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ORIGINAL ARTICLE

Does trade openness influence the real effective exchange rate? New evidence from panel time-series

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Abstract Using a dataset of 101 countries over the 1960–2011 period, we examine the relationship between the real effective exchange rate (REER), on the one hand, and trade openness, trade balance, the terms of trade, factor productivity, and exchange rate regime, on the other one. We use new econometric estimators that deal with the problems of potential endogeneity and cross-sectional dependence that are present in the data, while also allowing for cross-country heterogeneity in the parameters of interest. The findings of the study strongly support the hypothesis that an increase in trade openness produces a depreciation of the REER. The other variables considered in the analysis—factor productivity, trade balance, terms of trade, and exchange rate regime—do not have a statistically significant effect that is robust to different sample compositions and alternative statistical estimators.

Keywords Real exchange rate · Trade openness · Trade balance · Terms of trade · Total factor productivity · Exchange rate regime

JEL Classification F13 · F31 · F41

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1 Introduction

The study of the determinants of the real exchange rate is a topic that has received much attention in international economics. The first theoretical approach to its conceptualization dates back to Cassel's (1918, 1922) thesis, which stated that there is an equilibrium exchange rate for money across different countries and that the exchange rate should converge to this value regardless of temporary fluctuations (i.e., appreciation or depreciation due to different inflation rates). This is the core of the PPP theory, which has been extensively tested empirically with different methodological approaches in order to demonstrate that exchange rate time series are stationary. The evidence, however, is mixed (Froot and Rogoff 1995); and these inconclusive results have been explained as resulting from (1) the short time frame of the observation windows and (2) the particular exchange rate dynamics of the countries under analysis (e.g., in high-inflation economies, PPP theory appears to hold, while the evidence for normal economies tends to reject this thesis). Given the existence of long-term deviations from PPP in some countries, scholars were interested in explaining these deviations; and those who believed that PPP theory does not hold attempted to identify the factors behind appreciations or depreciations of the real exchange rate.

So far, the studies on this subject are not conclusive about the particular factors that affect the real effective exchange rate (REER).[1] This paper contributes to our knowledge about its determinants in a number of ways, mostly related to methodological aspects. Since the empirical studies have shown mixed results depending on the countries that have been studied, we use a methodological approach that does not restrict the slope coefficients of the independent variables to be the same for each country. We also take into account the issues of potential endogeneity between the REER and trade openness and of cross-sectional dependence. This latter problem arises because movements in nominal exchange rates and their concomitant effects on real exchanges rates may affect countries not only individually, but collectively as well—for instance, shocks to the US dollar, either caused by exogenous political factors or endogenous economic determinants, have an immediate impact upon the domestic exchange rates of individual countries. Omitting the consideration of cross-sectional dependence leads to a potentially severe bias in the regression coefficients; and our methodological strategy deals effectively with this problem, which is indeed present in the data as we will later show. We also use a new REER dataset that covers a larger numbers of countries over an extended period of time, allowing to observe changes of the REER subject to different economic conditions. In addition, given the issues that have been addressed pertaining the adequate operationalization of trade openness, our analysis uses three alternative indicators of this concept.

Taking all these methodological considerations into account, we find robust support for the hypothesis that trade openness is associated to a depreciation of the REER (Dornbusch 1974). This empirical finding is not only of theoretical interest. It also

[1] In this work, we use the expressions real exchange rate and real effective exchange rate (REER) interchangeably. While theoretical models are derived from a bilateral exchange rate perspective, the conceptual extension to multilateral trade is straightforward. In practice, however, there are some difficulties in operationalizing the notion of REER (Chinn 2006), basically due to problems of data availability and reliability.

has relevant implications for economic policy. In some countries, problems of overappreciation of the REER cannot be simply solved by means of a nominal devaluation because of limits to monetary policy (e.g., countries that use the Euro as a monetary unit; Ecuador whose monetary unit is the US dollar, etc.). Our study suggests a viable alternative as there are several economic measures that can be readily taken by the economic policy maker to increase trade openness and thus generate a depreciation of the REER.

The rest of the paper is organized as follows. In Sect. 2, we briefly review the literature on the determinants of the real exchange rate. Next, we present the data and methods used in Sect. 3. We report the results obtained in Sect. 4. Finally, the concluding section summarizes the findings of the study.

2 The determinants of the real exchange rate: a look at theory and evidence

2.1 Trade openness

The explanation of the relationship between trade openness and the REER is that when the real effective exchange rate appreciates, domestic products become more expensive for the rest of the world, and therefore their demand decreases. On the other hand, an overappreciated exchange rate makes foreign tradable products become cheaper than domestic ones, which increases imports unless the government raises their cost through tariffs or restrict their entrance by other means (e.g., quotas). Thus, protectionism through tariff barriers, quotas or other forms restricts imports and consolidates a situation of REER appreciation. Therefore, many authors have argued that trade liberalization leads to the opposite effect, a depreciation of the REER. Early theoretical models support this hypothesis (Dornbusch 1974). According to Balassa (1975), the logic is straightforward: once a reduction in import tariffs is implemented, there is an imbalance in the current account as a results of the increasing demand for imports. In turn, this induces the need to generate a depreciation in the real exchange rate.

However, Edwards (1989b) has shown that these initial theoretical approaches were too simplistic. He has argued that a trade liberalization does not have an unambiguous effect, since there are two different effects at work, a substitution and an income effect, that operate in opposite directions. Edwards (1989a) proposed an intertemporal model of the real exchange rate that leads to the same conclusion, under the assumptions that tradables and non-tradables are substitutes and that the substitution effect is greater than the income effect. A similar conclusion is deduced from Khan and Ostry's (1992) model, assuming that the income effect is not predominant. Nevertheless, for Edwards (1989b), the model should take into account the initial conditions of the tariffs level. If this level is low, a decrease in tariffs will produce a real depreciation, as a substitution effect will dominate (i.e., the price of nontradables will diminish relative to that of exports). But if the liberalization occurs with a large initial level of tariffs, there may be an increase in welfare (income effect), which may produce an excess demand for nontradables and their price will go upwards.

