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Temporal Dimension and Equilibrium Exchange Rate: a FEER / BEER Comparison

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TEMPORAL DIMENSION AND EQUILIBRIUM EXCHANGE RATE: A FEER / BEER COMPARISON¹

Antonia Lòpez-Villavicencio^{*}, Jacques Mazier^{**}, Jamel Saadaoui^{†2}

Abstract

We analyze, in a unified theoretical framework, the two main models for equilibrium exchange rate, namely, the BEER and the FEER approaches. In order to understand the interactions between them, we study in detail the temporal links between these two measures. Our results show that, in average, the BEER and the FEER are closely related. Yet, important differences can be observed for some countries and/or some periods of time. Therefore, we analyze some of the factors that may explain this disconnection, identifying several aspects which are able to alter the relation between the current account and the real effective exchange rate, and so, between the FEER and the BEER. Our analysis puts forward the structural changes in matter of competitiveness, the dynamics of foreign asset positions and valuation effects as explanations for the divergence.

Classification JEL: F31, F32, C23

Key words: Equilibrium Exchange Rate, BEER, FEER, Cointegration, Global Imbalances

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1. Introduction

Since the mid-1990s, we observe an important increase in global imbalances, implying, on the one side, sustained deficits in the current account of some major economies (particularly the United States) and, on the other, important surplus in emerging economies as China. In addition, even though the euro zone as a whole keeps an equilibrated position *vis-à-vis* the rest of the world, important differences are observed among its member countries. Indeed, whereas Germany is a creditor country with important surpluses, several countries of the zone present sustained deficits in their current account and negative external foreign assets positions as percentage of their GDP. These imbalances are a threat to the world economy because they reflect mainly inequalities in terms of growth, savings and investments and exchange rates misalignments (ERM) in the main economic areas.

In recent times, the “currency war” is causing international tensions and bringing the subject of currency misalignments, once again, at the heart of the economic policy discussions. Indeed, with countries as China jockeying to devalue their currencies in order to boost exports, several politics and economics are proposing to treat undervalued currencies as an illegal export subsidy and, therefore, to set tariffs to counterbalance the gain obtained by keeping an undervalued currency. An important question that arises at this point is then how to calculate real exchange rate misalignments.

By definition, ERM is defined as the gap, in percentage, between observed exchange rates and equilibrium exchange rates. However, even though the literature that deals with this subject is extensive, there is still no consensus about the reference point at which real exchange rates should be compared to and, therefore, there is not a unique, single measure of misalignment. Indeed, several methodologies can be used to estimate equilibrium exchange rates³.

In particular, ERM have been studied in detail in the literature using two main approaches: the Behavioral Equilibrium Exchange Rate (BEER) and the Fundamental Equilibrium Exchange Rate (FEER). Briefly, the FEER is defined as the level of exchange rate which allows the economy to reach simultaneously the internal and external equilibriums in the medium term (Williamson, 1994). On the contrary, the BEER approach explains the exchange rate

³ See Driver and Westaway (2004) for a survey.

dynamics with some main variables (usually the net foreign assets, the terms of trade, the productivity, the oil prices) which influence the real exchange rate in the long term (Clark and MacDonald, 1998)⁴.

Given its importance in policy analysis, the literature that aims at estimating equilibrium exchange rate is very extensive. Yet, there is still an extensive debate on which approach is the most convenient to make judgments about exchange rates being over or under-valued⁵. In the case of the FEER approach, questions have been risen with respect to its sensitivity to import and export exchange rate elasticities as well as issues related to deriving benchmarks for the current account. On the contrary, the BEER approach has been questioned for its lack of theoretical arguments as well as the scarce robustness of the reduced form equations⁶.

In this sense, the aim of this study is to contribute to the literature on equilibrium exchange rates by adding a new dimension to the analysis. In particular, we aim at understanding the economic reasons behind the divergence between the BEER and the FEER estimations for real exchange rate misalignment for a large panel of countries. To this end, we analyze, in a unified theoretical framework, the BEER and the FEER methodologies. In order to understand the links between these two approaches, we study carefully the temporal links between the two kinds of equilibrium exchange rate.

The contribution of the paper compared to previous studies on the equilibrium exchange rate lies in the fact that often, comparisons are made without taking into account sufficiently the time horizon of each measure, which may lead to serious misinterpretations of the nature and / or the magnitude of misalignments. We are dealing with *two concepts of equilibrium exchange rate* (FEER / BEER), which correspond to two different time horizons (the medium term / the long term) and two goals of macroeconomic policy (the stabilization of the current account balance / the stabilization of the net external position) that can *temporarily diverge*, as shown by the case of the United States during the second half of the 2000s for instance (see below). In addition, we go further than the previous literature by identifying a number of

⁴ In order to assess misalignments, the US government relies basically in the 3 methods favored by the IMF which are close to the FEER and the BEER methodologies.

⁵ Cheung et al. (2009), Dunaway et al. (2009) studies the robustness of estimates of equilibrium exchange rates across different methodologies in the case of the Chinese real exchange rate.

⁶ Bussière et al. (2010) provide a good discussion on the solutions in dealing with the large uncertainties surrounding equilibrium exchange rate estimates.

reasons that lie behind the divergence of the two approaches, a fact previously neglected.

This paper is organized as follow. Section 2 summarizes the theoretical and methodological background. Section 3 tests empirically the temporal links between FEERs and BEERs. Section 4 studies the differences between these two approaches and theirs implications in terms of economic policies. Section 5 concludes.

