and Finance, 97, pp. 35-56, ISSN 0261-5606, https://doi.org/10.1016/j.jimonfin.2019.06.001.

(18) Dooley, M. P., Folkerts-Landau, D., Garber, P., 2004. Direct Investment, Rising Real Wages and the Absorption of Excess Labour in the Periphery. NBER Working Paper 10626

(19) Edwards, S., 1988. Real and Monetary Determinants of Real Exchange Rate Behavior: Theory and Evidence from Developing Countries. Journal of Development Economics 29(3), pp. 311–341.

(20) Edwards, S. and Savastano, M., 1999. Exchange Rates in Emerging Economies: What Do We Know? What Do We Need to Know? Available at: http://dx.doi.org/10.3386/w7228.

(21) Engel, C., 1993. Is Real Exchange Rate Variability Caused by Relative Price Changes? An Empirical Investigation. Journal of Monetary Economics 32(1). Pp. 35-50.

(22) Frankel, J. A., Vegh, C. A., Vuletin, G., 2013. On Graduation from Fiscal Procyclicality. Journal of Development Economics 100(1), pp. 32–47.

(23) Gan, C., Ward, B., Ting Ting, S., Cohen, D. A., 2013, An Empirical Analysis of China's Equilibrium Exchange Rate: A Co-integration Approach. Journal of Asian Economics, 29, pages 33 to 44.

(24) Goldfajn, I., Valdes, R., O., 1996. The Aftermath of Appreciations. NBER Working Paper 5650.

(25) Gourinchas, P, and Obstfeld, M, 2012. Stories of the Twentieth Century for the Twenty First. American Economic Journal: Macroeconomics, 4(1), pp. 226-65.

(26) Goyal, A, Sharma, B., 2018. Government Expenditure in India: Composition, Cyclicality and Multipliers. Journal of Quantitative Economics, pages: 1-39. DOI: https://doi.org/10.1007/s40953-018-0122-y.

(27) Hamilton, J., 2017. Why You Should Never Use the Hodrick-Prescott Filter. NBER Working Paper No. 23429.

(28) Hassan, T. A., Mertens, T. M., Zhang, T. 2016. Currency Manipulation. NBER Working Paper No. 22790.

(29) Im, K.S., Pesaran, H.M., Shin, Y., 1997. Testing for Unit Roots in Heterogeneous Panels. Discussion Paper, University of Cambridge.

(30) Kao, C., Chiang, M.-H., 1995. On the Estimation and Inference of a Cointegrated Regression in Panel Data. Center for Policy Research Working Paper No. 2.

(31) Kao, C., 1999. Spurious Regression and Residual-based Tests for Cointegration in Panel Data. Journal of Econometrics 90(1), pp. 1-44.

(32) Kim, S., 2015. Country Characteristics and the Effects of Government Consumption Shocks on the Current Account and Real Exchange Rate. Journal of International Economics 97(2), pp. 436–447.

(33) Demirguc-Kunt, A., Klapper, L., Singer, D., Van Oudheusden, P., 2015. The Global Findex Database 2014: Measuring Financial Inclusion around the World. Policy Research Working Paper 7255.

(34) Levin, A., Lin, C.-F., J. Chu, C-S., 2002. Unit Root Tests in Panel Data: Asymptotic and Finite-sample Properties. Journal of Econometrics, Elsevier. 108(1), pp. 1-24.

(35) Levine, R., 2004. Finance and Growth: Theory and Evidence. NBER Working Paper 10766. http://www.nber.org/papers/w10766

(36) Maggiori, M., 2017. Financial Intermediation, International Risk Sharing, and Reserve Currencies. American Economic Review 107(10), pp. 3038–3071.

(37) MacDonald, R., 1996. Panel Unit Root Tests and Real Exchange Rates. Economics Letters. 50(1), pp. 7-11.

(38) Phillips, P.C.B., Hansen B.E., 1990. Statistical Inference in Instrumental Variables Regression with I(1) Processes. Review of Economic Studies 57(1), pp. 99-125.

(39) Pedroni, P., 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistics, Special Issue (1999), pp. 0305-9049.