So far, the empirical evidence about the relationship between trade openness and the REER has been mixed. This may partly be due to the operationalization of trade openness. The most used approach is trade volume (the sum of exports and imports over the GDP), which entails the idea that protectionism fundamentally reduces the value of this indicator on the imports side. The indicator's advantage resides in its wide availability. Alternative approaches involving the estimation of averages of quotas or tariffs have been proposed, but they have severe practical limitations of data availability over long time periods. Besides, as we do not know to what extent such indicators are reliable and comparable, their actual use is not widespread. As alternative indicators of trade openness, we have also used (1) the import penetration ratio (imports as a share of GDP), which has been utilized by Romelli et al. (2016) and Yanikkaya (2003), among others, and (2) structure-adjusted trade intensity, an indicator proposed by Pritchett (1991), which is the difference between a country's actual trade volume and its theoretical trade volume estimated as a function of its size and other structural characteristics.

Among the studies dealing with the relationship between trade openness and the REER, we can mention Devereux and Connolly's (1996), which found that import taxes (protection) appreciate the REER in a sample of Latin American countries, supporting the hypothesis that liberalizing trade produces a depreciation of the REER. Moreover, Li (2004) has also found that, consistently with theoretical expectations, the REER depreciates after trade liberalization, but his study shows that partial or incomplete liberalization policies do not produce this effect. More recent works by Zakaria and Ghauri (2011) and Yusoff and Febrina (2014) also suggest that economic openness produces a REER depreciation in some developing countries. Nevertheless, other studies have not found an association between trade openness and the REER (e.g., Elbadawi 1994), possibly because of the many factors at work in the establishment of trade policies or idiosyncratic aspects in the economies included in these studies.

2.2 Trade balance

Most empirical research on the link between the trade balance and the REER has focused on the effect of the latter over the former. The question posed in this regard is whether a nominal devaluation with actual effects on the REER improves the trade balance. In general, the answer to this question has been positive (Bleaney and Tian 2014; Brada et al. 1997; Himarios 1989; Narayan 2006; Shirvani and Wilbratte 1997).[2] For the purpose of our study, though, it seems relevant to ask the inverse question: does the trade balance have an effect on the REER? In this regard, Lane and Milesi-Ferretti (2002) have proposed an intertemporal open-economy model in which they consider the trade balance as a factor that influences the REER; and they found a statistically negative relationship among these variables with a sample of 20 OECD countries, indicating that a deterioration of the trade balance, which in many cases may

[2] However, some studies have not supported this relationship (Rose 1991; Shahbaz et al. 2012) or have only found partial support like Tandon's (2014), which focusing on some OECD countries shows that REER changes did not affect the trade balance in the case of Germany.

be tantamount to a deterioration of the current account, produces an appreciation of the REER. Similar results were also obtained in a recent study by Zhang and MacDonald (2014).

2.3 Terms of trade

The terms of trade is a measure of the purchasing power of exports relative to imports. As such, the evolution of this indicator represents the changes in relative prices of a country's foreign trade. Edwards (1988) and Edwards and Van Wijnbergen (1987) have argued that changes in the terms of trade may generate a substitution and an income effect. The income effect occurs when an increase in the price of exports or a decrease in the price of imports produce an increase in domestic income, which is spent in both tradable and non-tradable goods. Since the price of tradable goods is presumed to be exogenously determined, it is therefore unaffected; but there is an increase in the price of non-tradables relative to tradables, which may cause an appreciation of the REER. On the other hand, a substitution effect may occur when an increase in the price of exports causes a decrease in the foreign demand for these exports, which is then followed by decreased production of such goods. This generates a movement of production factors from the tradables sector to the non-tradables one, and the price of non-tradables will tend to diminish, something that may lead to a depreciation of the REER. In sum, the net effect of changes in the terms of trade is a priori ambiguous, depending on what effect, substitution or income, finally predominates.

Several empirical studies have found that improvements in the terms of trade tend to appreciate the REER (Clark and MacDonald 1999; De Gregorio and Wolf 1994). However, Dungey (2004) contends that most empirical analyses of the link between terms of trade and REER fail to consider relevant variables, hence yielding misleading results. On the other hand, the effects of changes in the terms of trade on the REER seem to differ according to the countries' exchange regime type. In this regard, Broda (2004) has found that terms-of-trade changes are larger in flexible regimes (floats) than in fixed regimes (pegs). In addition, Dungey (2004) suggests that terms-of-trade effects are larger in developed countries than in developing ones, although Mendoza (1995) claims the opposite. Moreover, Odedokun's (1997) study on African countries shows that improvements in the term of trade derived from falling imports prices appreciate the REER, but this does not occur when such improvements come from rising exports prices. Another factor that appears to have an intervening role in the impact of the terms of trade on the REER is the countries' financial integration with the world, which appears to diminish the volatility of terms-of-trade shocks (Al-Abri 2013).

2.4 Factor productivity

According to the Balassa–Samuelson effect, a key explanatory factor of the REER is the difference in productivity. In its more elementary version (Balassa 1964), it has been argued that since there is a productivity gap between high- and low-income countries, and assuming that differences in labor productivity are greater in the tradable-goods sector than in the nontradable-goods one, the real exchange rate in richer countries will be overappreciated relative to its purchasing power parity. While there has been some empirical evidence in favor of this effect, it may be contingent upon the estimation methods used (Drine and Rault 2003; Bahmani-Oskooee and Nasir 2005). Moreover, a recent work by Choudhri and Schembri (2010) suggests that variations in the elasticity of substitution between domestic and foreign goods may cause variable effects (either negative or positive) of the improvements in traded-goods productivity on the REER.

2.5 Exchange rate regime

A factor that may influence the REER is the type of exchange rate regime through its influence over the nominal exchange rate. In many cases, particularly in developing countries, a fixed or pegged exchange regime is used as an anchor against inflation (Palley 2003). As a result, while the inflation rate may be reduced, this is done at the expense of delinking the nominal exchange rate from actual inflation, thus producing an appreciation of the REER. Some studies have found that a floating exchange rate regime may be associated to a devaluation of the REER (Broda 2004), and Bodart et al. (2015) also suggest that a flexible exchange rate regime has a negative effect on the REER.

