*The effectiveness of expansionary devaluation at different stages of economic development*

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**Abstract**

*This paper aims at empirically assessing variations in the magnitude of the impact of RER misalignments on output growth, subject to the stage of economic and technological development of the country. Heterogeneous regressions are undertaken in order to accomplish such a task for a sample of 100 countries from 1970-2010. Estimates show that both the level of the technological gap and the degree of outward-orientation simultaneously determine cross-country differences regarding the effectiveness of devaluation as a macroeconomic policy tool. Lastly, as a possible explanation for the main findings of this paper, it is suggested that in the first stages of the economic development, the competition of domestic products in foreign markets takes place mostly through price mechanisms instead of cutting-edge products and processes, as in developed economies.*

**Key-words:** *Economic Growth, Exchange Rate, Productivity, Exports, Manufacturing*

**Resumo**

*Este trabalho tem por objetivo analisar empiricamente a magnitude do impacto dos desalinhamentos da taxa de câmbio real sobre o crescimento do produto, sujeito ao estágio de desenvolvimento econômico e tecnológico dos países. Para tanto, são utilizadas regressões heterogêneas para uma amostra de 100 países entre 1970 e 2010. As estimativas mostram que o grau de defasagem tecnológica e o grau de orientação para exportação determinam, simultaneamente, diferenças entre países no que diz respeito à eficácia da desvalorização como uma ferramenta de política macroeconômica. Finalmente, como uma possível explicação para as principais conclusões deste trabalho, sugere-se que, nos primeiros estágios do desenvolvimento económico, a concorrência dos produtos nacionais nos mercados estrangeiros ocorre principalmente através de mecanismos de preços, enquanto em economias desenvolvidas a concorrência é pela qualidade e diferenciação de produtos.*

**Palavras-chave:** *Crescimento Econômico, Taxas de câmbio, Produtividade, Exportações, Manufatura*

**Jel Code: O11, O14, O40, L60**

**Área ANPEC:** *Área 6 - Crescimento, Desenvolvimento Econômico e Instituições*

1. **Introduction**

Economic literature has extensively investigated the role played by competitive exchange rate in the most successful growth strategies over the past decades. Many studies have been undertaken in order to assess the role played by the maintenance of competitive currency for the successful growth strategies of East and Southeast Asian countries. Contrastingly, according to this literature, Latin American and African countries have fallen behind due to overvalued domestic currencies, amongst other factors. The existing literature explores several transmission channels through which devaluation might propel growth. Some works suggest that competitive devaluation helps to outweigh the negative impact of bad institutions and market failure on the tradable sector and hence boost growth (e.g. Rodrik, 2008). Some economists also argue that currency devaluation encourages exports, thus affecting positively growth due to economies of scale and adoption of new technologies (e.g. Gala and Libanio, 2010). Others argue that devaluation boosts growth by increasing domestic savings (via reduction of wages) and investments (e.g. Gala, 2007; Levy-Yeyati et al, 2013).

Despite the different types of methods, samples of countries and time periods considered within this literature, it is possible to identify the emergence of certain patterns: i) by and large, most studies suggest a positive relationship between currency undervaluation and growth; ii) this correlation is observed mostly in developing countries. In the present work we focus mostly on the second issue. That is, we want to answer the following question: ‘Why a positive relationship between devaluation and growth holds almost exclusively for developing countries?’ Rodrik (2008) provides a possible answer for this question from an orthodox standpoint. To begin with, Rodrik argues that the tradables sector is a special sector, as it is the main engine of economic growth. Thus, in developing countries, slow economic growth is a consequence of the poor performance of the tradables sector. According to the author, the rationale behind this argument is that the existence of bad institutions and market failures affect disproportionately the tradables sector in relation to the non-tradables. Thus, the improvement of institutions and the correction of market failures is the best way to promote economic development. However, given the impossibility of accomplishing these tasks in the short term, the depreciation of the real exchange rate becomes a second-best solution to promote growth, since higher real exchange rate increases profitability of tradables relative to non-tradables.

The problem with this explanation is that even in the absence of bad institutions and market failures, nothing guarantees *a priori* that only free-market competition would be able to promote the development of the country. The author himself states in his text that economic development consists of structural changes and investments in new productive activities. Therefore, the underlying assumption made by Rodrik that only free-market competition would be able to create the conditions for fast economic growth is, at best, misguided. Therefore, alternative research on this issue is needed.