2. The temporal dimension in the BEER and the FEER approaches

Some authors have compared the BEER and FEER approaches in the same theoretical framework (see e.g. Driver and Westaway, 2004, Rubaszek and Rawdanowicz, 2009, Benassy-Quéré et al., 2009). One important conclusion of these previous studies is that, despite of conceptual differences, the two approaches can be seen as complements rather than substitutes. This kind of comparison seems to be misleading because it neglects the temporal dimension. Certainly, as mentioned before, the FEER is a medium run concept in which the current account reaches a sustainable level at medium term. Therefore, it can be seen as a flow equilibrium which is relevant precisely at medium term. Instead, the BEER is a long run concept associated with a stock-flow equilibrium in which the current account is equal to zero and the growth rate of the net foreign assets is equal to zero in percentage of GDP (Driver and Westaway, 2004).

More in detail, the procedure to derive BEER series is quite standard (see, for instance Béreau et al. (2010)). It consists on the estimation of a reduced form relationship between the real exchange rate and a set of economic fundamentals with econometric techniques. This estimation provides an equilibrium level for the real exchange rate which then compared to the observed level of exchange rate.

On the other side, the FEER is defined as the exchange rate prevailing when the economy simultaneously reaches the external equilibrium and the internal equilibrium for all the trading partners. This measure was derived from a standard world trade model in which all the variables are endogenous except the external equilibrium (sustainable current account determined by structural parameters) and the internal equilibrium (full utilization of the productive potential). The external equilibrium is estimated with panel regression techniques.

The internal equilibrium is linked to the output gap⁷.

More precisely, the FEER is a medium run concept. This exchange rate allows the economy to reach internal and external equilibrium at the same period. The essential point is “how to define the equilibrium”. We can distinguish three time horizons (short run, medium run and long run) with an equilibrium exchange rate associated with each time horizon. These different measures of equilibrium may be not equal. The FEER concept can be seen as a medium term (flow) equilibrium, defined as in equation (1), in which the equilibrium current account is at a level compatible with an eventual convergence to the stock-flow equilibrium (Driver and Westaway, 2004).

Medium run (flow equilibrium)

$$CUR/GDP \neq 0 \quad (1)$$

Long run (stock-flow equilibrium)

$$\begin{aligned} CUR/GDP &= 0 \\ \Delta(NFA/GDP) &= 0 \end{aligned} \quad (2)$$

Conversely, since the BEER approach is based on a cointegration relationship between the real exchange rate and the so-called fundamental variables, as such, it is considered to be a long run concept. In this sense, one of the key variables that explain the real exchange rate is the net foreign asset (NFA) position of a country such that, when a country accumulates a surplus in its current account; its net external position increases in percent of GDP. To stabilize its net external position, its currency must appreciate in real terms above its equilibrium value and, thus, appears overvalued. In the long run, the current account is equal to zero and so is the growth rate of the net foreign asset in percent of GDP. This long term equilibrium corresponds to the stock-flow equilibrium for all the agents of the economy, as shown in equation (2). This equilibrium may be reached, but it might take years or decades (Driver and Westaway, 2004). This definition (of the long run equilibrium) has the merit of

⁷ See Jeong et al. (2010). The methodology used is a synthesis of previous works on the FEER (Borowski and Couharde, (2003), Jeong and Mazier, (2003)) and of the Symmetric Matrix Inversion Method (SMIM) recently proposed by Cline (2008).

precluding Ponzi strategies (Cline and Williamson, 2010).

3. Temporal links between FEER and BEER

As it was mentioned before, the aim of this paper is three folded. First, we compare real exchange rate misalignments obtained from the FEER and the BEER approaches⁸. In order to do so, we study a group of seventeen economies among which five industrialized and twelve emerging countries (the United States (USA), the United-Kingdom (UK), the Euro area (EU), Japan (JPN), Korea (KOR), China (CHN), Brazil (BRA), India (IND), Mexico (MEX), Argentina (ARG), Chile (CHL), Colombia (COL), Indonesia (INS), Malaysia (MYS), Philippines (PHL), Thailand (THA) and Uruguay (URU))⁹. Second, we detect periods of divergence between the two of them. Finally, we identify the reasons that lie behind the divergence of the two approaches.

In this sense, our BEER measure of misalignment was obtained as the difference between the observed and the equilibrium real exchange rate, which corresponds to the estimated value from a panel cointegration relationship between the (log) real effective exchange rate and the net foreign asset position as percentage of GDP (NFA), the (log) relative productivity and the (log) terms of trade¹⁰. The series from the FEER correspond to the level of exchange rate that reaches the target of the current account in the world trade model, assuming that domestic and foreign output gaps are closed, with its econometrically estimated target level.

Some authors have compared the FEER and the BEER approaches by using a current account balance that would stabilize the NFAs as a proportion of GDP at an appropriate level (see e.g. Benassy-Quéré et al., 2009). This kind of comparison seems to be misleading because it neglects the temporal dimension. Indeed, as mentioned, the FEER is a medium run concept in which the current account reaches a sustainable level at medium term. Therefore, it can be seen as a flow equilibrium which is relevant precisely at medium term. Instead, the BEER is a long run concept associated with a stock-flow equilibrium in which the current account is equal to zero and the growth rate of the NFAs is equal to zero in percentage of GDP (Driver

⁸ Notice that the real effective exchange rate corresponds to a CPI effective rate.