2.6 Other factors

To conclude this brief review, we must mention that other factors have also been suggested as relevant in predicting movements in the real exchange rate, but we were not able to obtain homogeneous and comparable empirical data about them for an extended period of time, so they have not been empirically tested here. One of them is the level of government spending. According to Froot and Rogoff (1995) government spending in an economy increases the real exchange rate, as it is presumed to produce an increase in prices of nontradable goods. However, recent work by Ravn et al. (2012) points at the opposite effect, suggesting that an increase in government spending raises private consumption and depreciates the real exchange rate.

It has also been argued that capital inflows tend to appreciate the REER, but this effect seems to vary by country and region. For Sjaastad and Manzur (2003), several reasons account for this variability: whether capital inflows are FDI, in which case they do not affect the REER since they are used to pay capital imports; whether they are used for investment or consumption; and whether the central bank can effectively sterilize their effect through financial markets mechanisms. A fourth explanation proposed by these authors is that trade openness reduces the effects of capital flows on the REER. In highly protected economies there is a large effect of capital inflows over the REER, while in liberalized economies the effect can be negligible. In any case, the net capital flow is reflected in the current account; and although we were not able to gather reliable comparative data on this variable, we did include the trade balance, which for some authors can be considered a reasonable proxy for the current account (Diaz-Alejandro 1984; Doukas and Lifland 1994).

3 Data and methods

The dependent variable, real effective exchange rate (REER), is operationalized through the real effective exchange rate index elaborated by Darvas (2012). For country i and period t, the REER is calculated as the nominal effective exchange rate of the focal country (which, in turn, is a geometrically weighted average of the bilateral exchange rates between this country and its trading partners) multiplied by the consumer price index of the focal country in period t and divided by the geometrically weighted average of the consumer price indexes of its trading partners for the same period. The base year of this calculation is 2007 with value 100.[3] The REER variable is expressed in natural logarithms.

We used three indicators for trade openness, which are expressed as natural logarithms. First, is has been operationalized as the sum of exports and imports as a percentage of the GDP (trade volume) using the World Development Indicators (WDI) as data source (World Bank 2016). Second, we have used the import-penetration ratio (imports as a percentage of GDP) also from the WDI. Third, we constructed an indicator for structure-adjusted trade intensity. Following Pritchett (1991), this was estimated as the residuals of a regression of trade volume on the following variables: population, surface area, real GDP, real GDP squared and whether the country is an oil producer.[4] To this end, we used an unbalanced panel of 164 countries for the 1960–2011 period with the WDI as data source except for real GDP, which we have estimated from the Penn World Table (PWT) 8.0 dataset (Feenstra et al. 2015).[5] As we used panel data, we also included a trend term in our pooled OLS regression. To avoid taking logs of negative values, we transformed the values of structure-adjusted trade intensity by adding 1 minus the minimum value of this indicator in our dataset.

For the terms-of-trade variable, we used two alternative indicators: (1) the natural logarithm of the net barter terms of trade taken from the WDI, which is expressed as an index with base value 100 for the year 2000, and (2) the natural logarithm of an index that we computed dividing the price of exports index by the price of imports index of the PWT. The base year for both, exports and imports price indexes, is the year 2005. We prefer indicator (2) because of its greater coverage of countries and time periods, since the barter terms of trade of the World Bank only has reported values from 1980 onwards.

[3] In the case of the Argentine Republic, given the problems of the national government indicator of inflation, we corrected the values in the Darvas dataset for the years 2008–2011 with the index of the official statistics of the provincial government of Santa Fe, which are generally deemed as more reliable than the statistics provided by the Argentine central government. For the manipulation of the official statistics in Argentina, see Jueguen and Bullrich (2010).

[4] Smaller economies are presumed to be more open to international trade than their larger counterparts. In this regard, some authors have used land area as an instrumental variable for trade openness (e.g., Hau 2002).

[5] Unlike Pritchett, we did not include the CIF/FOB ratio as a regressor because we did not obtain data of this variable for the whole period. This variable, however, did not have a statistically significant effect in Pritchett's regression.

We calculated the trade balance indicator as the difference between exports and imports as a share of the GDP. We used the natural logarithm of this indicator, but we previously transformed the figures by adding 1 minus the minimum value in the dataset in order to avoid logs with null values. For the factor productivity variable, we also used two alternative indicators, both taken from the PWT 8.0: (1) the logarithm of total factor productivity indicator, with value 100 for the base year 2005, and (2) the labor productivity indicator calculated as the yearly real GDP divided by the number of workers for each year, both figures provided by the PWT. Finally, the exchange rate regime variable was operationalized by a dummy variable with value 1 if the exchange rate regime is considered a peg and 0 otherwise for a given calendar year. The data source was the Shambaugh (2017) exchange regime classification dataset, which covers yearly observations for our whole period of analysis. Following the criteria of Klein and Shambaugh (Klein and Shambaugh (2008), 72), a peg is defined as such when a country has its currency pegged to the currency of a base country and "its month-end official bilateral exchange rate stays within the same $\pm 2\%$ band for the entire year".

Only countries with a population greater than 1,000,000 and more than 30 consecutive yearly observations for all variables are included in the sample.

We used the following econometric model:

$$g_{it} = \beta_{0i} + \beta_{1i}x_{1it} + \beta_{2i}x_{2it} + \cdots + \beta_{Ki}x_{Kit} + u_{it} \tag{1}$$

with

$$u_{it} = \alpha_i + \lambda_i' f_t + \varepsilon_{it} \tag{2}$$

and each independent m variable

$$x_{mit} = \eta_{mi} + \gamma_{mi}' h_{mt} + \lambda_{1mi} f_{1mt} + \cdots + \lambda_{nmi} f_{nmt} + e_{it} \tag{3}$$

for $i = 1\ldots$N, $t = 1\ldots$T, and $m = 1\ldots$.K

In Eq. (1), the dependent variable g_{it} is the log of the REER and k = 4, as we have four independent variables: trade openness, trade balance, terms of trade and factor productivity. The β_{ki} coefficients are country-specific slopes for each independent variable. The error term u_{it} is decomposed in Eq. (2) into unobservables: α_{i}, which captures country-specific fixed effects (i.e., time-invariant heterogeneity); $\lambda_{\mathrm{i}}' f_{\mathrm{t}}$, which is a set of time-variant common factors with country-specific factor loadings; and the random disturbance term $\varepsilon_{\mathrm{it}}$. Each observed independent variable can be decomposed in Eq. (3) into unobservable terms: an individual fixed-effects term, two sets of common factors, h_{mt} and f_{nmt}, which can capture time-variant heterogeneity and cross-sectional dependence, and a random noise error term. Since the model allows for the possibility that the f_{nmt} factors are included in f_{t}, these factors may influence both the observed regressors in (3) and the error term in (2), thus inducing endogeneity. Finally, we must add that the f_{t} and h_{t} unobserved factors could be nonstationary.

