The Growth and Exchange Rate Nexus: The Role of Global Value Chains*

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ABSTRACT

Despite a general belief that competitive currencies or real exchange rate undervaluation have a positive impact on growth, recent research shows that the magnitude of the growth impact of competitive currencies is not the same for all countries. A group of peripheral countries has transformed its export patterns since its integration into global value chains (GVCs) in the 1980s. GVCs imply a production process split between several firms and countries. Many peripheral countries with a high integration into GVCs tend to present high backward-GVC participation. This means that imported inputs account for a great share of the country's exports. This paper addresses thus the question of whether different levels of backward participation in GVCs moderate the nexus between growth and competitive currencies within peripheral countries. The paper argues that for the case of peripheral countries with high backward participation in GVCs, the growth impact of real exchange rate undervaluation will be lower. This is the case because higher backward-GVC participation implies less domestic value added in a country's export and, therefore, the competitiveness boost of exchange rate undervaluation impacts a lower share of domestic value added. Panel data regressions with annual data from up to 94 peripheral countries between 1950 and 2017 back the paper's argument.

KEYWORDS: competitive exchange rate, economic growth, global value chains, new developmentalism, peripheral countries.

JEL Classification: F31, F43, O11; O14.

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1. Introduction

New developmentalism, a development macroeconomics literature that emerged mostly in Argentina and Brazil in the beginning of the 2000s, underscores the importance of a competitive exchange rate as a growth-driving factor (L. C. Bresser-Pereira 2020). This literature underscores two transmission channels explaining the growth impact of competitive exchange rates. The first and most general argument of this literature is that the profitability of modern tradable sectors, be it manufacturing sectors, but also knowledge intensive tradable service and agricultural sectors, is highly sensible to the level of the real exchange rate (RER). Given that modern tradable sectors present increasing returns to scale, promoting investment in these sectors by keeping a competitive RER should increase growth rates (Frenkel and Rapetti 2015, 84).

The second argument laid out by the new developmentalist literature focuses on the post-1980 period, which witnessed severe trade and financial liberalization, especially in Latin America. Here authors like Bresser-Pereira (2002, 84) argue that a competitive exchange rate will avoid a "growth cum foreign savings strategy", which hurts long-term growth because reliance on foreign savings crowds-out domestic savings and is at the origin of currency overvaluation and balance of payment crises. Therefore, according to New Developmentalism, the disappointing growth performance in many peripheral countries is related to non-competitive, or overvalued, RER caused by specialization in natural resources (Dutch disease) or by capital account liberalization (Oreiro 2020)[2].

Within the new developmentalist literature, Rapetti, Skott and Razmi (2012) report a

[2] For a recent survey of the new developmentalist literature see Rapetti (2020). The term „new developmentalism" is mostly used by Brazilian authors while Argentinean authors refer to a „stable and competitive" RER development strategy. Authors from other countries refrain from using any of the aforementioned terms.

significant growth impact of competitive exchange rates in central and peripheral countries, although not for the case of semi-peripheral countries, which are at an intermediate level of development. The lack of significance of the competitive exchange rate's growth impact in semi-peripheral countries surprises the authors, who label this result as "both a theoretical and empirical puzzle" (Rapetti, Skott, and Razmi 2012, 14). Márquez-Velázquez (2016) argues that the inability to identify a growth impact of competitive exchange rates at intermediate development levels is related to the fact that not all countries within this development level exhibit the same level of economic complexity or national technological capabilities. Moreover, some studies have pointed out to the relevance of competitive exchange rates for growth in individual semi-peripheral countries[3]. However, a recent strand of the literature remains sceptical to the universal, positive growth impact of devaluations and competitive exchange rates for the case of (semi-)peripheral countries (e.g. de Medeiros 2020; Fiorito, Guaita, and Guaita 2015; Amico and Fiorito 2017; Ribeiro, McCombie, and Lima 2020).

This paper advances the literature by considering how global value chains (CVCs) can moderate the growth–exchange rate nexus. In his seminal contribution to the GVC literature, Gereffi (1999, 38) defines a value chain as "the whole range of activities involved in the design, production, and marketing of a product"[4]. The expansion of GVCs to include the Global South since the mid-1980s (Baldwin and Lopez-Gonzalez 2015, 1682) made obsolete the structuralist notion of an industrialized center and a natural resource specialized periphery. There are two types of GVC participation: backward and forward participation (Fernandes, Kee, and Winkler 2020, 4). A high backward participation means that the imported content of a country's total exports is high (e.g., the Slovak Republic with its exported cars). A high forward participation means a high share of domestic value added in the partner countries' exports (e.g., the share

[3] For Brazil see Alencar, Jayme and Britto (2020). For Mexico see Loría (2016).
[4] Gereffi (1999) actually uses the term global commodity chain. However, in the year 2000 he and other authors within the literature decided to adopt the term GVCs (Humphrey and Schmitz 2002, 1026).

of Saudi Arabia's exported oil in the exports of the countries that import its oil).

The argument advanced in this paper is that high backward participation in GVCs will reduce the impact that a competitive exchange rate will have on growth. Peripheral and semi-peripheral countries with high backward participation in GVCs, i.e., with a high share of imported inputs in their exports, might not benefit that much in terms of growth from competitive exchange rates (e.g., Mexico[5]). Therefore, the strong positive relationship expected by New Developmentalism between growth and competitive exchange rates will not hold for these countries[6].