⁹ We use annual data from 1982 to 2007.

¹⁰ In order to save space, we avoid these details. Notice, however, that given that all the variables were found to be integrated and cointegrated in a panel setting, we estimated the cointegration relationship relying on the Fully Modified OLS (FMOLS). Details are available upon request to the authors.

& Westaway, 2004). Once the two series for each country in the panel has been estimated, we proceed to the comparison between them. In addition to the correlation between the current account and the real exchange rate (see next section), another relevant comparison consists into analyzing if there is a long run relationship between these two measures of equilibrium exchange rate. In other words, if there is a long run relationship (or a stationary linear combination) consistent with an eventual convergence from flow equilibrium (FEER) to stock-flow equilibrium (BEER).

In a previous study (Barisone et al., 2006), it has been shown that FEERs are cointegrated with real exchange rates. The implication of this is that the FEER approach represents an improvement over PPP in explaining medium- to long term trends in the real exchange rate of the major industrialized countries. In addition, BEERs are cointegrated with REERs since the BEER aims to explain long run behavior of the REERs (Clark and MacDonald, 1998).

Table 1: Panel unit root tests

Test:	LLC	Breit.	F_ADF	F_PP	LLC	Breit.	F_ADF	F_PP
<i>Difference:</i>	No	No	No	No	Yes	Yes	Yes	Yes
<i>Exogenous variable:</i>	None	None	None	None	None	None	None	None
<i>Null Hypothesis:</i>	UR	UR	UR	UR	UR	UR	UR	UR
<i>Common UR:</i>	Yes	Yes	No	No	Yes	Yes	No	No
<i>feer_{i,t}</i>	1.7	1.9	9.1	9.9	-17.4***	-13.7***	312.8***	363.9***
<i>beer_{i,t}</i>	1.4	1.6	15.5	9.1	-18.2***	-15.5***	331.2***	394.9***

Notes: “UR” indicates the null hypothesis of the presence of unit root. The symbol *** indicates statistical stationarity at the 1 percent level. The table shows different panel unit root tests: Levin, Lin, and Chu (2002) (LLC); Breitung (2000); Maddala and Wu (1999) and Choi (2001) Fischer-type panel unit root tests (F_ADF and F_PP).

Source: authors' calculations

In line with this, we found that FEERs and BEERs are both unit root processes (table 1). The next step consists in using panel data techniques to test if a cointegration relationship between them. According to the panel cointegration test's results based on Pedroni's tests (1999), we strongly reject the null hypothesis of no cointegration at the 1% level (see appendix 1).

Therefore, given that the BEER and the FEER are integrated and cointegrated, we estimated

the following long run equation:

$$feer_{i,t} = \alpha_i + \beta beer_{i,t} + \mu_{i,t} \quad (3)$$

Where variables in minuscule represents natural logarithms. In order to estimate the long-run equation in a cointegrated panel, we implement the Fully Modified Ordinary Least square (FMOLS) and a Dynamic Ordinary Least Square (DOLS) estimators (Pedroni, 2001).

Table 2: Long run relationship between FEERs and BEERs

	Long Run Coefficient (β)	T-Statistic
FMOLS¹	0.881***	8.248
DOLS²	0.716***	9.743
<i>Number of Observations</i>	442	-

Notes: (1) FMOLS is the Fully Modified OLS estimation; (2) DOLS is the Dynamic OLS estimation. The symbol *** indicates statistical significance at the 1 percent level.

Source: authors' calculations

The results, presented in table 1, confirm that there is a long run relationship consistent with an eventual convergence from the flow equilibrium (FEER) towards the stock-flow equilibrium (BEER). Indeed, as seen by the value the long-term coefficient, when the BEER increases (depreciates) by 1%, the FEER increases (depreciates) by around 0.8%.

4. Comparison between FEER and BEER estimations

In terms of international monetary cooperation, the most relevant approach seems to be the FEER because it focuses on current account imbalances at medium term. In this context, the BEER seems to be less relevant because of its time horizon. Actually, the evidence suggests that assets stocks are not stabilized at medium term¹¹ in percent of GDP, as the evolution of net foreign assets in industrialized and developing countries confirms it. However a comparison between the BEER and the FEER estimations gives some interesting lighting.

¹¹ This statement remains true even in the case where the medium term is defined as a period of five or ten years.

This first diagnosis can be given by two indicators: a) the absolute average deviation between the FEER and the BEER and, b) the correlation coefficient between misalignments given by both approaches. According to our results, presented in table 2, the absolute average deviation is around 16% for all the countries, but it is smaller for two thirds of them. Similarly, the correlation coefficient is above 0.5 for two third of the countries. An interesting feature is that the FEER and BEER give more divergent estimations, both in terms of correlation and deviation, for the three main emerging countries, namely, China, Brazil and India, but also during some periods for industrialized countries (USA in the middle of the 2000s, Japan at the beginning of 1980s). On the whole, they are more convergent for industrialized countries as well as for Mexico, Chile, Malaysia and Indonesia.

