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Abstract: Using large panel data models that deal with the problems of potential endogeneity and cross-sectional dependence, while also allowing for cross-country heterogeneity in the parameters of interest, we demonstrate that trade openness produces a depreciation of the real effective exchange rate and total factor productivity leads to its appreciation.

Keywords: real effective exchange rate; trade openness; terms of trade; total factor productivity

JEL classifications: F13, F31, F41

1 Introduction

The effect over business of the real effective exchange rate (REER) is very important. A currency that is appreciated can lead to fail of the export sector and to the industries in competition with imports. The study of the determinants of the REER is a topic that has received much attention in the international economics literature. So far, the studies on this subject are not conclusive about the particular factors affects the real effective exchange rate. This paper contributes to our knowledge about its determinants in a number of ways. First, since the empirical studies show that theoretical predictions hold for certain countries and not for others, our methodological approach does not restrict the slope coefficients of the independent variables to be the same for each country. Second, not only do we consider the issue of endogeneity, which arises as a result of simultaneous causation between the REER and trade openness, but we also deal with the problem of cross-sectional dependence, which to our knowledge has not been adequately addressed by the literature so far. We believe that cross-sectional correlation should be taken into account because

movements in nominal exchange rates, and their potential concomitant effects on real exchanges rates, tend to affect countries not only individually, but collectively as well — e.g., 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. Third, our analysis is an improvement over previous studies by using a new REER dataset that covers a larger numbers of countries over an extended period of time. This provides enough empirical variability to observe changes of the REER subject to different economic conditions. Finally, the econometric technique employed is robust to the presence of potential relevant factors that may be unobserved.

2 The determinants of the real exchange rate

In our empirical analysis, we consider four determinants of the REER. The first of them is trade openness. When the REER appreciates, domestic products become more expensive for the rest of the world and therefore their international demand decreases. In addition, foreign tradable products become cheaper than domestic ones, which increases imports unless the government raises their cost through tariffs. Thus, protectionism restricts imports and consolidates a situation of REER appreciation, and it has therefore been argued that trade liberalization leads to the opposite effect, a depreciation of the REER (Dornbusch 1974). However, the empirical evidence about the relationship between trade openness and the REER has been mixed.

The terms of trade (a measure of the purchasing power of exports relative to imports) are also a factor that has been mentioned as a determinant of the REER. However, as Edwards and Wijnbergen (1987) argue, changes in terms of trade may generate a substitution and an

income effect, which may operate in opposite directions. The empirical evidence is again mixed in this regard.

Another explanatory variable proposed in the literature is the difference in factor productivity. According to the Balassa-Samuelson effect, the real exchange rate will be overappreciated in richer countries (Balassa 1964), and there has been some empirical evidence in favor of this effect.

It has also been suggested that capital inflows, which are reflected in the current account, tend to appreciate the REER. Unfortunately, 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 (Doukas and Lifland, 1994). However, there is a potential problem of simultaneous causation in this regard, which we address in our econometric model, as an overappreciated REER tends to deteriorate the trade balance (it increases imports and decreases exports).

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), expressed in natural logarithms. Regarding the independent variables, trade openness is operationalized as the log of the sum of exports and imports as a percentage of the GDP, obtained from the World Development Indicators database of the World Bank (2015). For the terms-of-trade variable, we used the natural logarithm of an index that we computed dividing the price of exports index by the price of imports index from the Penn World Table 8.0 dataset (Feenstra et al., 2013). 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 plus the minimum negative value in the dataset in order to avoid logs with null values. Finally, we used the logarithm of the total factor productivity indicator from the Penn World Table. 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 use an econometric model of the form:

$$g_{it} = \beta_{0i} + \beta_{1i}x_{1it} + \beta_{2i}x_{2it} + \dots + \beta_{ki}x_{kit} + u_{it} \quad (1)$$

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

In equation (1), the dependent variable g_{it} is the log of the REER rate 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. To cope with the problem of cross-sectional dependence, which otherwise could severely bias the regression coefficients, we used the Common Correlated Effects (CCE) Mean Group estimator introduced by Pesaran (2006), which utilizes an empirical augmentation of equation (1) that specifically addresses this issue as well as the potential presence of unobserved common factors in both the independent variables and the error term. In order to deal with these problems, 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 unaffected by unobserved common factors and robust to both endogeneity and the presence of nonstationary common factors. Therefore, it 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). So, the final estimated model is the following:

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

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{v}_t , and \bar{x}_t are the means of the dependent variable, the instrumented variables and the non-instrumented independent variable, respectively. The final estimations were performed with the Stata xtmg routine (Eberhardt 2012).