(40) Pedroni, P., 2001. Fully Modified OLS for Heterogeneous Cointegrated Panels. Chapter in Baltagi, B., Fomby, T. and Carter Hill, R. (Ed.) Nonstationary Panels, Panel Cointegration and Dynamic Panels, (Advances in Econometrics, Vol. 15), Emerald Group Publishing Limited, Bingley. Pp. 93–130.

(41) Rey, H., 2015. Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence. National Bureau of Economic Research Paper No. 21162. Available at http://www.nber.org/papers/w21162.

(42) Ricci, L. A., Milesi-Ferretti, G. M., Lee, J., 2008. Real Exchange Rates and Fundamentals: A Cross-Country Perspective. IMF Working Paper WP/08/13.

(43) Svirydzenka, K., 2016. Introducing a New Broad-based Index of Financial Development. International Monetary Fund WP/16/5.

(44) Talvi, E., Vegh, C., 2005. Tax Base Variability and Procyclical Fiscal Policy in Developing Countries. Journal of Development Economics, 78(1), pp. 156-190.

(45) Terra, C., Valladares, F., 2010. Real Exchange Rate Misalignments. International Review of Economics and Finance, Special Issue: Exchange Rate Pass-Through and Exchange Rate Dynamics. 19(1), pp. 119–144.

(46) Wang, T., 2004. China: Sources of Real Exchange Rate Fluctuations. IMF Working Papers, 04(18), p.1. Available at: http://dx.doi.org/10.5089/9781451843675.001.

(47) Williamson, J., 1983. The Exchange Rate System. Policy Analyses in International Economics. 5. Washington Institute for International Economics.

(48) Williamson, J., 2011 Getting Surplus Countries to Adjust. Peterson Institute of International Economics. Policy Brief. Number P b 1 1 - 0 1.

(49) Wu, R., 2016. A New Method of Estimating Equilibrium Real Exchange Rate in Developing Countries. International Journal of Economics and Finance. 8(3), pp. 171-177, March.

(50) You, K. & Sarantis, N., 2011. Structural Breaks and the Equilibrium Chinese Yuan/US Dollar Real Exchange Rate: A FEER Approach. Review of International Economics, 19(5), pp. 791–808. Available at: http://dx.doi.org/10.1111/j.1467-9396.2011.00986.x.

(51) Yue, L.H., Qiang, J. & Kai, T.Y., 2015. Determination of Renminbi Equilibrium Exchange Rate, Misalignment, and Official Intervention. Emerging Markets Finance and Trade, 52(2), pp. 420–433. Available at: http://dx.doi.org/10.1080/1540496x.2016.1110448.