The consideration of the different possibilities derived from Eqs. (1) to (3) is implemented in the Common Correlated Effects (CCE) Mean Group estimator introduced by Pesaran (2006), which utilizes an empirical augmentation of Eq. (1) that specifically addresses the presence of cross-sectional dependence, which if ignored may produce biased coefficients. In order to deal with this problem, the means of the dependent and all the independent variables are computed for each period and included as additional regressors in each individual country regression. Then, the coefficients obtained in the individual country regressions are averaged to give a consistent estimator of the observed variables. The CCE estimator is not affected by unobserved common factors and is robust to endogeneity, as well as to the presence of nonstationary common factors (Kapetanios et al. 2011). Therefore, this estimator does not require prior knowledge of the cointegrating properties of either the observables or the unobservables (Eberhardt and Teal 2011).

However, an additional difficulty is the problem of potential simultaneity bias between the REER and (1) trade openness and (2) trade balance, which we have approached by instrumenting both independent variables with their first available lags in a two-step OLS framework, as proposed by Banerjee et al. (2010) in what they denominate the IVCCE mean group estimator. Therefore, the final estimated model is of the form:

$$g_{it} = \beta_{0i} + \beta_{1i}\hat{v}_{it} + \beta_{2i}x_{it} + \beta_{3i}\bar{g}_t + \beta_{4i}\bar{\hat{v}}_t + \beta_{5i}\bar{x}_t + u_{it} \tag{4}$$

in which $\hat{v}_{it}$ stands for the instrumented variables (trade openness and trade balance), which were instrumented with their first lags individually for each country, and x_{it} represents the non-instrumented independent variables, while $\bar{g}_t$, $\bar{\hat{v}}_t$, and $\bar{x}_t$ are the means of the dependent variable, the instrumented variables and the non-instrumented independent variables, respectively. As a test of robustness, we also used the augmented mean group (AMG) estimator (Bond and Eberhardt 2009; Eberhardt and Teal 2010), which also takes into account the issue of cross-sectional dependence. In addition, we have also estimated the results of the robust versions of these estimators using the methodology introduced by Bond et al. (2010), which simply uses weights for the values of the country regression parameters to diminish the influence of extreme values in the calculation of the average coefficients of the parameters. The estimations were performed with the Stata xtmg routine (Eberhardt 2012).

4 Results and discussion

Since we have used different operationalizations of some of the independent variables, our results are presented in several tables with different combinations of indicators. Table 1 shows the results of the regression with trade openness operationalized by structure-adjusted trade intensity in combination with labor productivity and the terms of trade operationalized with data from the PWT. With this combination we have achieved coverage for 101 countries. The results obtained with the CCE estimator are presented in column 1. They show that our main variable of interest, trade openness in the structure-adjusted trade intensity operationalization, has a negative and statistically significant effect on the REER, suggesting that as an economy increases its international trade its local currency depreciates. In addition, the trade balance has also a negative and statistically significant association with the REER (i.e., a larger trade balance deficit is associated with an overappreciation of the REER), while the exchange regime variable (peg) has a statistically significant positive relationship with the REER, which is aligned with the literature that indicates that having a pegged exchange rate regime tends to appreciate the REER. Other independent variables lack statistical significance. Moreover, the coefficients of the averaged variables for the CCE model can be interpreted as nuisance parameters, which are simply incorporated in the model to deal with the issue of cross-sectional dependence.

Table 1 CCE and AMG estimators regression (trade openness indicator: structure-adjusted trade intensity)

	Model 1 CCE estimator	Model 2 CCE estimator (robust)	Model 3 AMG estimator	Model 4 AMG estimator (robust)
Contant	2.144	5.999**	8.355***	9.560****
	(4.062)	(3.035)	(2.413)	(1.627)
Ln structure-adjusted trade intensity	− 0.351**** (0.083)	− 0.384**** (0.068)	− 0.381**** (0.087)	− 0.422**** (0.067)
Ln trade balance	− 0.665*	− 0.590**	− 0.187	− 0.592*
	(0.361)	(0.290)	(0.466)	(0.316)
Ln terms of trade (PWT)	− 0.046 (0.067)	0.033 (0.056)	− 0.030 (0.083)	0.040 (0.056)
Ln Labor productivity	− 0.066 (0.061)	− 0.033 (0.046)	− 0.114 (0.082)	− 0.037 (0.042)
Pegged exchange rate	0.056*** (0.017)	0.032**** (0.009)	0.023 (0.021)	0.028*** (0.009)
Avg. ln REER	0.799**** (0.125)	0.692**** (0.113)		
Avg. ln trade openness (adj. trade)	0.348 (0.238)	0.544**** (0.116)		
Avg. ln trade balance	0.489 (0.817)	0.242 (0.541)		
Avg. ln terms of trade (PWT)	0.222 (0.158)	0.321*** (0.102)		
Avg. ln labor productivity	− 0.064 (0.118)	0.016 (0.090)		
Avg. pegged exchange rate	0.007 (0.065)	0.066 (0.044)		
Common dynamic process			0.957**** (0.152)	0.903**** (0.101)

Table 1 continued

	Model 1 CCE estimator	Model 2 CCE estimator (robust)	Model 3 AMG estimator	Model 4 AMG estimator (robust)
Pesaran CSD test (*p* value)	0.273	0.273	0.001	0.001
Countries	101	101	101	101
Obs.	4382	4382	4382	4382