This paper contributes to the literature in several aspects. First, this study investigates empirically the impact of RER misalignments in distinct economic structures. It helps to identify to which extent undervalued domestic currencies are able to boost countries economic growth rates and under which conditions stronger expansionary devaluation can be observed at different stages of the technological ladder. Second, the present work also adds to the existing literature by the use of heterogeneous regressions. As far as we know, this is a novel econometric technique within this literature. Different characteristics, such as level of the technological gap and the degree of outward-orientation are taken into account in the estimation of the impact of RER misalignments on countries’ growth rate through heterogeneous regressions. Standard econometric models cannot fully assess differences, if there is any, in the effectiveness of expansionary devaluation at different stages of technological development. Third, this work suggests a brief, alternative theoretical explanation for the argument advanced by Rodrik (2008) relative to the differences in the impact of currency devaluation for developed and developing countries. Through this approach is possible to provide additional knowledge for monetary authorities of developing countries aiming at making more informed decisions concerning the possible costs and benefits of devaluation in terms of growth bonus.

The remainder of this paper consists of three other sections. In section 2, we survey the empirical literature and show that heterogeneous regressions have not yet been applied in previous works. Section 3 presents the baseline model and its extensions, as well as the estimation technique and the dataset. Section 4 discusses the results. The last section concludes.

1. **Literature review: a brief overview**

There is a vast empirical literature testing the relationship between real exchange rate (RER) misalignments and economic growth. Below we cover some of the most relevant papers in this literature by highlighting their data set, econometric techniques and transmission channels through which RER variations affect growth.

Cottani et al (1990) analyses the effect of RER misalignments on several variables of economic performance such as per capita GDP growth, exports growth, investment rate, incremental capital-output ratio and agriculture growth for 24 less developed countries from 1960 to 1983. The estimation technique is pooled Ordinary Least Squares (OLS) and the economic performance equation are controlled for a measure of exchange rate variability. The authors find a significant negative impact of a RER overvaluation on per capita GDP growth. Dollar (1992) claims that outward-oriented policies and undervalued currency boosted the growth of the Asian countries, whereas Latin America and African countries lagged behind due to inward oriented policies and overvalued RER. A pooled OLS testing the impact of a RER devaluation on per capita GDP growth is carried out for 95 developing countries from 1976 to 1985. He controls the per capita GDP growth for the investment rate and a measure of exchange rate variability and finds a statistically significant relationship between a devalued RER and growth. Ghura and Grennes (1993) use a sample of 33 sub-Saharan African countries over the period 1972–1987 to estimate the impact of RER devaluation on economic growth and investments, amongst other measures of economic performance such as exports, imports and savings. They use pooled OLS and Instrumental Variables (IV) to regress these variables against alternative measures of RER misalignment. By using the investment rate, population growth and terms of trade growth as control variables, they find significant negative effects of a RER devaluation on growth and investments. Bleaney and Greenaway (2001) investigated the effects of terms of trade and exchange rate volatility on countries heavily dependent on the exports of primary goods. They also used data from a sample of 14 sub-Saharan African countries from 1980 to 1995 and ran fixed effects panel regressions with IV for investments and GDP growth. After using lagged dependent variables as instruments, terms of trade and RER volatility as control variables, they found that RER devaluation boosts investments and growth. These conclusions for sub-Saharan African countries are in line with the results found by Ghura and Grennes (1993) for a previous period. Loayza et al (2005) estimated the impact of a RER misalignment on the growth rate of GDP per capita for a sample of 78 countries from 1961-2000. The controls they used are the initial GDP per capita, education, private credit-GDP ratio, a measure for trade openness, government consumption, a proxy for public infrastructure, inflation, GDP volatility, a proxy for systemic banking crises and terms of trade. The estimation technique is the Generalised Method of Moments (GMM) System on the sample based on 5-year averages. It is shown that the overvaluation of the RER has a negative impact on growth. Gala (2007) also presented evidence for the relationship between RER and growth based on a sample of 58 developing countries from 1960-1999. The GMM-System methodology was used and the baseline equation was controlled for initial GDP per capita, initial output gap, human capital, public infrastructure, governance, inflation, terms of trade, and population growth. His results show a positive impact of a currency devaluation and growth. He argues that RER devaluation increases profit margins by reducing wages, and hence boosts investments and output. Rodrik (2008) argues that bad institutions and market failures put a heavier burden on the tradable sector than on the non-tradable sector, and hence currency devaluation might be able to correct this distortion on developing countries. He tests the relationship between currency devaluation and growth for 188 countries from 1950 to 2004. He uses fixed-effects panel data and includes in the baseline equation measures for institutional quality, government consumption, terms of trade, inflation, human capital, and saving rates. He also estimates the equation with the GMM-System. His findings support the claim that RER devaluation boosts growth. Gala and Libanio (2010) argue that a competitive currency boosts the manufacturing sector of the economy. Given the presence of increasing returns to scale in the industrial sector, currency devaluation helps to generate technological innovation, increases total productivity of the economy and propels the output growth rate. They examined the cases of Indonesia and Chile and suggested that the maintenance of a competitive currency was a key factor to explain the high growth rates of these countries over the 1980s and the 1990s. Gluzmann et al (2012) replicate Rodrik’s (2008) work and estimate the contribution of an undervalued currency to output growth, consumption, savings, investments, exports and imports. They use a fixed-effects panel analysis with dummies for countries and time periods and also find a positive impact of RER devaluation on growth. Razmi et al (2012) developed a model where currency devaluation spurs capital accumulation and growth in developing countries with high levels of underemployment in traditional sectors. For a data set of a maximum of 153 countries over the period 1960-2004, they carried out estimations using OLS and GMM and found a statistical positive relationship between RER devaluation and capital accumulation. Levy-Yeyati et al (2013) examined the relationship between RER devaluation and growth as well. Their dataset is constituted by 179 countries from 1974 to 2007 and the estimation technique employed is fixed effects panel regressions. The controls used include the terms of trade, the trade-weighted average of the GDP of the country's trading partners, the ratio of the financial account over GDP as a measure of capital inflows, and dummies for countries and time periods. Their findings support the idea that a currency devaluation boost growth by increasing domestic savings (via reduction of wages) and capital accumulation, rather than promoting export-led growth and import substitution. Lastly, Vaz and Baer (2014) examine the relationship between RER and growth for 39 countries (8 from Latin America), covering the period 1995-2008. The aim of their study is to evaluate the impact of RER changes on the manufacturing sector in Latin America as opposed to the rest of the sample. They follow Rodrik (2008) so that their results can be compared to the literature; however, they employ a fixed-effect panel analysis, as they consider that it is unlikely that the output of a given sector can determine the exchange rate. After including controls in the baseline model such as the openness degree, consumption and investment rates, they found that a RER devaluation boosts growth. They also conclude that manufacturing sectors in Latin America have been more affected by currency over or undervaluation.