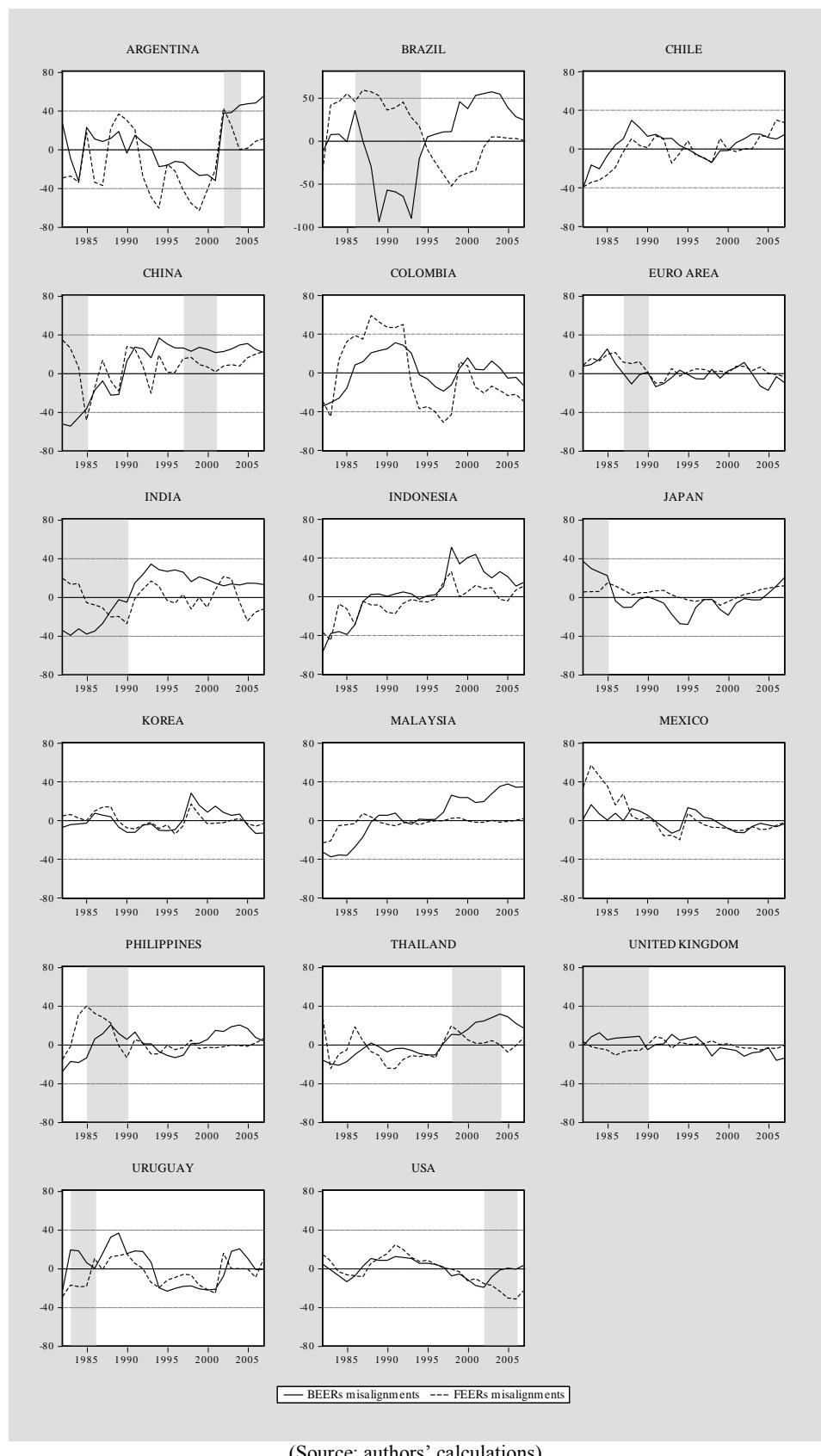
Table 3: FEER and BEER matrix

Absolute average deviation ¹		
	Below Average	Above Average
Above 50 %	USA, Euro area, Japan, Mexico, Korea, Indonesia, Malaysia, Chile	Argentina, Colombia, Uruguay
Correlation ²		
Below 50 %	UK, Philippines, Thailand	China, Brazil, India

Notes: (1) The absolute average deviation corresponds to the absolute average difference between the FEER and the BEER;
(2) The correlation is the correlation between FEER's and BEER's misalignments.
Source: authors' calculations

A better understanding of the FEER and BEER divergence would be useful to enlighten economic policy debates on exchange rate policy and on more structural issues. For a simple analysis of their divergence (figure 1), it can be recalled that, first, the BEER is rather stable in the long run and, consequently, BEERs' misalignments are mainly deviations between real exchange rates and their average values. Usually, a real appreciation above this mean value leads to an overvaluation and, inversely, a real depreciation leads to undervaluation. On the opposite, the FEER is linked to a rather stable current account balance. As a result, FEERs' misalignments reflect mainly deviations between the observed and the equilibrium current balance. Generally, a rising current account above the equilibrium value leads to an undervaluation and, inversely, a decreasing current account leads to an overvaluation.