Dependent variable: ln REER. *Source*: Darvas (2012)
Independent variables: ln structure-adjusted trade intensity (estimated with data from WDI and PWT), ln trade balance (*Source*: WDI), ln terms of trade (*Source*: PWT), ln labor productivity (*Source*: PWT), pegged exchange rate (*Source*: Shambaugh exchange rate regime classification). The averages of the variables and the common dynamic process are the augmentation terms of the CCE and AMG estimators, respectively
Common Correlated Effects Mean Group (CCE) and Augmented Mean Group (AMG) estimators with robust and non-robust options estimated with the Eberhardt (2012) xtmg Stata routine
Countries: Argentina, Australia. Austria, Bahrain, Bangladesh, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Canada, Central African Rep., Chad, Chile, China, Colombia, Congo (DR), Congo (R), Costa Rica, Côte d'Ivoire, Cyprus, Denmark, Dominican Rep., Egypt, El Salvador, Ethiopia, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Guatemala, Guinea-Bissau, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Peru, Philippines, Portugal, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sudan, Suriname, Swaziland, Sweden, Switzerland, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Venezuela, Zambia
$^{****}p < 0.001$; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$. Standard errors in parentheses

In column 2, we present the robust version of the CCE estimator, and the results are very similar. With the AMG estimator (column 3), only trade openness has a statistically significant influence on the REER. The common dynamic process coefficient, which is the term introduced by this estimation approach for dealing with cross-sectional dependence, has also statistical significance. With the robust version of the AMG estimator (column 4), not only trade openness has a statistically significant effect, but also the trade balance variable with a negative sign and the exchange regime variable with a positive sign gain statistical significance, possibly because this version of the estimator is less affected by outliers from the individual regressions.

At this point, we must make a digression. Is there indeed a problem of cross-sectional dependence that justifies our use of these estimators? In order to answer this, we have run the Pesaran (2004) test for cross-sectional dependence, performed on the residuals from the individual regressions with the xtcd Stata routine (Eberhardt 2011). We first run this test with the Pesaran's mean group (MG) estimator, a model that allows for individual variation of the coefficients' slopes but does not take cross-sectional dependence into account (i.e., this is basically the same model as those presented in Table 1 without the augmentation with the averages of the variables or the common dynamic process). Although the results for the coefficients (not reported here) were similar with this estimator, this model did not pass the Pesaran (2004) test, indicating that there is cross-sectional dependence in the data. In contrast, this test is unable to reject the null hypothesis of no cross-sectional dependence for the CCE estimator in Table 1, and thus it can be concluded that models 1 and 2 have dealt adequately with this problem. However, the Pesaran (2004) test does not reject the possibility of cross-sectional dependence with the AMG estimator models. Therefore, the issue of cross-sectional dependence has not been solved in models 3 and 4, but we have nevertheless included them in Table 1 for informative purposes.[6]

In Table 2, we report the results of the estimated models with trade openness operationalized as trade volume. In this case, the number of countries is just 80 because we use total factor productivity instead of labor productivity. We did not report the results with the sample of 101 countries when trade openness (operationalized either by trade volume or import penetration ratio) is combined with labor productivity, which are similar to those obtained in Table 1, because the Pesaran (2004) test indicates that both the CCE and AMG estimators do not eliminate the problem of cross-sectional dependence with this sample. In models 1 and 2, trade openness has again a negative and statistically significant effect on the REER.

The same occurs with the trade balance. For the other independent variables there are a few differences between model 1 and model 2, which is to be preferred because it eliminates distortions caused by the presence of outliers. In model 2, the exchange regime variable acquires statistical significant and has a positive sign as in Table 1. In addition, the log of the terms of trade shows a positive and statistically significant effect over the REER, consistent with some findings of the literature, while total factor productivity has the positive sign predicted by the Balassa–Samuelson effect, but lacks statistically significance (it appears significant in model 1, but possibly as a result of some outlier values). Models 3 and 4, the non-robust and robust versions of the AMG estimator, do not pass the Pesaran (2004) test of cross-sectional dependence for the 81 countries sample, so the results presented should be interpreted with caution. Trade volume has a negative effect, but it is only statistically significant with the robust version of the AMG indicator (model 4). Only the trade balance variable has statistical significance in both models. The coefficient of the terms of trade is positive and statistically significant with the robust version of the estimator; total factor productivity has only a positive and statistically significant in the robust version of the estimator; and the exchange regime variable, while having a positive sign as expected, lacks statistical significance.

Table 3 presents the results of trade openness operationalizated by the import penetration ratio. As with the case of trade volume, the sample of 101 countries did not pass the Pesaran (2004) cross-sectional dependence test, so we report the results for the sample of 80 countries in which factor productivity is operationalized by total factor productivity. The log of the import penetration ratio shows a negative and statistically significant effect in both variants of the CCE estimator as well as in the robust version of the AMG estimator—the results of this estimator, however, should be taken with caution since it could not eliminate the problem of cross-sectional dependence

[6] Regarding the issue of stationarity, and even when the technique used is considered to be robust to different possibilities (existence of cointegration relationships or not), we have tested this property on the residuals. We used the Pesaran (2007) test, which has the null hypothesis of nonstationarity in all countries and the alternative hypothesis of stationarity in some countries, and the test (using up to four lags) rejects the null hypothesis in the models considered in all the tables of this study.

according to the Pesaran (2004) test. Regarding the other independent variables, only trade balance has a negative and statistically significant effects in all the models. The terms of trade have the positive and statistically significant effect expected by the literature in the robust versions of both the CCE and the AMG estimators, and total factor productivity only has a positive effect and statistically significant effect with the non-robust version of the CCE estimator.