Appendix

Appendix Section I: Choice of cross-sections

Chart 1.a.i : Europe, Middle East and Africa

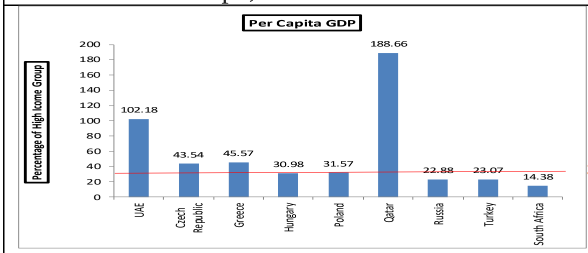


Chart 1.a.ii: After excluding outliers

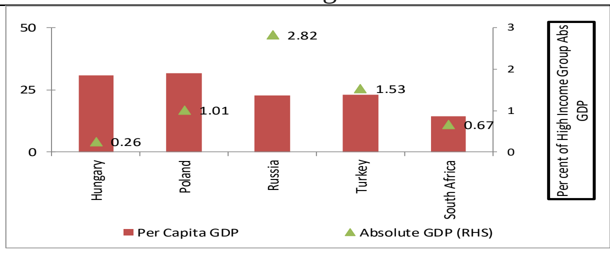


Chart 1.b.i: Latin America

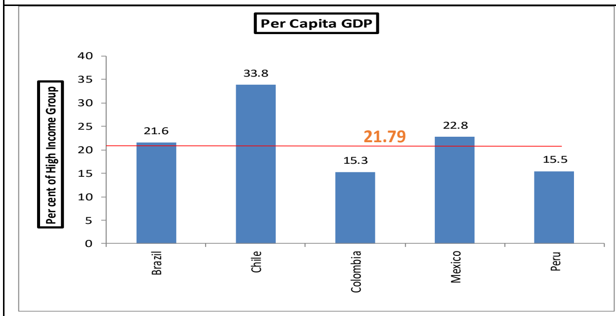


Chart 1.b.ii: After excluding outliers

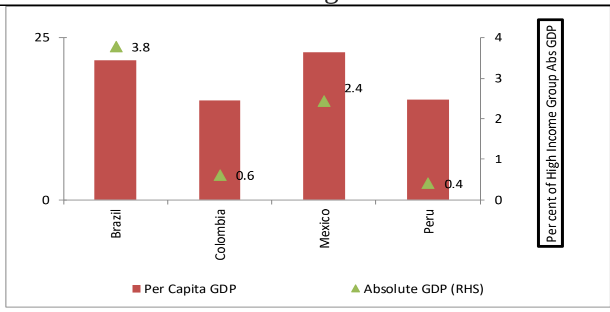


Chart 1.c.i :Asia

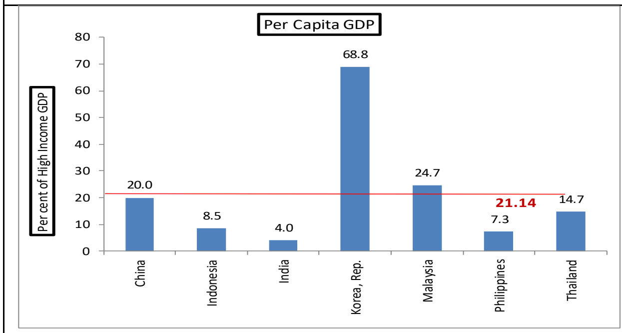


Chart 1.c.ii: After excluding outliers

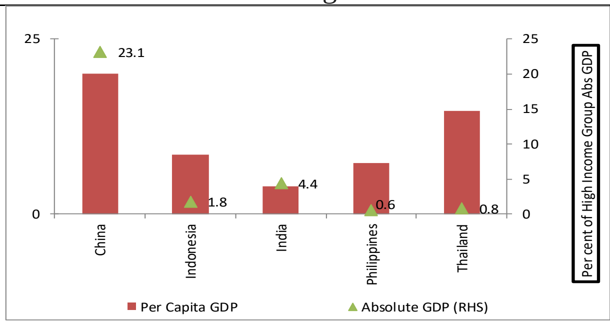


Chart 1. Country choice

To determine the set of countries for our analysis, we use information on economic size (proxied by absolute GDP) and economic development (proxied by per capita GDP in current Dollars as a percentage of per capita GDP of high income countries). Data from World Development Indicators for three regions e.g. 1) Latin America, 2) Asia, 3) Eastern Europe and Africa is plotted in Chart 1. We plot per capita GDP (in current Dollars) as a percentage of per capita GDP of high income countries (HICs). We de-select those countries having considerably more than the average measure for the region. For example, for Europe, Middle East and Africa, we exclude outlier economies with more than 30 per cent in per capita GDP as a proportion of HICs e.g. the OPEC nations Qatar and UAE have more than 100 per cent per capita GDP of HICs, as well as Greece, Czech Republic have more than 40 per cent in per capita GDP. Next, in the trimmed set, we construct our sample selecting those countries that have adequate economic size based on both per capita GDP as well as absolute GDP (see Charts 1. a, b, c – ii). We de-select those countries that have less than 1 per cent in average absolute GDP (as a percentage of absolute GDP of HICs)[21]. We keep Thailand, which has slightly less than 1 per cent, as a representative for South-Eastern Asia and also because of comparable per capita income in the region.

The final set of countries chosen is:
Latin America: Brazil and Mexico
Asia: China, Indonesia, Thailand, India
Eastern Europe: Russia and Turkey, South Africa