In this paper, I apply estimation techniques common in the literature stemming out of Rodrik's (2008) seminal contribution measuring the impact of RER undervaluation (RERU) on growth, but with a more recent version of the Penn World Table (PWT) (Feenstra, Inklaar, and Timmer 2015) and only for the case of peripheral countries. The sample comprises data for 94 countries during the 1950–2017 period. Omitting centers acknowledges Schröder's (2013, 147) critique to the new developmentalist literature that tends to ignore differences in "surplus labor" between centers and peripheral countries when estimating a Balassa-Samuelson based measure of RERU. Unfortunately, data on GVC-backward integration or vertical specialization is only available since the 1990s (Lenzen et al. 2012; 2013). Therefore, by showing how the impact of RERU on growth varies depending on which World Bank region a country is in, I argue that this is due to different levels of backward-GVC integration across regions. I repeat the exercise dividing the sample in periods before (up to 1985) and after (from 1986) the Global South's backward integration into GVCs. The results obtained remain in line with the paper's hypothesis. Section 2 presents the literature on GVC, development

[5] See Ibarra and Blecker (2016) and Goda and Priewe (2020).

[6] This paper ignores the case of peripheral countries with high forward GVC participation. These are countries mainly exporting raw materials for further processing in central countries. The developmental implications of such trade pattern have been analyzed in depth within the structuralist and resource curse literature. See for instance the literature surveys of Di John (2011) and Van der Ploeg (2011).

and exchange rates, Section 3 the method and data, Section 4 the results and the last section concludes the paper.

2. Global Value Chains, Development, and the Exchange Rate

The origins of GVCs can be traced back to Europe's colonial expansion in the 16th century according to the world-systems literature, with the integration of the Global South via raw materials to the world market (Hopkins and Wallerstein 1977, 128). However, the phenomenon of interest for this paper, backward-GVC participation in the Global South with inputs sourced from the Global North, started to have a significant magnitude in the 1980s (Baldwin and Lopez-Gonzalez 2015). A series of factors allowed for this transition, both technological and in the realm of political economy. These include the continuous reduction of overseas transportation and communication costs and the liberalization wave that took place during the 1980s because of the Latin American debt crisis, the implementation of the Washington Consensus and the opening of the Chinese economy. Moreover, increasing backward-GVC participation seems to be a process concentrated in the Global South. In this sense, Lopez-Gonzalez (2012, 22) finds evidence of an inverted-U relationship between backward-GVC participation and development level, with backward-GVC integration rising from low- to middle-levels of GDP per capita and decreasing afterwards.

Within the GVC literature there is some evidence on the relationship between backward-GVC participation and the exchange rate. For instance, there are studies on how backward-GVC participation affects the elasticity of manufactured exports. Ahmed, Appendino and Ruta (2016, 17) show that during 1996–2012 for 46 countries RER elasticity of manufactured exports declined 20% due to backward-GVC participation. Moreover, the degree of intensity of backward-GVC participation is negatively associated with the RER elasticity of manufactured exports. The basic intuition explaining this result is that the higher the foreign value added in a country's gross exports, the more depreciations can be equated with raising production costs and the less they can be related to increased competitiveness of the exported domestic value added. I argue in this paper that what follows is a weakened trade transmission mechanism driving the growth and RER nexus.

There is a debate on whether GVC participation always promotes long-term growth in low- and middle-income countries. Rodrik (2018) argues that in general GVCs might not be conducive to long-term growth because they do not provide employment opportunities for low-skilled labor, which is abundant in the Global South. On the other hand, Baldwin and Lopez-Gonzalez (2015) attribute the declining share of the G7 countries' GDP world share to GVCs. In this paper, I am interested on how backward GVC participation affects one of the two transmission channels of the RER and growth nexus, i.e., the tradable sector channel.

I believe that the high-backward integration of some (semi-)peripheral countries indeed represents a revolution for their industrialization process, allowing for historically unheard of rapid increases in their industrial activity. Therefore, it is to be expected that traditional growth enhancing mechanisms, including the tradable sector transmission channel of the RER, might be affected for these countries. However, global scale production is less globalized than one may think. The share of imported intermediates in worldwide production was in 2009 only eight percent (Baldwin and Lopez-Gonzalez 2015, 1692). Therefore, a development strategy relying on a competitive exchange rate should still work for most peripheral countries that are not located in regions where backward-GVC participation is more common.

Moreover, successful backward-GVC participation of some (semi-)peripheral countries does however pose a challenge to the development perspectives of the remainder peer countries. Baldwin and Lopez-Gonzalez (2015, 1700) argue that natural resource (semi-)peripheral countries that have not joined GVCs also benefit from the increased backward-GVC integration of some of their peers, because of the rising demand and prices of primary goods. Taken at its face value, the claim ignores the lessons of the resource curse literature, where it has been shown that the degree upon which natural resource rich countries can benefit from price booms is contingent on the quality of their institutions (Robinson, Torvik, and Verdier 2006).

Moreover, the most recent commodities' super cycle that begins in the early 2000s ends in the first half of the 2010s, and coincides with a slowdown of the Chinese economy (Erten and Ocampo 2021, 2), a major player in GCVs. In particular, Timmer et al. (2021) report a slowdown in the expansion of GVCs in the electronics and apparel sectors since the 2008 global financial crisis. Therefore, the positive impact of GVC on demand and prices of raw materials seem to have stopped since the mid-2010s, and this has left natural resource rich peripheral countries that did not integrate into GVC with weaker manufacturing sectors within a period of lower prices of their main export goods. Therefore, backward-GVC integration of a minority of (semi-)peripheral countries rather challenges the development perspectives of their peer countries.