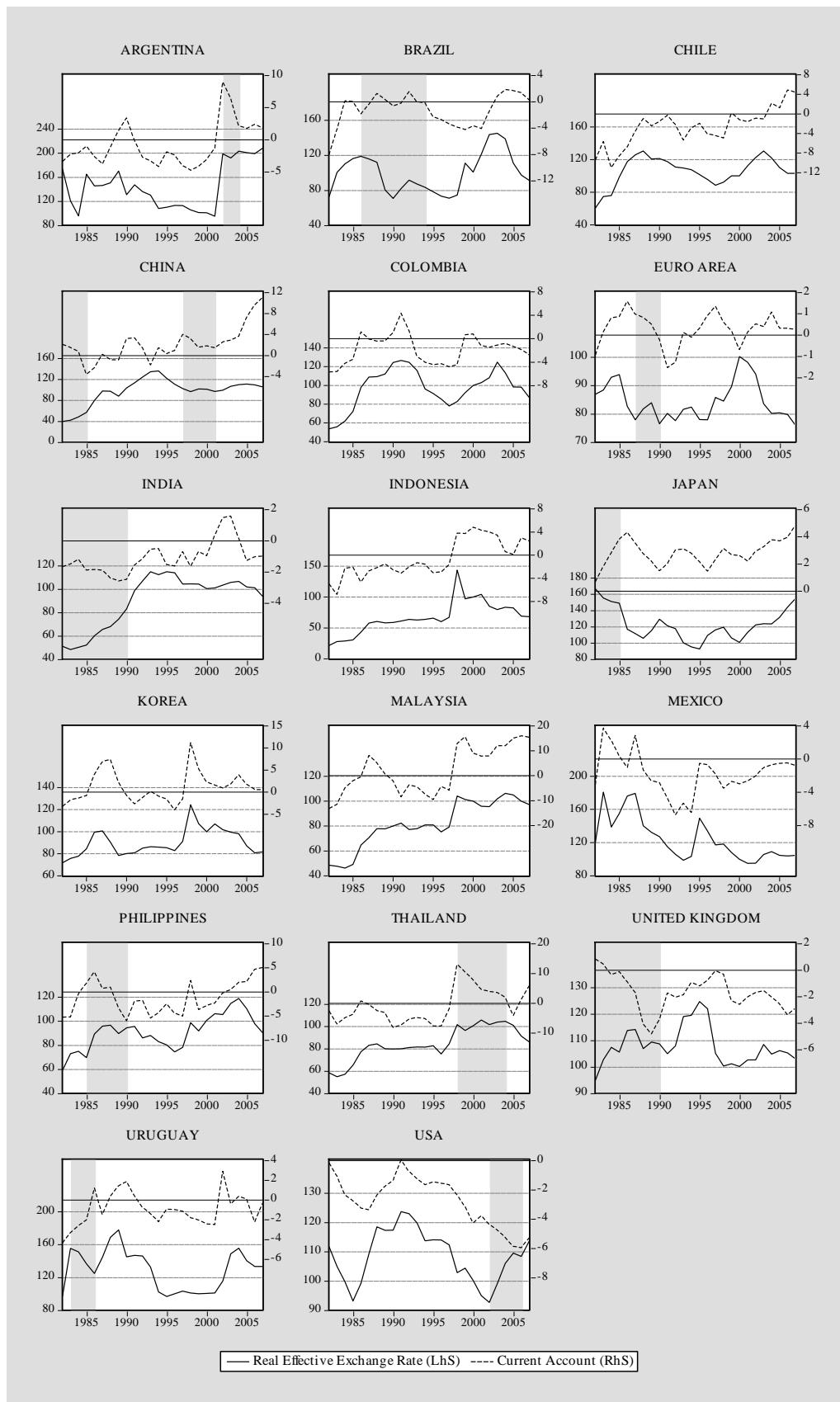
Figure 1: BEERs and FEERs misalignments (in percent)¹²



(Source: authors' calculations)

¹² A positive number indicates an undervaluation and a negative number indicates an overvaluation.

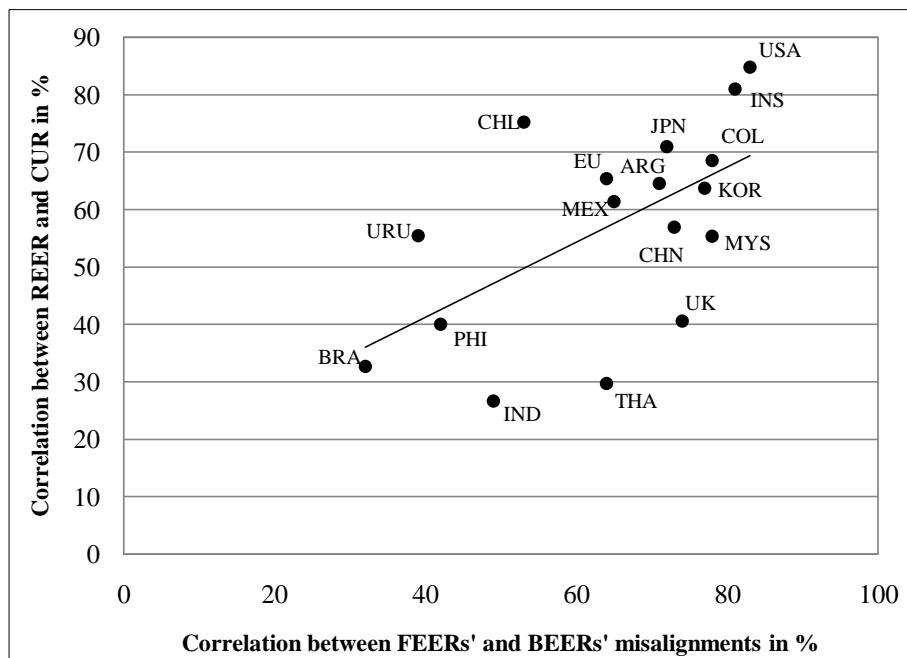
Figure 2: Real effective exchange rates and current account



(Source: Bank for International Settlements for the real effective exchange rate basis 100 in 2000 (annual average of monthly data), International Monetary Fund (World Economic Outlook, April 2010) for the observed current account as % of GDP)