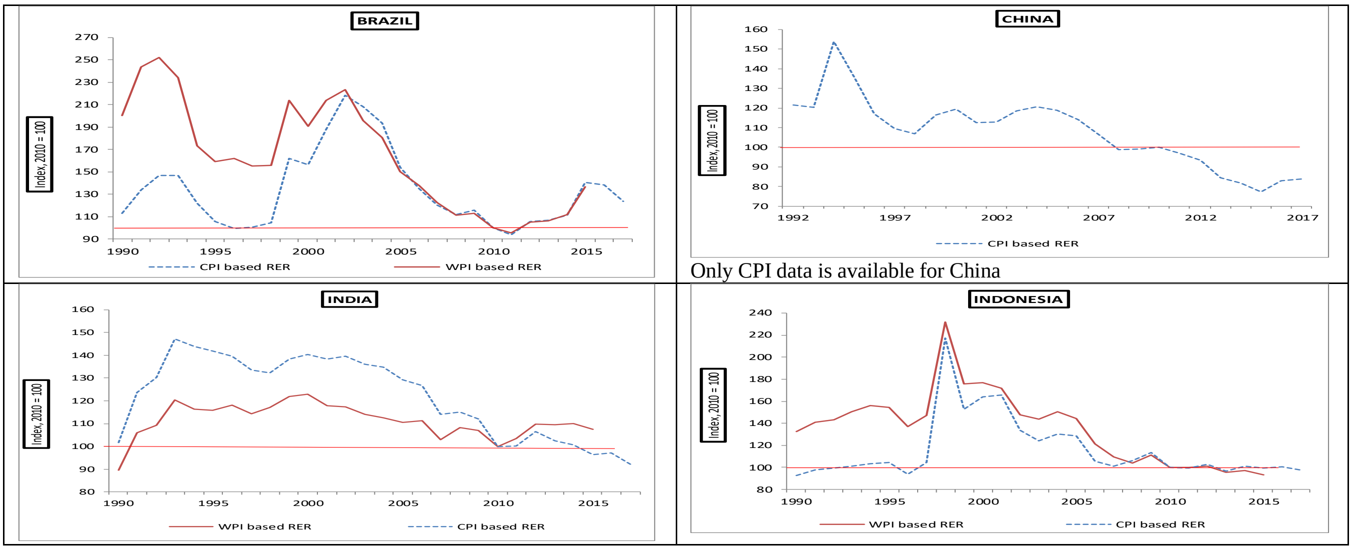
Appendix Section II: Data

Brazil					
Classification	Year of adoption	US	UK	JAPAN	AUSTRALIA
H0	1991-1996	21.47	2.63	6.09	0.64
H1	1997-2001	22.75	2.55	5.02	0.50
H2	2002-2007	19.62	2.24	3.63	0.50
H3	2008-2011	13.01	1.93	3.56	0.56
H4	2012-2016	13.59	1.61	2.90	0.37
H5	2017	14.18	1.40	2.45	0.50
China					
H0	1992-1995	13.55	1.62	19.00	1.53
H1	1996-2001	15.90	1.98	18.40	1.71
H2	2002-2006	15.02	1.74	14.28	1.77
H3	2007-2011	13.16	1.73	10.21	2.65
H4	2012-2016	13.28	1.84	7.56	3.09
H5	2017	14.24	1.92	7.38	3.32
India					
H0	1990-1995	13.65	6.19	7.47	2.20
H1	1996-2002	13.45	5.53	4.69	2.00
H2	2003-2008	10.37	3.47	2.61	2.30
H3	2009-2012	7.64	2.11	2.28	2.37
H4	2013-2016	8.89	2.04	2.15	1.77
H5	2017	9.49	1.80	2.03	2.47
Indonesia					
H0	1990-1995	12.89	2.40	28.38	3.40
H1	1996-2001	13.05	2.41	20.30	4.02
H2	2002-2009	9.58	1.41	17.00	3.45
H3	2010-2011	7.63	0.83	14.26	2.83
H4	2012-2016	7.44	0.79	11.76	2.83
H5	2017	7.98	0.75	9.79	2.93
Mexico					
H0	1990-1995	74.15	0.88	3.98	0.12
H1	1996-2001	79.64	0.64	2.42	0.14
H2	2002-2007	70.67	0.63	3.11	0.21

[21] We could not include Poland due to lack of data.