3. Method and data

3.1. Data and descriptive statistics

All but two variables come from the version 9.1 of the PWT (Feenstra, Inklaar, and Timmer 2015). The economic complexity index (ECI), a variable used as a proxy of the economic complexity of countries, is taken from Simoes and Hidalgo (2011). According to Hidalgo and Hausmann (2009), the complexity of the economic structure is a major growth driver. This complexity is related to a series of non-tradable capabilities or inputs (e.g., tacit knowledge, and regulations) necessary to produce specific products or services. Higher levels of economic complexity will imply a larger variety of capabilities and their more complex recombination (Hidalgo and Hausmann 2009). To measure backward-GVC integration, I generated a variable called vertical specialization, which is the share of foreign value added in a country's gross exports. The variable was first proposed by Hummels, Ishii and Yi (2001) and the data on foreign value added and gross exports to calculate vertical specialization was taken from the UNCTAD-Eora Global Value Chain database (Lenzen et al. 2012; 2013).

The sample includes 94 peripheral countries[7]. This implies that the countries that remain in the sample present some level of surplus labor, a common characteristic among peripheral countries[8]. Moreover, excluding centers controls for the fact that in years of crises, the impact of flight to quality has a similar sign for all the countries in the sample[9]. Furthermore, the inclusion criteria for countries in the sample followed Simoes and Hidalgo (2011) in the sense that countries with a population under one million inhabitants or with exports below one billion USD are excluded. Moreover, countries with bad quality data according to Hausmann et al. (2013, 69), including Chad, Iraq and Macau are excluded from the sample. Also, countries with extreme RERU values were taken out of the sample[10]. Given that the method applied in this paper considers all countries equally, countries that are either too small, have data quality issues or are extreme outliers may bias the results.

The data frequency in the three databases that are used in the paper is yearly. However, following the RER and growth literature, I aggregated the data into multi-year periods. I used four-year periods, to make use of most of the available data points. This aggregation of the data is due to the interest of the literature on the mid-term impact of RERU on growth. The PWT 9.1. has data for the period 1950–2017, data on the ECI is available for the period 1964–2017, while data to calculate vertical specialization was only available between 1990 and 2018. Table I presents a description of the main variables used in this paper.

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[7] This means that I excluded the following centers: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Switzerland, Spain, Sweden, United Kingdom, and the United States. These are the countries that belonged to the OECD in 1987 and where classified by the World Bank as high-income in 1987, the first year this institution made such country classification (The World Bank n.d.; Organisation for Economic Co-operation and Development n.d.).

[8] This has implications for the estimation of the Balassa-Samuelson effect.

[9] Idem.

[10] These countries include: Algeria, Bosnia and Herzegovina, Cambodia, Mexico, Liberia, Serbia, Sudan, Trinidad and Tobago and United Arab Emirates. The list of 94 countries finally retained for the analysis is available in Appendix 1.

Table I. Data definition of relevant variables

Variable	Description
Real GDP per capita growth	Compound annual growth rate (within four-year periods) computed using GDP per capita obtained from dividing the variable "output-side real GDP at chained PPPs (rgdpo, in millions of 2011 US$)" by population (pop, in millions) from the PWT 9.1 (Feenstra, Inklaar, and Timmer 2015). $GROWTH = \sqrt[3]{(RGPC_{t+3}/RGPC_t)} - 1$
Real exchange rate	I used the inverse of the PWT variable pl_gdpo as the real exchange rate measure. pl_gdpo is the price level of the output-side real GDP (CGDPo) at current purchasing power parity (PPP), with the price level of US' CGDPo in 2011 equal to one. Therefore, the variable is the price level of countries in comparison to the US in 2011.
Real GDP per capita	I divided the variable "output-side real GDP at chained PPPs (rgdpo, in millions of 2011 US$)" by population (pop, in millions) from the PWT 9.1 (Feenstra, Inklaar, and Timmer 2015) to obtain the real GDP per capita of countries.
Initial real GDP per capita	Real GDP per capita in the first year of each four-year period, i.e., the usual converge term in growth regressions.
RERU	The idiosyncratic error term $\varepsilon_{i,t}$ in Equation 1: $\ln RER_{i,t} = \beta_0 + \beta_1 \ln RGDPC_{i,t} + y_t + \varepsilon_{i,t}$
ECI	Measure of the relative knowledge intensity within a country (Simoes and Hidalgo 2011).
Human capital index.	A measure of a country's human capital based on years of schooling and assumed returns to years of schooling (Feenstra, Inklaar, and Timmer 2015).
Vertical specialization	The share of foreign value added in gross exports. Data taken from the UNCTAD-Eora Global Value Chain database (Lenzen et al. 2012; 2013).

Note: all the variables available in the PWT 9.1 database for the 118 countries for which ECI data is available in Simoes and Hidalgo (2011) were used when applying Honaker and King's (2010) multiple imputation algorithm.

Given the fact that non-random missing data might bias the results, I followed Honaker and King's (2010) multiple imputation model to address the issue of data missingness. This is a superior approach to simply averaging the variables of interest over a period of years to reduce data missingness, which is commonly done in the RER and growth literature. The several limitations of this approach include the fact that it causes the new averaged dependent variable to lose variability (Honaker and King 2010, 562). The multiple imputation approach to deal with missing data involves filling the holes in the data set with values generated by a statistical model that uses as input the actual data of the dependent and independent variables, as well as the prior knowledge of the researcher (Honaker and King 2010, 563)[11].

The basic assumption of the statistic model used to impute the missing data is that both the observed and non-observed data follow a multivariate distribution and, therefore, all variables are linear combinations of the others. The imputation process is repeated five times and then the expected value for each imputed quantity of interest is the average of the five imputations (Honaker and King 2010, 564). The imputed values in each of these five data sets will vary depending on the uncertainty related to their prediction (Honaker and King 2010, 561). I use a software developed by Honaker et al. (2011) to implement this approach.