We have also run other robustness tests using an alternative indicator of the terms of trade obtained from World Bank data. This reduces the sample to 65 and 48 countries (when combined with labor productivity and total factor productivity, respectively,

Table 2 CCE and AMG estimators regression (trade openness indicator: trade volume)

	Model 1 CCE estimator	Model 2 CCE estimator (robust)	Model 3 AMG estimator	Model 4 AMG estimator (robust)
Contant	− 1.515	2.796	11.729****	11.087****
	(4.078)	(2.711)	(2.977)	(1.916)
Ln trade volume	− 0.340****	− 0.327****	− 0.163	− 0.249****
	(0.067)	(0.049)	(0.189)	(0.048)
Ln trade balance	− 0.970**	− 0.790***	− 1.596***	− 1.121***
	(0.412)	(0.255)	(0.604)	(0.357)
Ln terms of trade (PWT)	− 0.006	0.101*	0.016	0.170**
	(0.123)	(0.061)	(0.160)	(0.070)
Ln total factor productivity	0.214*	0.117	0.273**	0.040
	(0.123)	(0.085)	(0.143)	(0.077)
Pegged exchange rate	0.0193 (0.013)	0.016* (0.009)	− 0.009 (0.019)	0.012 (0.009)
Avg. ln REER	1.045****	0.896****		
	(0.177)	(0.169)		
Avg. ln trade openness (trade vol.)	0.233** (0.112)	0.187** (0.092)		
Avg. ln trade balance	1.433*	0.666		
	(0.756)	(0.466)		
Avg. ln terms of trade (PWT)	0.012 (0.196)	0.012 (0.095)		
Avg. ln total factor productivity	0.359 (0.264)	− 0.174 (0.226)		
Avg. pegged exchange rate	− 0.008 (0.042)	0.007 (0.038)		
Common dynamic process			0.842****	0.849****
			(0.168)	(0.161)
Pesaran CSD test (*p* value)	0.51 (0.61)	0.51 (0.61)	3.49 (0.00)	3.49 (0.00)

Table 2 continued

	Model 1 CCE estimator	Model 2 CCE estimator (robust)	Model 3 AMG estimator	Model 4 AMG estimator (robust)
Countries	80	80	80	80
Obs.	3562	3562	3562	3562

Dependent variable: ln REER. *Source*: Darvas (2012)
Independent variables: ln trade volume (*Source*: WDI), ln trade balance (*Source*: WDI), ln terms of trade (*Source*: PWT), ln total factor productivity (*Source*: PWT), pegged exchange rate (*Source*: Shambaugh exchange rate regime classification). The averages of the variables and the common dynamic process are the augmentation terms of the CCE and AMG estimators, respectively
Common Correlated Effects Mean Group (CCE) and Augmented Mean Group (AMG) estimators with robust and non-robust options estimated with the Eberhardt (2012) xtmg Stata routine
Countries: Argentina, Australia. Austria, Bahrain, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, Canada, Central African Rep., Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Cyprus, Denmark, Dominican Rep., Egypt, Finland, France, Gabon, Germany, Greece, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Malaysia, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Niger, Norway, Panama, Peru, Philippines, Portugal, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Switzerland, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela
$^{****}p < 0.001$; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$. Standard errors in parentheses

as alternative indicators of factor productivity). The different combinations of indicators for trade openness and factor productivity are presented in summary form in Tables 4 and 5. In addition, we report the results of the sample of 80 countries for the indicator of structure-adjusted trade intensity in Table 6. All the models estimated in Tables 4, 5 and 6 pass the Pesaran (2004) cross-sectional dependence test, except the AMG estimator in Table 6. The indicators for trade openness, in their three variants, have a negative and statistically significant effect in all cases, except with the non-robust versions of some estimators. The effect of some of the other independent variables is consistent with theoretical expectations but is not completely robust to the choice of alternative estimators.

To sum up, after dealing with the problem of endogeneity in two of our variables and with the issue of cross-sectional dependence, we find a few interesting results. First, there appears to be a robust relationship between trade openness and the REER. In this regard, since we have controlled for the dominance of exports over imports or vice versa with the introduction of trade balance as a regressor, it can be affirmed that this relationship holds whether the "size" effect of trade openness is dominated by an export economy (i.e., a trade superavit) or by an economy relying on imports (i.e., a trade deficit). This robust relationship holds regardless of the instrumentation adopted for the trade openness variable and the number of countries included in the analysis. For example, according to the results of the CCE robust estimator in Table 2, a one percentage point increase in trade volume is associated to a 0.33 percentage points depreciation of the REER. Likewise, in model 2 of Table 3 (CCE robust estimator), a one percentage point increase in imports over GDP leads to a REER depreciation of about 0.35 percentage points.

Moreover, the trade balance—which in most countries can be understood as a proxy for the current account and, in this sense, may reflect the net inflow/outflow of foreign currency—is significant in many cases with a negative effect on the REER. This gives partial support to the work of Lane and Milesi-Ferretti (2002), but the relationship is not quite robust. On the other hand, the effect of the terms of trade is positive and statistically significant in some cases, but this finding is not robust to different samples and models. In contrast to the predictions of the Balassa–Samuelson effect, factor productivity of the economy (in both indicators of this variable, total factor productivity and labor productivity) does not have a positive and statistically

Table 3 CCE and AMG estimators regression (trade openness indicator: import penetration ratio)

	Model 1 CCE estimator	Model 2 CCE estimator (robust)	Model 3 AMG estimator	Model 4 AMG estimator (robust)
Contant	2.103	6.185**	12.602****	13.812****
	(4.154)	(3.006)	(2.864)	(2.122)
Ln import penetration ratio	− 0.248*	− 0.347****	− 0.130	− 0.252****
	(0.133)	(0.048)	(0.181)	(0.049)
Ln trade balance	− 1.623****	− 1.639****	− 1.730***	− 1.721****
	(0.438)	(0.317)	(0.532)	(0.394)
Ln terms of trade (Penn WT)	− 0.099 (0.216)	0.116** (0.059)	0.020 (0.150)	0.174*** (0.067)
Ln Total factor productivity	0.224*	0.135	0.194	0.041
	(0.118)	(0.087)	(0.125)	(0.082)
Pegged exchange rate	0.009 (0.014)	0.009 (0.009)	− 0.009 (0.019)	0.009 (0.010)
Avg. ln REER	1.000****	0.854****		
	(0.171)	(0.152)		
Avg. ln trade openness (imp. GDP)	0.207**	0.196**		
	(0.099)	(0.089)		
Avg. ln trade balance	1.423* (0.753)	0.599 (0.439)		
Avg. ln terms of trade (PWT)	0.039 (0.215)	0.016 (0.086)		
Avg. ln total factor productivity	− 0.388 (0.278)	− 0.124 (0.192)		
Avg. pegged exchange rate	− 0.028	− 0.008		
	(0.043)	(0.041)		
Common dynamic process			0.824**** (0.166)	0.817**** (0.161)
Pesaran CSD test	0.72	0.72	3.52	3.52