H3	2008-2011	64.21	0.66	2.84	0.26
H4	2012-2016	63.99	0.60	2.65	0.21
H5	2017	62.95	0.57	2.68	0.18
Russia					
H0	1996	5.33	3.13	2.91	0.07
H1	1997-2001	6.22	3.58	2.49	0.11
H2	2002-2006	3.78	3.20	2.51	0.08
H3	2007-2011	3.53	2.74	3.57	0.13
H4	2012-2016	3.69	2.13	3.81	0.11
H5	2017	3.83	1.65	3.11	0.11
Thailand					
H0	1990-1998	16.07	2.79	23.19	1.78
H1	1999-2001	16.81	2.58	18.99	2.12
H2	2002-2006	12.47	2.11	18.17	2.61
H3	2007-2011	8.67	1.57	15.08	3.76
H4	2012-2016	8.39	1.46	13.20	3.28
Turkey					
H0	1990-1995	9.33	5.17	3.43	0.46
H1	1996-2001	8.34	5.80	2.44	0.51
H2	2002-2006	6.00	5.88	1.74	0.33
H3	2007-2011	5.01	4.14	1.28	0.33
H4	2012-2016	4.90	4.19	1.02	0.33
H5	2017	5.27	4.13	1.20	0.70

Table A1. Trade weights with AEs[22] (calculated from UN Comtrade)



[22] Trade defined as bilateral exports and imports with an AE over total multilateral trade of a country.

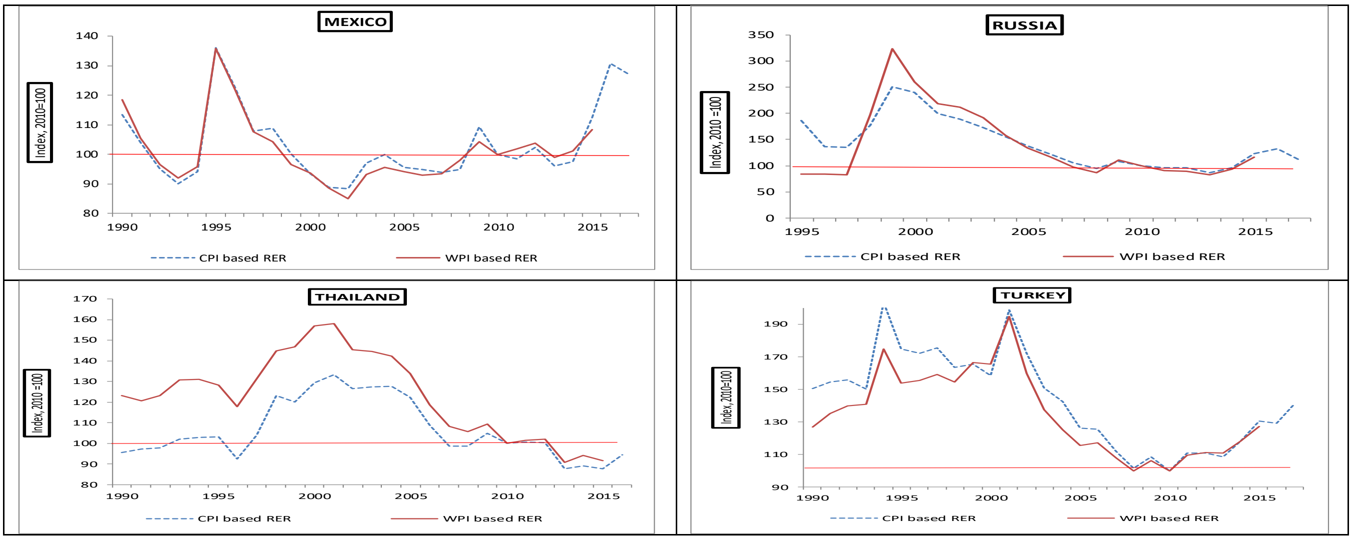


Chart 2. Constructed WRER for emerging markets

Note: The red horizontal line indicates the 100 mark of purchasing power parity.

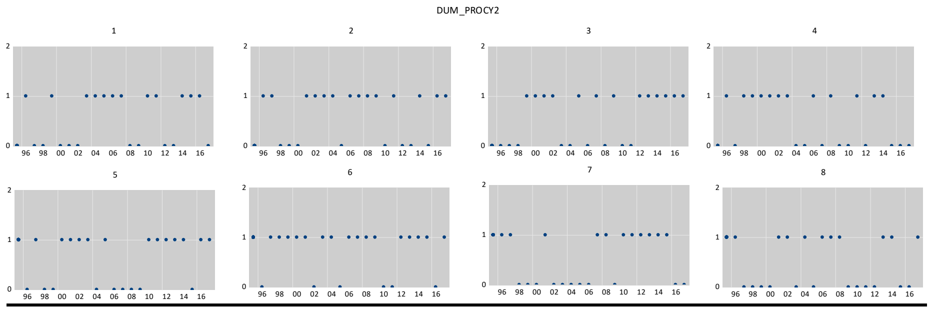


Chart 3. Dummy (1-0) of procyclicality index (+ve means years of procyclical fiscal policy)