Table 2 presents the mean and standard errors of the variables used in the panel regressions. The mean compound annual growth rate of real GDP per capita is almost 4%. The mean RER amounts to a price level of real GDP four times lower than that of the US in 2011. This is about the same mean RER that a semi-peripheral country as Chile has within the sample. The mean real GDP per capita is little more than 7,600 USD of 2011. Using Chile as a comparison again, this value that about 20% lower than Chile's mean. The mean initial real GDP per capita is somewhat lower than the mean real GDP per capita, which is to be expected in a sample with mean positive growth values.

[11] Given the limited time period for which the variables used to calculate vertical specialization was available (1990–2018), and the fact that I only use this variable for the robustness check of the main results, I did not take into consideration these variables when performing the multiple imputation algorithm.

Table 2. Summary statistics (n = 1,598)

Variables	Mean (Standard error)
Real GDP per capita growth (compound annual growth rate, %)	3.853 (0.514)
Real exchange rate (US in 2011=1. The greater the value, the more depreciated the currency is).	4.2 (0.093)
Real GDP per capita (2011 USD)	7,631.53 (271.92)
Initial real GDP per capita (2011 USD)	7,358.21 (277.73)
RERU (0 stands for no misalignment, positive values for undervaluation)	0.045 (0.018)
ECI (higher values mean higher complexity)	-0.086 (0.009)
Human capital index (higher values mean higher levels of human capital)	2.13 (0.019)
Vertical specialization (% of gross trade)[a]	21.016 (0.573)

Source: own calculation. [a] Sample only includes 86 countries during the 1994-2017 period. Therefore, for vertical specialization n=516.

The mean RERU was slightly above zero, meaning a small average RERU. As a comparison, China's mean value is much higher (0.635). The mean ECI is slightly negative, pointing to a rather low average economic complexity within the sample. As a comparison, China's mean ECI within the sample is 0.335. Furthermore, the sample's mean human capital of little more than 2 is about 17% higher than China's mean. Last yet not least, the mean vertical specialization within a reduced sample of countries (86)[12] and years (1994-2017) is little more than 21 %. As a comparison, an oil exporting country such as Saudi Arabia has a much lower mean (little more than 13%), while Singapore, one of the two Asian Tiger city states has a much higher one, almost 65%.

Table 3 presents balance tests to see whether mean growth and the means of explanatory and control variables differ among regions of the Global South with different backward-GVC integration levels. The table depicts the case of the peripheral countries of the World Bank region "Europe and Central Asia" and all the countries of the "Middle East and North Africa" region. The former is the region with the highest backward-GVC integration during the 1994-2017 period, with a vertical specialization mean of 31.31%, while the latter is the second to last region with the lowest integration, with a vertical specialization mean of 15.793%. These means differ at all statistical levels, as shown in Table 3.

Although the region with the lowest GVC-backward integration during this period is South Asia, Table 3 presents the Middle East and North Africa (MENA) because it has more countries (14 vs. 4)[13]. The last column of Table 3 shows that although the RER mean for Europe and Central Asia was significantly more overvalued than that of the MENA (greater negative value of RERU), the growth means of the two regions were equivalent in statistical terms. Therefore, panel growth regressions might help elucidate whether the different level of

[12] Due to data limitations I could not compute vertical specialization for: Belarus, Congo, Ethiopia, Guinea, Republic of Moldova, Serbia, Yemen and Zimbabwe.

[13] Comparing the vertical specialization regional means after dividing the period for which data is available into an earlier 1994-2005 and a later 2006-2017 period reveals the following. All regional vertical specialization means increase in the later period, although the change is not statistically significant for the cases of the East Asia and Pacific and Middle East and North Africa regions. Moreover, the regional ranking remains almost unchanged with the three regions with the highest vertical specialization mean not changing positions, i.e. Europe and Central Asia, East Asia and Pacific and Latin America and the Caribbean. The region with the lowest vertical specialization mean is in both periods South Asia. However, there is a change in the second to last position. During the 1994-2005 period this position was occupied by Sub-Saharan Africa, while during the 2006-2017 period the region with the second to last lowest vs mean is the Middle East and North Africa.

backward-GVC integration of the two regions changes the expected impacts of the treatment variable (RERU) on growth.

Table 3. Balance tests between Europe and Central Asia and the Middle East and North Africa regions, 1950–2017

Variables	Mean (Standard error)		Test of difference
	Europe and Central Asia (n=357)	Middle East and North Africa (n=238)	
Real GDP per capita growth (compound annual growth rate, %)	6.634 (1.639)	3.702 (1.276)	
Real exchange rate (US in 2011=1)	2.659 (0.136)	3.477 (0.2123594)	***
Real GDP per capita (2011 USD)	11,160.65 (353.38)	14,286.93 (1,414.11)	***
Initial real GDP per capita (2011 USD)	10,580.66 (435.32)	13,996.84 (1,434.26)	***
RERU (0 stands for no misalignment, positive values for undervaluation)	-0.314 (0.045)	-0.016 (0.049)	***
ECI (higher values mean higher complexity)	0.245 (0.017)	-0.143 (0.021)	***
Human capital index (higher values mean higher levels of human capital)	3.008 (0.033)	2.034 (0.042)	***
Vertical specialization (% of gross trade)[a]	31.31 (1.163)	15.793 (1.172)	***

Source: own calculation. [a] Sample only includes the 1994-2017 period. Therefore, for vertical specialization in Europe and Central Asia n=108 and for the Middle East and North Africa n=78.