All the works cited above assume a linear effect of RER misalignments on growth. However, a more recent literature cast some doubts on this direct relationship between RER and growth by incorporating non-linearities in the previous models. Using data from 60 countries over the 1965-2003 period, Aguirre and Calderon (2005) identify a non-linear effect of a RER misalignment on growth. The GMM-System technique is employed to estimate the parameters of interest. By using the initial GDP per capita, a proxy for human capital, private credit-GDP ratio, a proxy for trade openness, inflation rate, a measure of currency crises, and terms of trade as control variables, they find that a small-to medium undervaluation spurs growth, whereas a sufficiently large undervaluation harms growth. Nouira and Sekkat (2012) use a panel of 30-50 countries over the period 1980-2005 to estimate the relationship between RER misalignment and growth. Three methods of estimation were used, namely, OLS, GMM and Panel Cointegration. They also used as explanatory variables the investment rate, school enrolment and population growth. They analyse separately the impacts of an overvaluation and an undervaluation on growth. Their results show that an undervaluation has no statistical effect on growth while an overvaluation might have an impact on growth. Schroder (2013) estimates the impact of RER misalignments on growth for 63 developing countries over the period 1970-2007. He employs the GMM-System technique and controls the baseline equation for variables such as initial income, investments, terms of trade, government consumption, net foreign assets position, human capital and rule of law. He also separates RER misalignments in undervaluation and overvaluation variables and concludes that RER distortions of any kind have a negative impact on growth. And finally, Couharde and Sallenave (2013) also identify a non-linear impact of a currency devaluation on growth. Their sample constitutes of 25 countries over the period 1980-2009. They implement a panel smooth transition regression methodology to estimate the threshold beyond which currency devaluation reduces growth. After controlling for the initial GDP, investments, inflation and the degree of openness, their results show that any devaluation beyond 19.65% impacts the growth rate negatively.

Hence, it can be observed that none of the works aforementioned have conducted an empirical analysis of the correlation between RER and growth through the use of heterogeneous regressions. In the next section this novel econometric technique is described, as well as its application to the assessment of the effectiveness of expansionary devaluation on growth at different stages of technological development.