Therefore, from the way they are defined, it follows that the FEER and BEER misalignments are consistent when the real exchange rate and the current account are closely connected (figures 1 and 2). As an illustration, we calculate the linear correlation coefficient between the current account and real effective exchange rate for each of the countries in our sample. When the correlation is strong, the misalignments computed by the FEERs and BEERs follow the same path. On the contrary FEER and BEER diverge when real exchange rates and current account are more disconnected. Indeed, as seen in figure 3, which plots the average correlation between the current account and the exchange rate versus the correlation for the two series of misalignment, there is clearly a positive relationship between both. Indeed, whereas for some countries (as the USA) the evolution of the current account is closely related to its real exchange rate and, at the same time, the FEER and the BEER measures do not differ significantly, in Brazil, India and other countries there are very low correlations between current account and exchange rate, on the one hand and FEER and BEER, on the other.

Figure 3: Correlation between real effective exchange rate and current account versus correlation between BEER and FEER misalignments



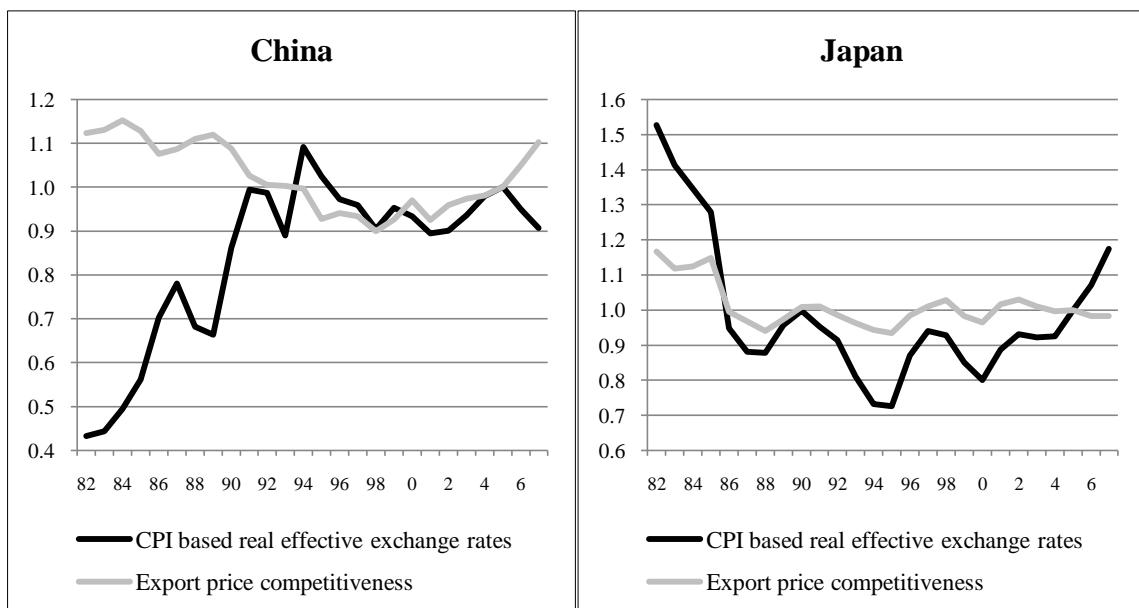
(Source: authors' calculations)

FEER and BEER divergence can be better understood by taking into account two structural factors, the international prices' formation and its effects on current account on one hand, the

valuation effect and its impact on net foreign assets on the other hand. These points will be illustrated successively by case studies.

First, for Japan, the most striking period of disconnection between FEERs' misalignments and BEERs' misalignments occurs during the first half of the 1980's. The current account increased from 1 to 4 percent of GDP in spite of a real effective appreciation of 40 percent between 1982 and 1986. In consequence, the FEER measure records an increasing undervaluation and the BEER measure a decreasing undervaluation (figure 1). This can be related to the strong disconnection which exists in Japan between real effective exchange rate measured with CPI index and export price competitiveness due to the nature of the Japanese international specialization. Japanese firms can preserve their export competitiveness for a rather long period in spite of the real revaluation of the yen (figure 4). This has been especially the case during the first part of the 1980s. The same observation can be made for the middle of the 1990s during which the overvaluation of the yen is more marked according to the BEER.

Figure 4: Export price competitiveness and CPI based real effective exchange rates



(Source: Bank for International Settlements for the real effective exchange rate basis 1 in 2005 (annual average of monthly data), authors' calculations for the export price competitiveness basis 1 in 2005)

This divergence between export price competitiveness and CPI based real effective exchange rate is also strong in China during the 1980s and at the end of the 2000s. In the early 1980s the yuan strongly depreciated according to a CPI based real effective index, but without any