One can nevertheless argue that given that the backward-GVC integration of the Global South started to attain important trade volumes in the 1980s it makes little sense to compare the variables of interest of the two regions during the sampled period (1950–2017) based on the different average GVC backward-integration of the regions during the 1994–2017 period. Therefore, Table 4 compares the means of the dependent, treatment and control variables within a single region for the periods 1950–1985 and 1986–2017. The region presented in Table 4 is comprised by the peripheral countries belonging to the World Bank's "East Asia and Pacific" region, the second region with the highest mean vertical specialization during the 1994–2017 period.

The region's vertical specialization mean was equal to almost 29%, without significant changes between the 1994–2005 and 2006–2017 periods, as Table 4 shows. In the table's last column one can see that there was no statistical difference of growth and RERU between the 1950–1985 and 1986–2017 periods. Moreover, variables with statistically different means included the typical controls of growth regressions (initial real GDP per capita, human capital), RER and real GDP per capita. Here again, panel growth regressions for the periods up to 1985 and thereafter might help elucidate whether the different level of backward-GVC integration within a region changes the expected impacts of the treatment and control variables. Table 5 compares the means of the variables of interest divided into observations related to vertical specialization values greater or equal to the mean during 1994–2017 (21.016%) and values lower than it. The table shows that growth and RERU between the two groups of observations are equivalent in statistical terms. Moreover, the vertical specialization means are significantly different, as expected.

Table 4. Balance tests between the East Asia and Pacific region after 1985 and before 1986

Variables	Mean (Standard error)		Test of difference
	East Asia and Pacific (1950–1985) (n=117)	East Asia and Pacific (1986–2017) (n=104)	
Real GDP per capita growth (compound annual growth rate, %)	3.316 (2.321)	4.834 (0.458)	
Real exchange rate (US in 2011=1)	6.463 (0.571)	3.525 (0.192)	***
Real GDP per capita (2011 USD)	3,427.82 (316.15)	11,684.22 (1,363.40)	***
Initial real GDP per capita (2011 USD)	3,448.52 (357.77)	11,038.04 (1,333.50)	***
RERU (0 stands for no misalignment, positive values for undervaluation)	0.177 (0.081)	0.184 (0.031)	
ECI (higher values mean higher complexity)	0.008 (0.034)	0.024 (0.044)	
Human capital index (higher values mean higher levels of human capital)	1.901 (0.051)	2.316 (0.054)	***
Vertical specialization (% of gross trade)[a]	28.844 (2.9)	28.936 (2.989)	

Source: own calculation. [a] Sample only includes the 1994–2017 period. Therefore, the two periods compared were 1994–2005 (n=39) and 2006–2017 (n=39).

Table 5. Balance tests between observations with vertical specialization above and below the mean (1994–2017)

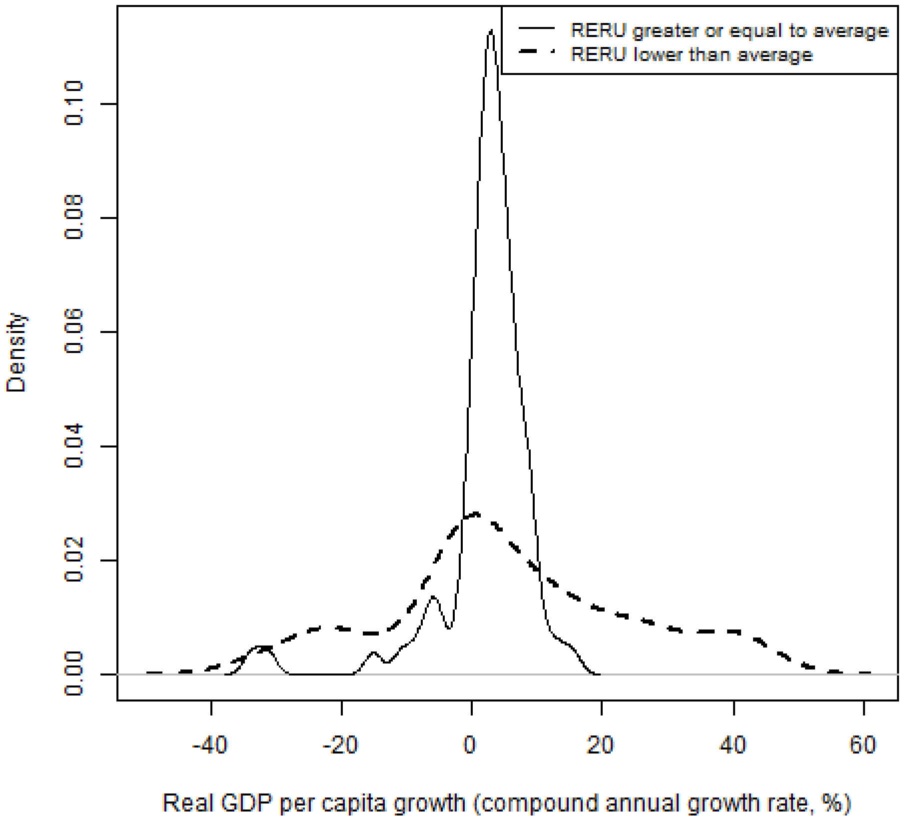
Variables	Mean (Standard error)		Test of difference
	Vertical specialization lower than the mean (n=304)	Vertical specialization greater or equal to the mean (n=212)	
Real GDP per capita growth (compound annual growth rate, %)	3.663 (0.341)	3.630 (0.288)	
Real exchange rate (US in 2011=1)	2.947 (0.068)	2.424 (0.085)	***
Real GDP per capita (2011 USD)	9,050.16 (919.31)	14,841.71 (722.45)	***
Initial real GDP per capita (2011 USD)	8,586.50 (893.96)	14,119.26 (708.76)	***
RERU (0 stands for no misalignment, positive values for undervaluation)	0.007 (0.02)	0.001 (0.022)	
ECI (higher values mean higher complexity)	-0.307 (0.018)	0.066 (0.027)	***
Human capital index (higher values mean higher levels of human capital)	2.149 (0.031)	2.776 (0.036)	***
Vertical specialization (% of gross trade)	12.167 (0.266)	33.704 (0.716)	***

Source: own calculation.