1. **The model**
   1. ***The baseline model***

To begin with, let us define the RER misalignment measurement employed in the present work. The RER is given by the foreign price level in terms of domestic currency divided by the domestic price level. It can be computed as the ratio of the nominal exchange rate (NER) to the Purchasing Power Parity (PPP) of the country, as follow:

where denotes an index for countries and for time. In other words, if the RER is greater (smaller) than one, than the value of the domestic currency is lower (higher). However, according to the widely known Balassa-Samuelson effect, poorer countries tend to have cheaper non-tradable goods and, consequently, higher RER. Hence, a more accurate RER misalignment index must take into account such an effect. Drawing upon Rodrik (2008), we regress the RER on per-capita GDP () in order to account for the Balassa-Samuelson effect:

Therefore, the RER undervaluation index () is given by the difference between the current RER and the RER adjusted by the per-capita income level:

Once again, if is greater (smaller) than unity, than the domestic currency is depreciated (appreciated).

Next, we define the baseline model. Following the vast literature of empirical studies, we analyse the impact of RER misalignment on output growth rate. Therefore, the baseline model is given by:

where is the growth rate of country , is the lagged growth rate and denotes the set controls variables. The long-term impact of RER undervaluation on growth is given by:

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This equation shows that the higher the parameter , the higher the impact of a RER undervaluation on the country’s long-term growth rate. If the autoregressive term, , is lower than one, and is positive, a currency undervaluation boosts economic growth. A negative , however, indicates that RER undervaluation reduces the country’s growth rate. Moreover, because the RER is measured as the price of foreign currency in terms of domestic currency, can be interpreted as the impact of undervaluation of 100% on the country’s growth rate (in percentage points).

* 1. ***Technological catching-up***

There is an important literature addressing the issue of a growth bonus obtained by laggard countries from catching up to a technological leader. According to these works, the higher the technological gap, the higher the opportunities for learning related to imitation and hence the higher the productivity growth. Barro and Sala-i-Martin (1997) argue that relatively low costs of imitation compared to the costs of discovering new technologies enable developing economies to grow faster than the advanced ones. However, Fagerberg (1994) and Fagerberg and Verspagen (2002) point out that one of the basic assumptions of neoclassical models is that technology is a public good and thus technological gap cannot explain differences in the level of productivity between countries. It is noteworthy that the definition of technology as a global public good stands in stark contrast with a stylised characteristic of modern economies which is the persistence of differences in the level of technological capabilities between countries. Hence, through the process of technological catch-up poorer economies can grow at faster rates than richer countries.

Many studies have tested the hypothesis of convergence. Bernard and Jones (1996) analysed the role of sectors in the convergence process for OECD countries, and found that manufacturing shows little evidence of productivity convergence, whilst other sectors, especially services, are driving the aggregate convergence. Sorensen (2001) criticises this study by arguing that the result obtained by Bernard and Jones is not robust to the choice of base year. Sorensen estimates use different base-years and found that aggregate Purchasing Power Parities (PPPs) are not suitable conversion factors for manufacturing, once it presents strong (and statistically significant) convergence if the base years are either 1985, or 1990 or 1993. More recently, Le Gallo and Dall’erba (2008) used spatial lags as controls to estimate convergence amongst sectors and regions in Europe. The authors found that labour productivity tends to converge to the same productivity level in the aggregate level, as well as in manufacturing and in market services. Conversely, in agriculture, construction and non-market services, productivity in peripheral regions and central regions conditionally converge to different levels.

In light of these findings, it is important to investigate to which extend the positive correlation between currency devaluation and growth is determined by the level of technological capabilities of the country relative to the technological leader. The most appropriate econometric technique to tackle this issue seems to be the *heterogeneous regressions*[[1]](#footnote-1). Unlike the previous works, in this paper technological gap will not be used as a control variable in the baseline equation, but as a variable of heterogeneity. Since our dataset consists of countries in different stages of technological development, we can add an interaction term between RER misalignment and technological gap to the regression model in order to capture the impact of currency devaluation on growth for different levels of technological gap. Therefore, the partial effect of currency undervaluation on growth, that is, the coefficient of the interaction term, varies according to countries’ technological gap. This estimate may shed light on some important issues in the current debate concerning the effectiveness of RER undervaluation for boosting growth.