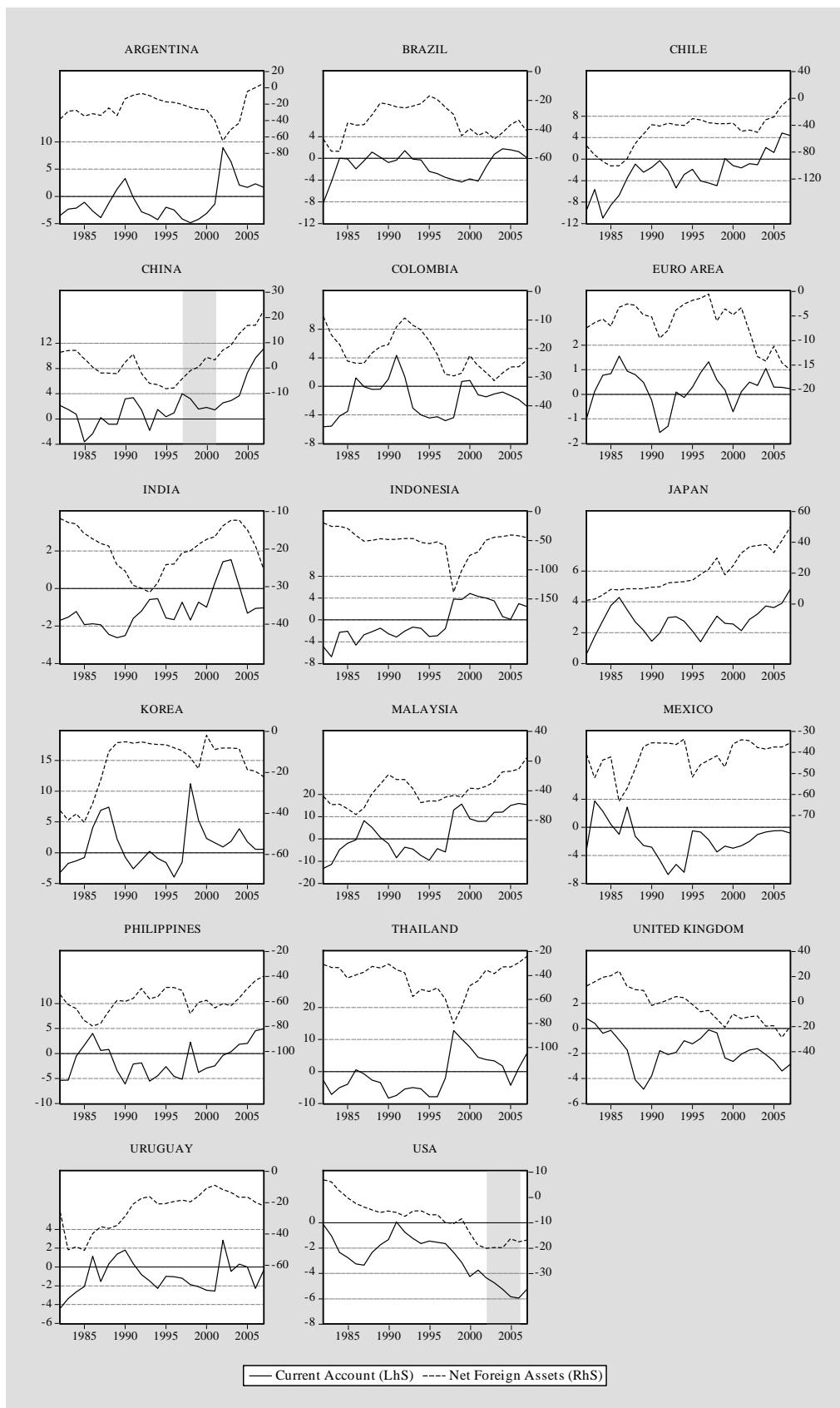
improvement of export price competitiveness (figure 4). This could be explained by the poor quality of the Chinese international specialization at that time. With the beginning of trade openness, current surplus was replaced by deficit, which explains the evolution of FEERs' misalignments in sharp contrast with the BEERs' one. In a different economic context a disconnection can also be noticed at the end of the 2000s. The CPI real effective exchange rate appreciates moderately while export price competitiveness improves. Furthermore Chinese non price competitiveness improves also a lot, thanks to changes in the nature and the quality of export products, which explains the growing undervaluation of the yuan in the FEER approach.

Second, if the BEER is stable, it is influenced in the long run by structural factors, among which the NFA and also the relative productivity trends play a central role. In this sense, the NFAs are mainly determined by the cumulated current accounts but, at the same time, may be also strongly influenced by valuation effects. These mechanisms (valuation effects, productivity gains) could be taken into account in complementing the previous analysis which was only focused on real exchange rate and current account. This could improve the understanding of FEER and BEER divergence.

To illustrate the previous point, we analyze the divergence of the ERM measured by these two approaches for the U.S dollar in real terms between 2002 and 2006 (figure 1). Even though for the US the BEER and the FEER are closely related for the whole period, an important divergence is observed during these years. At the same time, it is precisely between 2002 and 2006 when the evolutions of the current account and of the net foreign asset are clearly disconnected. Indeed, whereas with a real depreciation of about 20% of the dollar, the deficit in the current account in the USA increased considerably, the net foreign assets position did not deteriorate in the same magnitude¹³ (figures 2 and 5). This disconnection between exchange rate, current account and the net foreign asset position during these years is at the heart of the disconnection between the two measures of equilibrium exchange rate: whereas the FEER indicates a growing overvaluation which corresponds to a growing U.S. current deficit until 2006, the BEER indicates a decreasing overvaluation which corresponds to a progressive stabilization of the NFAs due to the valuation effects.