Before comenting the real exchange rate estimation, I plot kernel estimate densities of growth in the East Asia and Pacific region for growth values related to greater than or equal to the sample's average RERU (0.045) values and to RERU values lower than the sample's mean. Figure 1 uses data from the 1950–1985 perriod and Figure 2 from 1986–2017. In the former period, the vast majority of the growth values associated with high RERU fall into the

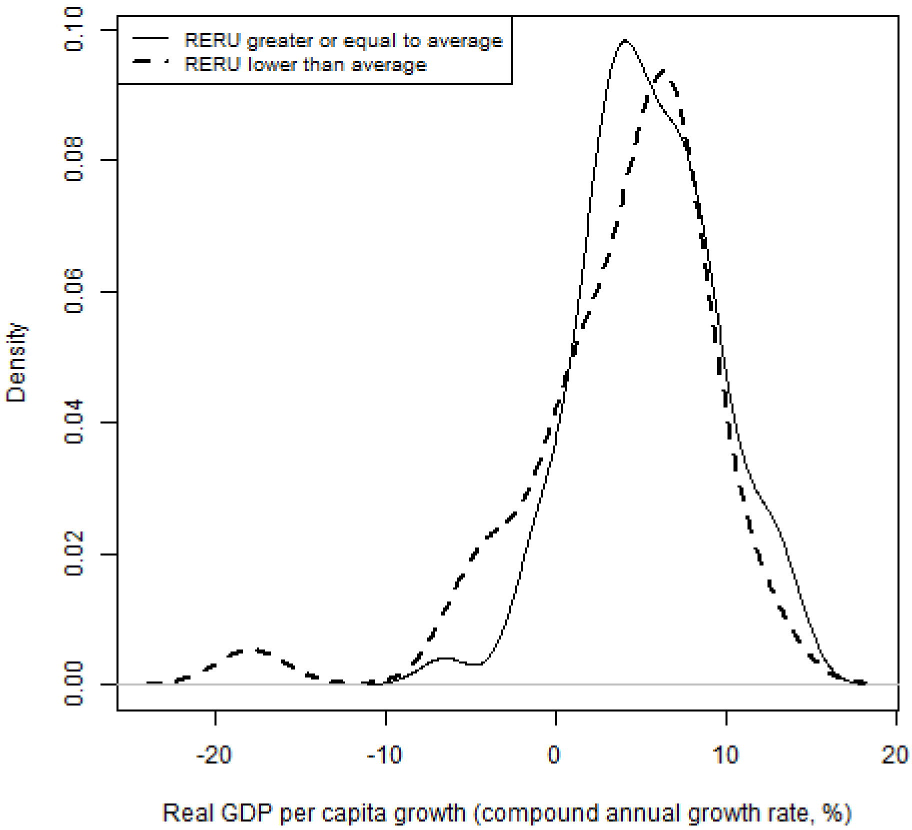
0–20% compound annual growth rate. Growth values associated with low RERU values are much more dispersed. In Figure 2, the depicted kernel density estimates are much more similar. This is evidence pointing towards the idea that RERU has less influence on growth within a period of higher GVC-backward integration.

Figure 1. Kernel density estimates of growth in the East Asia and Pacific region (1950–1985)



Source: own calculation.

Figure 2. Kernel density estimates of growth in the East Asia and Pacific region (1986–2017)



Source: own calculation.

3.2. Real exchange rate undervaluation's estimation

The dependent variable used in the empirical model to obtain the RERU estimations is a measure of a country's RER. The only explanatory variable to estimate RERU levels in countries is GDP per capita, following Rodrik (2008). As the author explains, according to the Balassa-Samuelson effect one should expect that, *ceteris paribus*, increases in GDP per capita should appreciate the equilibrium RER in a country. Following Rodrik's (2008, 371) approach, I generate a RERU measure equal to the residuals of a model of the RER following a PPP rule adjusted by the Balassa-Samuelson effect. Therefore, I estimate the following model:

$$\ln RER_{i,t} = \beta_0 + \beta_1 \ln RGDPC_{i,t} + y_t + \varepsilon_{i,t} \qquad (1)$$

in which $\ln RER_{i,t}$ stands for the annual average of the natural log of country *i*'s *RER* in the four-year period *t*, $\ln RGDPC_{i,t}$ is the annual average of the natural log of its respective GDP per capita, y_t the fixed effect for the four-year period t and $\varepsilon_{i,t}$, an idiosyncratic error term[14]. Accordingly, the RERU measure is equal to the residual obtained when estimating Equation 1. Positive values of this residual are equivalent to RERU, since this means that the actual RER is higher than or depreciated with respect to the 'equilibrium' RER predicted by the PPP theory, corrected by the Balassa-Samuelson effect[15].

By replicating Rodrik's (2008) method, I obtain an estimate of the GDP per capita's coefficient of -0.18, which is highly significant (t-stat of -8.40). Rodrik (2008, 371) reports a coefficient with a somewhat larger magnitude (-0.24) and with a much higher significance, which may be due to the fact that his sample only covered the 1950–2004 period while my sample spans through 1950–2017, among other reasons[16]. Regressing Equation 1 with multiple imputed data, which reduces bias due to the non-random nature of missing data, the GDP per capita's coefficient that I obtain has a somewhat larger magnitude (-0.231) yet a slightly lower significance (t-stat of -6.755). According to this last result, there is statistical evidence supporting the hypothesis that, *ceteris paribus*, a 10% increase in the GDP per capita level of a country appreciates its equilibrium RER by 2.31% on average, for the 94 countries included in the sample during 1950–2017.