Thereby, the following model is considered:

where denotes the productivity of the home country divided by the US productivity, which means that the higher is the value for the higher is the country’s relative productivity. The impact of RER undervaluation provided by these estimations is not obtained directly through , such as in (5). Instead, it is obtained through the interaction of RER undervaluation with countries’ technological gap, which means that it is not a parameter, but a function. Thus, rather than one value, this impact is obtained, as follows:

(7)

In the case of the base model, the impact of RER undervaluation, , was given only by and . Here, however, a term that interacts with the technological gap is included. Similarly to (5), if is lower than one, the higher the higher the impact of a RER undervaluation on growth. Unlike equation (5), in equation (7) the interaction term indicates that this impact varies according to the value of and . If is negative, than the higher the country’s productivity in relation to the US (or the higher is the value of ), the lower is the impact of RER undervaluation on growth. Analogously, for a positive , the higher the country’s productivity in relation to the US (or the higher is the value of ), the higher the impact of RER undervaluation on growth. By equation (7) it is possible to analyse the importance of currency undervaluation for countries in different stages of development. A negative indicates that currency devaluation if more effective for low-productivity countries.

* 1. ***Level of outward-orientation and degree of industrialisation of exports***

RER undervaluation tends to be more effective when coupled with outward-oriented policies (Dollar, 1992). This explains, according to the author, the successful growth strategy of East-Asian countries relative to Latin-American countries over the last decades. Alternatively, there is a convincing new structuralist literature providing considerable information on potentially contractionary effects of devaluation due to adverse impacts on components of the aggregate demand such as imports, export supply, consumption and investment; they also point out unwanted effects of devaluation on the cost of production of domestic firms, external debt, inflation and income distribution (Diaz-Alejandro, 1963; Krugman and Taylor, 1978; Bruno, 1979; Razmi, 2007). Ergo, since currency undervaluation may reduce domestic demand, it is plausible to assume that that RER undervaluation impacts negatively inward-oriented countries, whilst it boosts the economic performance of outward-oriented countries.

The level of countries’ outward-orientation () is computed as the share of exports on GDP. The following model aims at analysing the heterogeneous impact of devaluation om growth at different stages of development:

By equation (9), the impact of RER undervaluation is given by the interaction of RER undervaluation with technological gap and outward-orientation. Such as in the analysis of technological gap, it means that the impact is not a parameter, but a continuous function. In this case, however, it is a function of two variables. Thus, it is obtained, as follow:

(9)

This equation adds another interaction term to the impact of a RER undervaluation on growth. Herein, the outward orientation, , interacts with , and hence the impact of undervaluation depends on countries’ technological gap, such as in (7), but it also depends on countries’ outward-orientation. If is positive, the higher the countries’ exports share of GDP (the variable used here to measure outward-orientation), the higher the impact of a RER undervaluation on growth. Analogously, for a negative , the higher the countries’ exports share of GDP, the lower the impact of a RER undervaluation on growth.

* 1. ***Estimation methodology and dataset***

The estimation technique employed here is the GMM-System estimator (Brundel and Bond, 1998). This estimator extends the standard Arellano and Bond (1991) GMM estimator by utilising lagged differences as instruments for equations in level and lagged levels as instrument for equations in first difference. Hence, there is no need to find exogenous regressors as instruments for the level of RER undervaluation and for the variables used to assess the heterogeneous effects.

The time series of income growth, real exchange rates, technological gap and outward orientation is taken from the Penn World Table 8.1, as well as some variables used as control such as government expenditure as a share of GDP and population growth.

There is a number of variables that can be used to explain growth. In order to enhance comparability, we decided to take into account government expenditure as a share of GDP and population growth. Neoclassical growth models use ‘government expending (%GDP)’ as a proxy for government burden. These models argue that government can be a heavy burden on the economy when they impose high taxes, promote inefficient programs, do not eliminate unnecessary bureaucracy, and distort market signals. The proxy commonly used to account for the government burden is the ratio of government current expenditures to GDP. They argue that excessive government consumption is mostly used to maintain the bureaucracy’s payroll. However, neoclassical economists, by and large, also acknowledge the importance of public investments on health, education, and security to promote growth. The ‘population’ is included as an explanatory variable that accounts for the growth of the labour force. A missing variable in our model is the ‘initial real GDP per capita’. In the empirical literature of growth this variable stands for the hypothesis of transitional dynamics. In the neoclassical growth models, a country’s growth rate depends on the initial level of the GDP. The conditional convergence hypothesis states that, other things held constant, economies that are lagging behind should grow faster than the rich countries due to the existence of diminishing returns to factors of production. This variable is often used as a proxy for the level of technological capabilities of the country. However, it is assumed in this work that the ‘technological gap’ variable already captured most of the effects that the ‘initial real GDP per capita’ could possibly account for.