Note: 1: Brazil, 2: China, 3: India, 4: Indonesia, 5: Mexico, 6: Russia, 7: Thailand, 8: Turkey

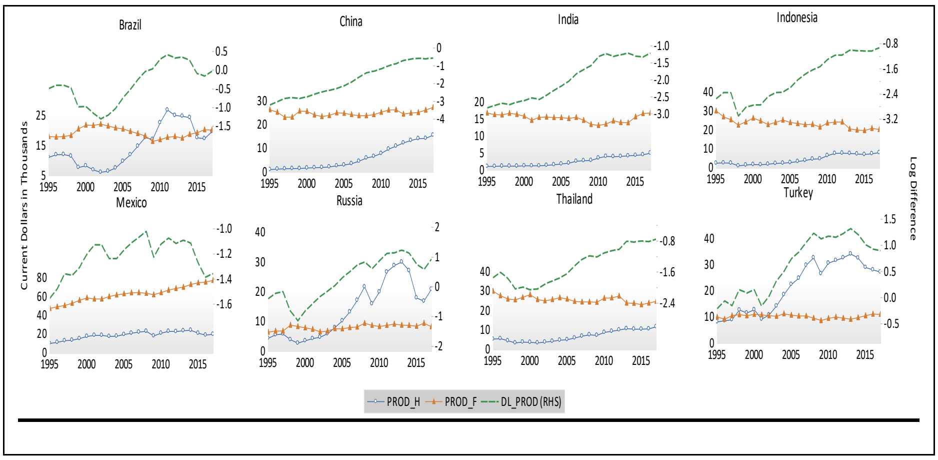


Chart 4.a: Productivity

PROD_H: Productivity of home country (EME), PROD_F: Productivity (trade weighted) of AEs, DL_PROD: Log Productivity differential b/w EME and AE.