Table 3 continued

	Model 1 CCE estimator	Model 2 CCE estimator (robust)	Model 3 AMG estimator	Model 4 AMG estimator (robust)
(p value)	(0.47)	(0.47)	(0.00)	(0.00)
Countries	80	80	80	80
Obs.	3562	3562	3562	3562

Dependent variable: ln REER. *Source*: Darvas (2012)
Independent variables: ln import penetration ratio (Imports as % of GDP) (*Source*: WDI), Ln trade balance (*Source*: WDI), ln terms of trade (*Source*: PWT), ln total factor productivity (*Source*: PWT), pegged exchange rate (*Source*: Shambaugh exchange rate regime classification). The averages of the variables and the common dynamic process are the augmentation terms of the CCE and AMG estimators, respectively
Common Correlated Effects Mean Group (CCE) and Augmented Mean Group (AMG) estimators with robust and non-robust options estimated with the Eberhardt (2012) xtmg Stata routine
Countries: Argentina, Australia. Austria, Bahrain, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, Canada, Central African Rep., Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Cyprus, Denmark, Dominican Rep., Egypt, Finland, France, Gabon, Germany, Greece, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Malaysia, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Niger, Norway, Panama, Peru, Philippines, Portugal, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Switzerland, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela
****$p < 0.001$; ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$. Standard errors in parentheses

significant association with the REER, except in a few cases when the indicator of total factor productivity was used and mostly with the non-robust version of the estimators. This is consistent with recent findings of Gubler and Sax (2017), who suggest that this effect may depend on the dataset that has been selected. Finally, having a fixed (pegged) exchange rate appears in some cases as having a positive and significant effect on the REER. For instance, according to the results of the CCE robust estimator in Table 2, pegging the exchange rate would generate approximately a 1.6 percentage points appreciation of the REER. In terms of economic policy, this finding would suggest that, while the choice of exchange rate regime may matter for purposes of inflation control, it may also cause a small appreciation of the REER.

The fact that the results for some independent variables are not robust across all model specifications should not come as a surprise since, as we have seen earlier, conflicting results have not been unusual in the literature on the determinants of the REER. Besides, in the case of the terms of trade, a REER appreciation occurs in a country when the income effect is greater than the substitution effect; and given that our choice of alternative indicators has led to samples of quite different sizes, statistically significant results are contingent upon the countries included in each sample. On the other hand, even the effect of outliers may alter the results, so results from robust versions of the estimators are to be preferred.

A serious problem for the economic policy maker in developing countries is how to reduce an overappreciated exchange rate without a large nominal depreciation, which is feared to fuel inflation. Our findings suggest that increasing trade volume or even just imports is likely to decrease currency overappreciation. In the case of imports,

Table 4 Summary of CCE and AMG estimators regression (alternative indicator of terms of trade with World Bank Data)

Estimator	Ln trade openness (structure-adjusted trade intensity)	Ln trade openness (trade volume)	Ln trade openness (import penetration ratio)	Ln trade balance	Ln terms of trade (World Bank data)	Ln labor productivity	Exchange Rate Regime (Peg)
CCE	−0.057			−2.824*	0.534	0.320	0.073***
CCE robust	−0.409***			−0.714	0.180***	−0.055	0.040***
AMG	−0.509			1.227	−0.122	−0.280	0.024
AMG robust	−0.425****			−0.797*	0.120**	−0.060	0.009
CCE		−0.442****		−0.264	0.174*	0.079	0.074**
CCE robust		−0.376****		−0.006	0.148**	0.002	0.028**
AMG		−0.500***		−1.350	0.334**	0.099	0.053*
AMG robust		−0.406****		−0.605	0.135**	0.061	0.030*
CCE			−0.355**	−1.505	0.150	0.060	0.109***
CCE robust			−0.419****	−0.910	0.114	0.019	0.032**
AMG			−0.450**	−2.835***	0.360**	0.130	0.059
AMG robust			−0.422****	−1.663***	0.102*	0.081	0.021

Dependent variable: ln. REER. *Source*: Darvas (2012)

Independent variables: ln structure-adjusted trade intensity (estimated with data from WDI and PWT), ln trade volume (*Source*: WDI), ln import penetration ratio (Imports as % of GDP) (*Source*: WDI), ln trade balance (*Source*: WDI), ln terms of trade (*Source*: WDI), ln labor productivity (*Source*: PWT), pegged exchange rate (*Source*: Shambaugh exchange rate regime classification). Augmentation terms omitted

Common Correlated Effects Mean Group (CCE) and Augmented Mean Group (AMG) estimators with robust and non-robust options estimated with the Eberhardt (2012) xtmg Stata routine

Number of countries: 65. Observations: 2072

Countries: Argentina, Bangladesh, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Central African Rep., Chad, Chile, China, Colombia, Congo (DR), Congo (R), Costa Rica, Dominican Rep., Egypt, El Salvador, Gabon, Gambia, Ghana, Guatemala, Guinea-Bissau, Honduras, Hong Kong, India, Indonesia, Jordan, Kenya, Korea, Lesotho, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Niger, Nigeria, Pakistan, Panama, Peru, Philippines, Rwanda, Senegal, Singapore, South Africa, Sri Lanka, Sudan, Swaziland, Thailand, Togo, Tunisia, Turkey, Uganda, United States, Uruguay, Venezuela, Zambia

****$p < 0.001$; ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$. Standard errors in parentheses

Table 5 Summary of CCE and AMG estimators regression (alternative indicator of terms of trade with World Bank Data)

Estimator	Ln trade openness (structure-adjusted trade intensity)	Ln Trade openness (trade volume)	Ln trade openness (import penetration ratio)	Ln trade balance	Ln terms of trade (World Bank data)	Ln total factor productivity	Exchange rate regime (Peg)
CCE	−0.685****			−0.613	0.077	0.214	0.039**
CCE robust	−0.346***			−0.830	0.055	0.182	0.014
AMG	−0.786**			−1.157	0.255	0.217	0.031*
AMG robust	−0.400****			−1.083**	0.006	0.151	−0.006
CCE		−0.194		−3.038	0.114	−0.037	−0.008
CCE robust		−0.302****		−0.482	0.010	0.322*	0.030**
AMG		−0.156		−4.309	0.141	−0.192	−.0042
AMG robust		−0.436****		−0.902**	0.032	0.225	0.001
CCE			−0.192	−1.780	0.063	0.089	0.016
CCE robust			−0.284***	−0.945*	0.032	0.270	0.024**
AMG			−0.309*	−2.846**	0.079	0.040	−0.002
AMG robust			−0.450****	−1.823****	0.048	0.212	0.004