This work consists of a sample of 100 countries and covers the period 1970-2010. Our estimates were done based on five-year period averages. This is a standard procedure in panel data analysis, as it reduces the effects caused by unit roots.

1. **Results**
   1. ***Baseline model***

First we estimate the long-term impact of RER undervaluation on countries’ growth rate given by the standard model with no controls, as specified by equation (5). The result suggests that, given , currency undervaluation of 10% increases countries’ long-term growth rate by 0.0179x10/100 = 0.00179 or approximately 0.18%, as presented in the first column of Table 2 below:

**Table 1 – Impact of undervaluation on growth – baseline model**

|  |  |  |  |
| --- | --- | --- | --- |
|  | (1) | (2) | (3) |
|  | 0.0820 | 0.0830 | 0.0929 |
|  | (0.0584) | (0.0631) | (0.0723) |
|  | 0.0165\*\*\* | 0.0150\*\*\* | 0.0166\*\*\* |
|  | (0.00334) | (0.00405) | (0.00400) |
|  |  | -0.0259\* | -0.0264 |
|  |  | (0.0150) | (0.0163) |
|  |  | 0.539\*\* | 0.541\*\* |
|  |  | (0.223) | (0.265) |
|  |  |  | 0.00171 |
|  |  |  | (0.00224) |
|  |  |  | 0.00769 |
|  |  |  | (0.00828) |
|  | 0.0235\*\*\* | 0.0205\*\*\* | 0.0158\* |
|  | (0.00355) | (0.00663) | (0.00833) |
| Long-term impact | 0.0180\*\*\* | 0.0164\*\*\* | 0.0179\*\*\* |
|  | (0.00334) | (0.00405) | (0.00400) |
| Observations | 1180 | 1180 | 1133 |
| Number of code | 167 | 167 | 166 |
| Hansen test | 13.64 | 17.50 | 17.31 |
| Hansen p-value | 0.0580 | 0.0144 | 0.0155 |

Standard errors in parenthesis; \*\*\*: p<0.01, \*\*: p<0.05, \*: p<0.1.

(1): no controls; (2) controlled by population growth and government expenditure as a share of GDP; (3) controlled by population growth, government expenditure as a share of GDP, technological gap and outward-orientation.

Long term impact: long-term impact of undervaluation on growth rate; calculated based on equation (4).

The second and third estimation corroborates the result obtained in the estimation with no controls. According to the second estimation, which considers government expenditures and population growth as controls, devaluation of 10% increases the long-term growth rate by 0.180 p.p. per year (to calculate this impact, as presented in equation (5), the coefficient of the impact has to be divided by 1 – 0.082, which is the autoregressive term), whilst according to the third estimation, which incorporates technological gap and outward-orientation as controls, the same undervaluation propels growth by 0.183 p.p. per year.

It is worth pointing out that the validity of the GMM estimators depends greatly on the exogeneity of the instruments used in the baseline model. The exogeneity of the instruments can be tested by the *J* statistics of the commonly used Hansen test. The null hypothesis implies the joint validity of the instruments. In other words, a rejection of the null hypothesis indicates that the instruments are not exogenous and hence the GMM estimator is not consistent. In Table 1 only the model 1 shows a Hansen test *p*-value above the standard 0.05, thus implying that the instruments used in the models 2 and 3 are not jointly valid.

These findings are in line with previous studies analysing the linear effect of undervaluation on growth, as discussed in Section 2. In other words, our estimates suggest that RER undervaluation boosts income growth.

* 1. ***Heterogeneous analysis***

Table 2 presents the results of the heterogeneous analysis for the impact of undervaluation on growth. Unlike the results from the previous subsection, herein we focus not on the absolute, positive impact of devaluation on growth itself, but on changes in the magnitude or effectiveness of expansionary devaluation as the economies climb up the ladder of technological development.

As shown in Table 2 below, in the first model (which considers only heterogeneity from technological gap), the partial effect of undervaluation on growth is positive (0.00927) and significant at the 0.10 level, whereas the coefficient of the interaction between and is not statistically significant. Further, the Hansen test *p*-value of 0.08 suggests the validity of the instruments used.