3.3. The growth model

The baseline model used to test the impact of RERU on growth is the following:

$$GROWTH_{i,t} = \beta_0 + \beta_1 \ln INIRGDPC_{i,t} + \beta_2 RERU_{i,t} + \beta_3 ECI_{i,t} + \beta_4 HC_{i,t} + c_i + y_t + \varepsilon_{i,t} \quad (2)$$

in which $GROWTH_{i,t}$ is defined as GDP per capita's compound annual growth rate for country *i* in a four-year period t, $\ln INIRGDPC_{i,t}$ is country *i*'s natural logarithm of its real GDP per capita in the first year of each four-year period t, i.e. the usual converge term in growth regressions, $RERU_{i,t}$ its real undervaluation measure for period t, $ECI_{i,t}$ the country's average annual economic complexity index (ECI) during the same period, $HC_{i,t}$ country *i*'s annual

[14] Although typically five-year periods have been used in the literature, I selected four-year periods to be able to use the entire dataset, i.e. the 17 four-year periods between 1950 and 2017.

[15] Several theories derive other equilibrium RER indices. Berg and Miao (2010, 11) compare indices derived from the fundamentals equilibrium exchange rate (FEER) and the PPP corrected by the Balassa-Samuelson theories and obtain a correlation of 0.96. This means that both indices behave very similarly despite the different theories from which they are derived.

[16] Rodrik groups the data into five-year periods. Moreover, Rodrik reports using "robust" t statistics, while I use panel-corrected standard errors.

average human capital index, c_i is country *i*'s fixed effect, y_t the fixed effect for period t and $\varepsilon_{i,t}$ an idiosyncratic error term. The inclusion of both country and period fixed effects in Equation 2 allows us to interpret β_2, our main coefficient of interest, as the impact that changes in RERU have on the growth rate within each country. Whenever necessary, I include a lag to the left-hand side variable to control for serial correlation (Beck and Katz 2011).

4. Results

In Table 6 the results of two growth panel regressions are presented. RERU's growth impact in Regression (1–1) (which replicates Rodrik's (2008, 375) procedure) is positive, significant and has a similar magnitude as in previous studies[17]. However, Regression (1–1) suffers from serial correlation, as can be seen from its serial correlation test's p-value. In Regression (1-2) I address the serial correlation issue by including the lagged outcome variable ($GROWTH.lag$) in the right-hand side of the regression, as recommended in Beck and Katz (2011). The magnitude of RERU's growth impact remains similar as in the previous regression, yet its significance level decreases to the 10%. Including the lagged dependent in Regression (1-2) entails estimating RERU's short- and long-run growth impacts, or its impact multiplier and long-run propensity. For the case of RERU's impact multiplier, there is weak evidence that a 10 percent RERU is accompanied by a 3.1 percentage point increase in the real GDP per capita compound annual growth rate of a four-year period, *ceteris paribus*. The long-run propensity is somewhat smaller, 3.094 percentage points. Both short- and long-term impacts of RERU on growth are large.

Let us now analyze whether the World Bank region in which a peripheral country is located affects the relationship between RERU and growth. The region of reference in Table 7 is East Asia and Pacific, which together with Europe and Central Asia were the regions with the highest backward-GVC participation during 1994–2017, as shown in Section 3.1. The table

[17] See Rapetti et al. (2012, p. 7) among others.

presents evidence in favor of the hypothesis that both the short- and long run impacts of RERU on growth for countries within these regions is not different from zero. This is not the case for all the other regions, for which RERU's impact multiplier and long-run propensity are positive and significant, except for the case of South Asia.

Table 6. Panel growth regressions for all countries during 1950–2017

Right-hand side variable	(1–1)	(1–2)
$\ln INIRGDPC_t$	-0.192*** (0.030)	-0.180*** (0.030)
$RERU$	0.039*** (0.018)	0.031* (0.017)
ECI	0.069*** (0.023)	0.058** (0.024)
HC	0.198*** (0.047)	0.186*** (0.044)
$GROWTH.lag$		-0.002 (0.079)
Observations	1,598	1,504
Adjusted R-squared	0.258	0.251
Serial correlation test (p-value)	0	0.001

Note: panel-corrected standard errors in parenthesis, *p<10%, **p<5%, ***p<1%. Breusch-Godfrey serial correlation test in 1-1 and Wooldridge serial correlation test in 1-2.

Regression 3–2 in Table 8 reruns Table 7's Regression 2–1 yet only with data during 1954–1985, a period of lower intensity of backward-GVC participation in peripheral countries. The results remain unchanged. Moreover, Table 8's Regression 3–1 provides evidence of stronger and more significant RERU short- and long-run growth impacts for the 1954–1985 period. Table 9 repeats the exercise with data for the 1986–2017 period. Regression 4–1 shows that RERU short- and long-run growth impacts for the 1986–2017 period are no longer significant for the entire sample. However, in Regression 4–2, that includes interactions between World Bank regions and RERU, it can be seen that RERU does have positive short- and long-run growth effects for the countries within the three regions with lower backward-GVC participation, i.e. the MENA, South Asia and Sub-Saharan Africa.