Dependent variable: ln REER. *Source*: Darvas (2012)

Independent variables: ln structure-adjusted trade intensity (estimated with data from WDI and PWT), ln trade volume (*Source*: WDI), ln import penetration ratio (Imports as % of GDP) (*Source*: WDI), ln trade balance (*Source*: WDI), ln terms of trade (*Source*: WDI), ln total factor productivity (*Source*: PWT), pegged exchange rate (*Source*: Shambaugh exchange rate regime classification). Augmentation terms omitted

Common Correlated Effects Mean Group (CCE) and Augmented Mean Group (AMG) estimators with robust and non-robust options estimated with the Eberhardt (2012) xtmg Stata routine

Number of countries: 48. Observations: 1530

Countries: Argentina, Benin, Bolivia, Botswana, Brazil, Burundi, Cameroon, Central African Rep., Chile, China, Colombia, Costa Rica, Dominican Rep., Egypt, Gabon, Guatemala, Honduras, Hong Kong, India, Indonesia, Jordan, Kenya, Korea, Lesotho, Malaysia, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Niger, Panama, Peru, Philippines, Rwanda, Senegal, Singapore, South Africa, Sri Lanka, Swaziland, Thailand, Togo, Tunisia, Turkey, United States, Uruguay, Venezuela

****$p < 0.001$; ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$. Standard errors in parentheses

Table 6 Summary of CCE and AMG estimators regression (alternative indicator of terms of trade with Penn World Table data)

Estimator	Ln trade openness (structure-adjusted trade intensity)	Ln trade balance	Ln terms of trade (Penn World Table)	Ln total factor productivity	Exchange rate regime (Peg)
CCE	− 0.397****	− 0.836**	− 0.031	− 0.007	0.020*
CCE robust	− 0.392****	− 0.848***	0.083	− 0.032	0.014**
AMG (a)	− 0.244	− 0.662*	0.102	0.076	0.004
AMG robust (a)	− 0.391****	− 0.999***	0.177***	− 0.029	0.016**

Dependent variable: ln. REER. *Source*: Darvas (2012)
Independent variables: ln structure-adjusted trade intensity (estimated with data from WDI and PWT), ln trade balance (*Source* WDI), ln terms of trade (*Source*: WDI), ln total factor productivity (*Source*: PWT), pegged exchange rate (*Source*: Shambaugh exchange rate regime classification). Augmentation terms omitted
Common Correlated Effects Mean Group (CCE) and Augmented Mean Group (AMG) estimators with robust and non-robust options estimated with the Eberhardt (2012) xtmg Stata routine
(a) The results of this estimator do not pass the Pesaran (2004) test of cross-sectional dependence
Number of countries: 80
Observations: 3557
Countries: Argentina, Australia. Austria, Bahrain, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, Canada, Central African Rep., Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Cyprus, Denmark, Dominican Rep., Egypt, Finland, France, Gabon, Germany, Greece, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Malaysia, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Niger, Norway, Panama, Peru, Philippines, Portugal, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Switzerland, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela
****$p < 0.001$; ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$. Standard errors in parentheses

the interpretation is straightforward. Increasing imports may lower the price of some tradable goods in the local country. In other words, following the logic of PPP theory, with the same amount of foreign currency than before trade openness, tradable goods become cheaper (i.e., the local currency depreciates vis-à-vis the foreign currency). However, it must be pointed out that increasing trade openness is a measure that may face resistance, particularly in some developing countries. The usual argument in this regard is that opening up the economy to international trade may harm domestic industries that cannot compete with foreign imports. A case in point is the Argentine economy where protectionism has been rampant and is considered by some authors as one of the main causes of the country's underdevelopment (Espert 2017).

Finally, we must acknowledge some limitations in this study. It would have been interesting to use another additional indicator of trade openness, more directly linked with trade policies, like average weighted tariffs, whose results could have been potentially more useful for informing economic policy. Unfortunately, we could not collect data about such indicator over a large enough period of time. In addition, another variable that should have been incorporated as a relevant control regressor in the analysis is the level of public expenditure.

5 Conclusion

This study advances our empirical knowledge of the determinants of the REER by using novel estimation techniques and a new dataset covering a large number of countries over an extended period of time. Given the existence of disparities in the results from individual country studies, constraining the parameters to be homogeneous across countries does not seem a reasonable assumption. By allowing heterogeneity in the parameters and taking into account the issue of cross-sectional dependence, which appears as a basic feature of an increasingly interconnected international economy, our econometric approach is a realistic way to address the complex nature of the global economy. In addition, our use of the REER, instead of the real exchange rate (a construct based on a bilateral relationship), represents an improvement over other previous studies.

After considering five potentially relevant determinants of the REER in our regression, we obtained the following findings. Factor productivity, trade balance, the terms of trade, and the exchange rate regime have statistically significant results that are in accordance with theoretical expectations, but these results are not robust to different sample compositions and choice of alternative estimators. The most important result, though, is a strong support for the hypothesis of the existence of a negative relationship between trade openness and the REER (i.e., increasing trade openness depreciates the REER), which is robust to (1) the number of countries used in the regressions, (2) two alternative indicators for two of the regressors included in the analysis, and (3) three alternative operationalizations of trade openness. This result demonstrates that trade openness is indeed a relevant determinant of the REER, supporting earlier thinking on this subject. Thus, our findings suggest that increasing overall trade volume or even the import penetration ratio—something that can be achieved by several means like reducing tariffs, diminishing export taxes, signing trade agreements, eliminating quotas, etc.—are instrumental in achieving a competitive exchange rate, which is considered by many economists as a basic prerequisite to put in motion a virtuous circle of export-oriented development

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