¹³ It has been proposed (Blanchard et al., 2005) that this situation reflects the effects of exchange revaluation of assets denominated in foreign currencies owned by U.S. residents

Figure 5: Current accounts and net foreign assets

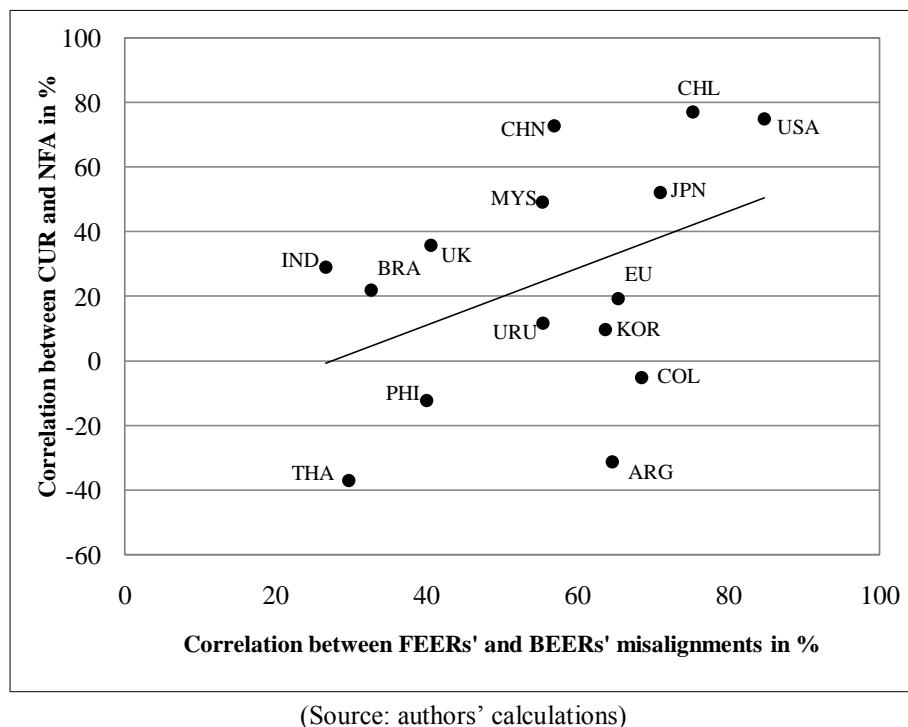


(Source: International Monetary Fund (World Economic Outlook, April 2010) for the observed current account as % of GDP, P.R. Lane and G.M. Milesi-Ferretti's Database (2009) for the net foreign asset as % of GDP)

Another interesting episode is the case of the Chinese yuan after the Asian crisis of 1997-98. Between 1997 and 1999, we observe a halving of the Chinese current surplus due to regional economic slowdown and currency devaluations in its major trading partners. The FEER measure indicates a sharp decrease of the yuan real undervaluation which corresponds to the current account decrease. On the contrary, the BEER indicates a rather stable undervaluation on this period (around 25 %) which corresponds to a net external position above its structural value and to a rather stable real effective exchange rate (figures 2 and 5).

Indeed, the effects of the NFA being in discordance to the current account are another explanation for the temporal divergence between the flow equilibrium and the stock-flow equilibrium (i.e. the FEER and the BEER). As before, this can be better illustrated by plotting average correlations between the NFA and the current account, and the misalignments (figure 6).

Figure 6: Correlation between current account and NFA position versus correlation between BEER and FEER misalignments



In sum, BEER and FEER misalignments would be closely related when current account react to real exchange rates. However the dynamic of foreign asset positions, valuation effects and structural changes in matter of competitiveness could alter the relation between FEER and BEER.

5. Conclusion

The objective of this study was to understand the temporal links between the two main measures of equilibrium exchange rate, namely the BEER and the FEER approaches. In order to do so, we analyzed carefully the temporal dimension and we test empirically a unified theoretical framework, inspired from Driver and Westaway (2004), which posits a positive and significant long run relationship between the flow equilibrium (the FEER) and the stock-flow equilibrium (the BEER).

To avoid serious misinterpretations, it is important to underline that we are dealing with *two concepts of equilibrium exchange rate* (FEER / BEER), which correspond to two different time horizons (the medium term / the long term) and two goals of macroeconomic policy (the stabilization of the current account balance / the stabilization of the net external position) that can *temporarily diverge*.

Our results show that, in average, the two measures are closely related. Yet, important differences can be observed for some countries and/or some periods of time. Therefore, we identified several factors which are able to alter the relation between the FEER and the BEER. These factors are mainly temporal disconnections between the current account and the real effective exchange rate, which probably are the result of structural changes in matter of competitiveness, as it is the case in Japan in the first half of the 80s, the dynamic of foreign asset positions, and valuation effects, as in the USA between 2002-2006.

Finally, as mentioned before, our conclusions point to the fact that there are, sometimes, temporary divergences between the BEER and the FEER measures of misalignment. Yet, the fact that they may diverge reflects structural factors such as the international prices' formation and its effects on current account or/and the valuation effect and its impact on net foreign assets. This is important if the two approaches for assessing misalignments are used for policy decisions as, for example, setting tariffs in order to cope with the “currency war”.

Appendix 1

Table A1.1: Panel cointegration test

Pedroni panel cointegration test (1999)	
Null Hypothesis: No cointegration	
Alternative hypothesis: common AR coefficients (within-dimension)	
Panel-v	-2.62
Panel-rho	-2.40***
Panel-PP	-4.14***
Panel-ADF	-5.11***
Alternative hypothesis: individual AR coefficients (between-dimension)	
Group rho-Statistic	0.17
Group PP-Statistic	-2.02**
Group ADF-Statistic	-3.10***

Notes: The symbols *, **, and *** indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. ***Reject null of nonstationarity even at the 1% level; **Reject null of nonstationarity at the 5% level.
Source: authors' calculation.

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