Table 7. Panel growth regressions with RERU and World Bank regions interactions, 1954–2017

Right-hand side variable	(2–1)
$\ln INIRGDPC_t$	-0.216*** (0.030)
$RERU$	0.026 (0.041)
$RERU\ x\ Europe\ and\ Central\ Asia$	-0.028 (0.046)
$RERU\ x\ Latin\ America\ and\ the\ Caribbean$	0.097** (0.045)
$RERU\ x\ Middle\ East\ and\ North\ Africa$	0.161*** (0.043)
$RERU\ x\ South\ Asia$	0.052 (0.088)
$RERU\ x\ Sub-Saharan\ Africa$	0.161*** (0.057)
ECI	0.053** (0.023)
HC	0.188*** (0.044)
$GROWTH.lag$	-0.006 (0.078)
Observations	1,504
Adjusted R-squared	0.306
Wooldridge's serial correlation test (p-value)	0.001

Note: panel corrected standard errors in parenthesis, *p<10%, **p<5%, ***p<1%.

Table 8. Panel growth regressions with RERU and World Bank regions interactions, 1954–1985

Right-hand side variable	(3–1)	(3–2)
$\ln INIRGDPC_t$	-0.273*** (0.039)	-0.308*** (0.035)
$RERU$	0.106*** (0.033)	-0.053 (0.070)
$RERU\ x\ Europe\ and\ Central\ Asia$		0.080 (0.066)
$RERU\ x\ Latin\ America\ and\ the\ Caribbean$		0.137** (0.069)
$RERU\ x\ Middle\ East\ and\ North\ Africa$		0.269*** (0.064)
$RERU\ x\ South\ Asia$		0.103 (0.138)
$RERU\ x\ Sub-Saharan\ Africa$		0.164** (0.069)
ECI	0.047 (0.041)	0.059 (0.037)
HC	0.283*** (0.087)	0.222** (0.089)
$GROWTH.lag$	-0.054 (0.096)	-0.006 (0.078)
Observations	752	752
Adjusted R-squared	0.395	0.441
Wooldridge's serial correlation test (p-value)	0	0.004

Note: panel corrected standard errors in parenthesis, *p<10%, **p<5%, ***p<1%.

Table 9. Panel growth regressions with RERU and World Bank regions interactions, 1986–2017

Right-hand side variable	(4–1)	(4–2)
$\ln INIRGDPC_t$	-0.149*** (0.053)	-0.181*** (0.058)
$RERU$	-0.001 (0.024)	-0.014 (0.030)
$RERU\ x\ Europe\ and\ Central\ Asia$		-0.077 (0.047)
$RERU\ x\ Latin\ America\ and\ the\ Caribbean$		0.048 (0.038)
$RERU\ x\ Middle\ East\ and\ North\ Africa$		0.101* (0.059)
$RERU\ x\ South\ Asia$		0.100* (0.059)
$RERU\ x\ Sub-Saharan\ Africa$		0.178** (0.072)
ECI	0.004 (0.027)	0.006 (0. 027)
HC	0.112 (0.100)	0.082 (0.085)
$GROWTH.lag$	0.051 (0.159)	0.029 (0.150)
Observations	752	752
Adjusted R-squared	0.263	0. 325
Wooldridge's serial correlation test (p-value)	0.019	0.005

Note: panel corrected standard errors in parenthesis, *p<10%, **p<5%, ***p<1%.

5. Conclusion

New Developmentalism holds that a competitive exchange rate is a major development determinant. A competitive exchange rate should increase the profit rate of capitalist in modern tradable sectors, the key growth sector, and thus incentivize their expansion. Nevertheless, there is no empirical consensus as to whether competitive exchange rates always have a positive impact on growth. In this paper evidence is presented on the nexus between competitive exchange rates and growth when taking into consideration differences in backward-GVC participation in peripheral countries. Moreover, empirical results presented address the presence of serial correlation and the bias generated by data missingness. Results suggest that RERU has strong growth effects in countries with lower backward-GVC participation. Nevertheless, given the small sample size of vertical specialization data, evidence to support the paper's claim was mainly collected by comparing RERU's growth impact in peripheral countries within different World Bank regions and periods. Based on the paper's results, new developmentalist theoretical predictions maintain their validity for peripheral countries outside Europe and Central Asia and East Asia and Pacific, the two regions with the highest GVC-backward participation since the 1990s.

Appendix

Appendix 1. List of countries

Albania	El Salvador	Madagascar	Senegal
Algeria	Ethiopia	Malawi	Serbia
Argentina	Gabon	Malaysia	Singapore
Bangladesh	Ghana	Mali	Slovakia
Belarus	Greece	Mauritania	South Africa
Bolivia (Plurinational State of)	Guatemala	Mauritius	Sri Lanka
Botswana	Guinea	Mongolia	Syrian Arab Republic
Brazil	Honduras	Morocco	Tajikistan
Bulgaria	Hungary	Myanmar	Thailand
Cambodia	India	Namibia	Togo
Cameroon	Indonesia	Nicaragua	Tunisia
Chile	Iran (Islamic Republic of)	Oman	Turkey
China	Israel	Pakistan	Turkmenistan
China, Hong Kong SAR	Jamaica	Panama	U.R. of Tanzania: Mainland
Colombia	Jordan	Paraguay	Uganda
Congo	Kazakhstan	Peru	Uruguay
Costa Rica	Kenya	Philippines	Uzbekistan
Côte d'Ivoire	Kuwait	Poland	Venezuela (Bolivarian Republic of)
Croatia	Kyrgyzstan	Portugal	Viet Nam
Czech Republic	Lao People's DR	Qatar	Yemen
D.R. of the Congo	Latvia	Republic of Korea	Zambia
Dominican Republic	Lebanon	Republic of Moldova	Zimbabwe
Ecuador	Liberia	Romania	
Egypt	Lithuania	Saudi Arabia	

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