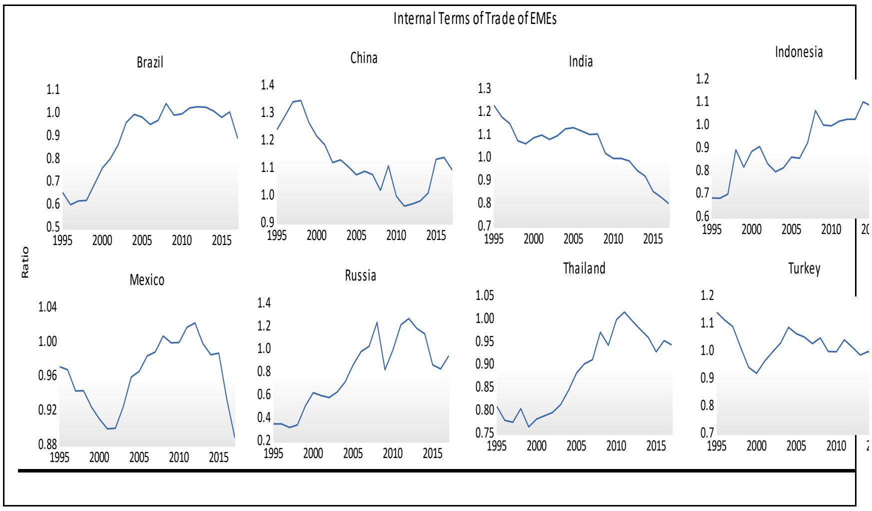


Chart 4.b: EME internal terms of trade

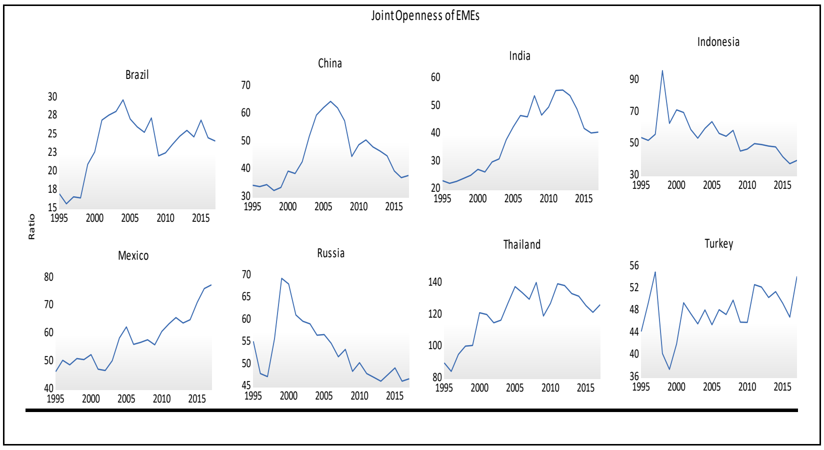


Chart 4.c: EME joint openness ratio

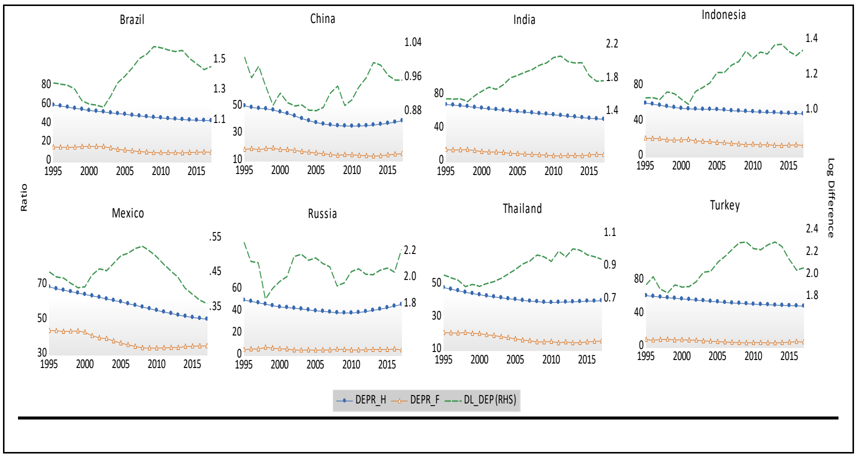


Chart 4.d.: Dependency ratio

DEPR_H: Dependency ratio of Home country (EME), DEPR_F: Dependency ratio (trade weighted) of AEs, DL_DEP: Log Dependency ratio differential b/w EME and AE.

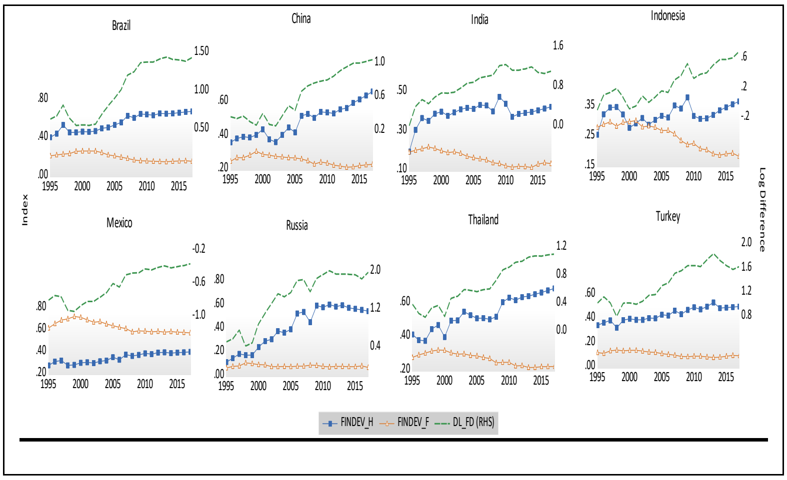


Chart 4.e.: Financial development index

FINDEV_H: Financial Development Index of Home country (EME), FINDEV_F: Financial Development Index (trade weighted) of AEs, DL_FD: Financial Development Index differential b/w EME and AE.

Chart 4.f.: Government consumption expenditure

GOVT_EXP_H: Government Consumption Expenditure of Home country (EME), GOVERNMENT_EXP_F: Government Consumption Expenditure of (trade weighted) of AEs, DL_GOV: Log Government Consumption Expenditure differential b/w EME and AE.