4 Results and conclusions

Table 1 presents the results of the analysis. The CCE estimator (column 1) shows that trade openness has a negative and statistically significant effect on REER, suggesting that, as an economy increases its external trade as a share of the GDP, there is a real depreciation of its currency. Regarding the log of the trade balance the sign is also negative and statistically significant (i.e., the lower the trade balance, the greater the REER overappreciation). The coefficient of the terms of trade is also aligned with theoretical expectations with a positive

sign, but it also lacks statistical significance. Finally, total factor productivity shows a positive and statistically significant relationship with the REER. The rest of the coefficients for the CCE model can be interpreted as nuisance parameters, which are simply incorporated to deal with the issue of cross sectional dependence. In column 2, we present the robust version of the CCE estimator, introduced by Bond et al. (2010), which 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 results are very similar, except that the terms-of-trade variable is now statistically significance. With the augmented mean group estimator (columns 3 and 4), all the explanatory variable have statistically significant effects and values that are similar to those obtained with the CCE estimator. The common dynamic process coefficient, which is a term utilized in this estimator for dealing with cross sectional dependence, is also statistically significant.

Table 1 CCE estimator regression

	Model 1 CCE estimator	Model 2 CCE estimator (robust)
Contant	-3.212 (3.580)	0.359 (2.627)
Ln. trade openness	-0.331 **** (0.052)	-0.336 **** (0.050)
Ln. trade balance	-1.038 *** (0.349)	-0.757 *** (0.230)
Ln. terms of trade	0.079 (0.104)	0.154 ** (0.064)
Ln. TFP	0.198 ** (0.099)	0.149 * (0.085)
Avg. ln. REER	1.193 **** (0.191)	1.036 **** (0.180)
Avg. ln. trade openness	0.266 ** (0.107)	0.220 ** (0.091)
Avg. ln trade balance	1.996 *** (0.684)	1.060 ** (0.479)
Avg. ln. terms of trade	-0.228	-0.143

	Model 1 CCE estimator	Model 2 CCE estimator (robust)
	(0.191)	(0.106)
Avg. ln. TFP	-0.522 ** (0.239)	-0.441 ** (0.223)
countries	81	81
obs.	3634	3634

Notes: **** p<0.001, *** p<0.01, ** p<0.05, * p<0.10

Dependent variable: ln. REER

As a test of robustness, we used an alternative estimator, the augmented mean group estimator of Eberhardt and Teal (2011), which also takes into account the issue of cross-sectional dependence, and the obtained results (not reported here) were similar. In addition, we used as an alternative indicator of the terms of trade obtained from the World Bank (2014). With this indicator, the number of countries diminished to 49 and two variables, the trade balance and the terms of trade, were no longer statistically significant. Therefore, the only robust results correspond to trade openness and total factor productivity.

This study advances our empirical knowledge of the determinants of the REER by allowing heterogeneity in the parameters and recognizing the issue of cross-sectional dependence, which appears as a basic feature of an increasingly interconnected international economy. Our findings support the existence of a Balassa-Samuelson effect, as total factor productivity has a positive effect on the REER. In addition, there is also support for the hypothesis of a link between trade openness and the REER, supporting earlier thinking on this subject. However, since openness has been measured as the share of total international trade over GDP and not directly by looking at the specific trade policies adopted by the countries (e.g., lowering tariffs, establishing trade agreements with other

countries, abolishing quotas, subsidizing exports, etc.), the actual mechanisms by which trade openness affects the REER merit further research.

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