Based on equations (7) and (9) it is possible to estimate the long-term impact of a RER undervaluation on growth according to countries’ technological gap and outward-orientation. According to the first estimation, for a country with the same level of productivity of the technological leader (in this case, the U.S.), the long-term impact of undervaluation of 10% on annual growth rate is 0.113 p.p. (the coefficient , is obtained through the division of the coefficient 0.00927 by 1 – 0.182, which is the autoregressive term; in this case, the interaction effect of the GAP is null because ). However, if the productivity of the home country is only half of the productivity of the technological leader, then the impact of a 10% devaluation on growth is 0.140 p.p. rather than 0.113 p.p. as before. In this case, (), which means that the interaction term increases the devaluation impact on growth because the interaction coefficient is negative (-0.00314). This result suggests that the impact of RER undervaluation is greater for low-productivity countries. Nevertheless, this result is not significant at the 0.10 level, and hence one cannot conclude it from the first estimation.

**Table 2 – Impact of undervaluation on growth – baseline model**

|  |  |  |  |
| --- | --- | --- | --- |
|  | (1) | (2) | (3) |
|  | 0.182\* | 0.149 | 0.177\* |
|  | (0.0950) | (0.173) | (0.0956) |
|  | 0.00927\* | 0.0168\*\*\* | -0.00144 |
|  | (0.00547) | (0.00496) | (0.00642) |
|  | -0.00314 |  | -0.00622\*\* |
|  | (0.00260) |  | (0.00289) |
|  |  | -0.0298 | 0.0378\*\* |
|  |  | (0.0244) | (0.0164) |
|  | -0.0319\* | -0.0321\* | -0.0308\* |
|  | (0.0172) | (0.0180) | (0.0171) |
|  | 0.460\*\*\* | 0.713\* | 0.402\*\*\* |
|  | (0.150) | (0.391) | (0.151) |
|  | 0.00124 | 0.00255 | 0.00128 |
|  | (0.00203) | (0.00363) | (0.00209) |
|  | 0.00937 | 0.0118 | 0.00523 |
|  | (0.00634) | (0.00841) | (0.00698) |
|  | 0.0297\*\*\* | 0.0163 | 0.0311\*\*\* |
|  | (0.00552) | (0.0110) | (0.00573) |
| Observations | 785 | 1061 | 785 |
| Number of code | 100 | 142 | 100 |
| Hansen test | 12,58 | 13,36 | 12,07 |
| Hansen p-value | 0.0831 | 0.0639 | 0.0982 |

Standard errors in parenthesis; \*\*\*: p<0.01, \*\*: p<0.05, \*: p<0.1.

(1): heterogeneity only from technological gap; (2) heterogeneity only from outward-orientation; (3) heterogeneity from technological gap and outward-orientation.

The second model (which takes into account only heterogeneity from outward-orientation) also identifies a positive relationship between devaluation and growth. Like the first model, the variable of interest, that is, the interaction between and is not significant at the 0.10 level. Therefore, by the models 1 and 2 in Table 2, it is not possible to conclude that structural differences, such as technological gap and degree of outward-orientation, are relevant to explain difference in the impact of undervaluation on growth. In other words, it cannot be said that the effectiveness of expansionary devaluation varies across countries according to either differences in their stage of technological development or with differences in their degree of outward orientation separately.

However, the third model (which considers heterogeneity from technological gap and outward-orientation simultaneously) shows that the impact of devaluation on growth is jointly determined by both variables and . As shown in Table 2, the coefficient of the interaction between undervaluation and technological gap is significantly different from zero at the 0.05 level, as well as the coefficient of interaction between undervaluation and outward-orientation. It is worth noting that, in model 3, the partial effect of becomes statistically non-significant following the inclusion of both interactions and , thus indicating that the relative level of technological capabilities coupled with the degree of outward-orientation are powerful determinants of the magnitude of the impact of devaluation on growth.

Figures 1 and 2 present the partial effect of RER undervaluation on growth per period according to countries’ technological gap and degree of outward-orientation. By equation (9), we have:

**Figure 1 – Impact of undervaluation on annual growth according to outward-orientation (in p.p.)**

|  |  |  |
| --- | --- | --- |
| Impact if GAP=0.2 | Impact if GAP=0.5 | Impact if GAP=1.0 |

**Source:** authors’ elaboration.

**Note:** The continuous line indicates the long-term impact estimated through equation (8); the dash line indicates the 5% confidence interval.