Appendix Section III: Estimation Results

	LWRER	TOT_H	OPEN_H	DL_PROD	DL_DEP	DL_FD	DL_GOV
Breusch-Pagan LM	260.10***	266.73***	161.36***	415.68***	206.28***	511.75***	592.41***
Pesaran scaled LM	31.02***	31.90***	17.82***	51.81***	23.82***	64.64***	75.42***
Bias-corrected scaled LM	30.83***	31.72***	17.64***	51.62***	23.64***	64.46***	75.24***
Pesaran CD	11.46***	1.13*	3.47***	19.49***	9.49***	22.57***	24.33**

Table A2: Tests for cross sectional dependence

Note: Each test statistic tests for the null of no cross-section dependence

Case 1: WRER with TOT_H, OPEN_H, DL_PROD, DL_DEP, DL_FD			
	Statistic	p-value	
Panel ni (Variance ratio)	-0.11	0.54	^
Panel rho	1.71	0.96	^
Panel t non parametric (PP Zt)	-2.72	0.00	**
Panel t parametric (ADF)	-3.20	0.00	**
Group rho	2.51	0.99	^
Group t non par	-5.87	0.00	**
Group t par	-3.11	0.00	**
Kao ADF statistic	-4.62	0.00	**
Case 2: LWRER with TOT_H, OPEN_H, DL_PROD, DL_GOV			
Panel ni (Variance ratio)	1.03	0.15	^
Panel rho	1.36	0.91	^
Panel t non parametric (PP Zt)	-1.06	0.14	^
Panel t parametric (ADF)	-2.94	0.00	**
Group rho	2.27	0.99	^
Group t non par	-1.06	0.14	^
Group t par	-2.91	0.00	**
Kao ADF statistic	-5.45	0.00	**

Table A3: Multivariate panel cointegration test

Expansion of X'it β:

$X'_{it}\beta$ can be futher simplified as:

Case A: $\beta_1 TOT\_H + \beta_2 OPEN\_H + \beta_3(DL\_PROD) + \beta_4(DL\_DEP) + \beta_5(DL\_FD)$

Case B: $\beta_1 TOT\_H + \beta_2 OPEN\_H + \beta_3(DL\_PROD) + \beta_4 (DL\_GOV)$

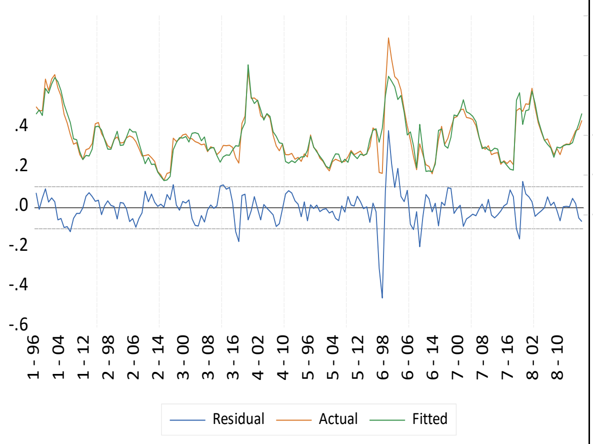
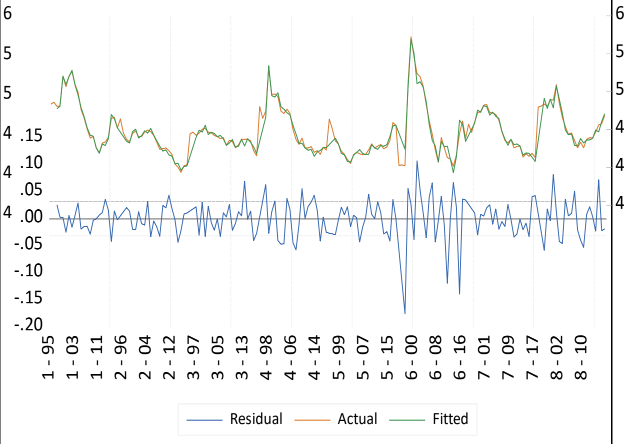
Chart 5.a.: FMOLS: Case 1A	Chart 5.b: DOLS: Case 2A
	

Chart 5. Residual graphs