Figure 1 shows that, for a given level of the technological gap, the higher is the degree of outward-orientation, the higher is the impact of undervaluation on countries’ annual growth rates. For a country that the productivity is half of the U.S. productivity, if the degree of outward-orientation is 20%, the impact of an RER undervaluation of 100% on income growth rate is 1.25 p.p. per year. However, if the degree of outward orientation is 50%, the impact of the same currency undervaluation will be 2.64 p.p., which indicates that the benefit of undervaluation is higher for open economies than for closed economies.

Similar results are found for the technological gap. As can be seen from Figure 2, the lower the productivity relative to the U.S., the stronger the impact of a currency undervaluation. For a country that exports 30% of its GDP (degree of outward-orientation is equal to 30%), if its productivity is 40% of the U.S., a devaluation of 100% increases growth by 1.90 p.p.. However, if its productivity is equal to the U.S. (GAP=1), the impact of the same undervaluation will be 1.20 p.p., thus indicating that the higher the countries’ productivity, the weaker the expansionary devaluation.

**Figure 2 – Impact of undervaluation on annual growth according to technological gap (in p.p.)**

|  |  |  |
| --- | --- | --- |
| Impact if OUT=10% | Impact if OUT=30% | Impact if OUT=50% |

**Note:** Continuous lines indicate the long-term impact estimated through equation (8); dash lines indicate the 5% confidence interval.

In light of our findings, we suggest a brief alternative explanation for the relationship between the effectiveness of currency devaluation and the stages of economic development. As aforementioned, Rodrik (2008) states that expansionary devaluation is usually observed in developing countries because the existence of bad institutions and market failures affect disproportionately the tradables sector in relation to the non-tradables in these countries and hence devaluation acts as a second-best solution to promote growth, since higher real exchange rate increases profitability of tradables relative to non-tradables. This argument only makes sense due to the underlying assumption that only free-market competition would be able to create the conditions for fast economic growth. Alternatively, from a Kaldorian standpoint the growth rate of a given region or country is based on its sectoral composition. Along the course of economic development, countries present distinct sectoral compositions, i.e., the share of primary sector, manufacturing and services in the economy varies across countries. As the economies move forward in the dynamical process of economic and technological development, the share of agriculture in the value added falls whilst the share of manufacturing increases. In the case of the so-called middle-income countries, for instance, the transition from a reasonably diversified production structure to a mature economy is known as ‘industrialisation’. In this vein, the impact of expansionary devaluation on exports and output growth tends to be much more effective in low- and middle-income countries since the share of the manufacturing sector and high-technology sectors are lower than the share of the same sector in high-income economies. Ergo, in the first stages of the economic development, the competition of domestic products in foreign markets takes place mostly through price mechanisms instead of cutting-edge products and processes, as in developed economies. In other words, since price competition seems to be a more prominent aspect of developing economies in foreign trade, as opposed to non-price competition which is more commonly observed trade pattern in developed countries, currency devaluation (or lower unit labour costs through wage cuts) tends to be a powerful growth-enhancing policy tool in an economy with excess capacity.

1. **Concluding remarks**

This paper supplements the existing literature on RER misalignments and growth by conducting an empirical work that aims at analysing the effectiveness of expansionary devaluation at different stages of economic and technological development. In order to accomplish this task, it is used heterogeneous regressions. This econometric technique adds to the previous econometric models as it allows us to assess possible differences in the magnitude of the impact of devaluation on growth subject to the degree of economic and technological development. Our estimates show that both the level of the technological gap and the degree of outward-orientation simultaneously determine cross-country differences in the effectiveness of devaluation as a macroeconomic policy tool.

Lastly, we provide an alternative explanation to Rodrik’s argument concerning the different impact of currency devaluation for developed and developing countries. The later states that the tradables sector is a special sector for economic growth and that bad institutions and market failures affect disproportionately this sector in developing countries; in this scenario, currency devaluation raises tradables profitability and propels economic growth. Alternatively, inspired by the Kaldorian tradition, the present work argues that the impact of expansionary devaluation on exports and output growth tends to be much more effective in low- and middle-income countries since the share of the manufacturing sector and high-technology sectors are lower than the share of the same sector in high-income economies. It is argued that, in the first stages of the economic development, the competition of domestic products in foreign markets takes place mostly through price mechanisms instead of cutting-edge products and processes, as in developed economies. However, this work only suggests an alternative explanation to Rodrik’s argument and provides recommendation and guidelines to future research needed by policymakers.

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1. See Agung (2014:278-285) for a detailed presentation of this method and prior applications. Woodridge (2002:170-171) presents an example of this method for a panel data model. [↑](#footnote-ref-1)