The relationship between Profit Margins, Exchange Rates and Structural Change: Empirical Evidences between 2000-2014[1]

Preliminary version

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Abstract: The research seeks to understand the relationship between the profit rates and the exchange rates and how this relationship can impact the production structure. We built a theoretical model that try to explain the influence of exchange rates on profit rates and we argue that once the exchange rate overvalues, entrepreneurs aim to maintain the profit rates quite stable through the raise of imported inputs coefficients, since it reduces costs. We confirm this hypothesis by performing econometric tests, for a sample of 41 countries in the period 2000-2014, in which we estimate the significance of exchange rate misalignments to explain variations in the ratio between exports and imported inputs coefficients. The results show that this influence is positive and relevant for a set of model specifications and groups of products. Although it seems to be a rational strategy for entrepreneurs in the short term, it can imply a decrease in aggregate demand and a deindustrialization process in the medium term.

Key words: Profit-Margins, Exchange Rate, Investment, New Developmentalism, Deindustrialization, Manufacturing, Structural Change.

JEL classification: F41, F63, L16, O11, O14

Introduction

Sectors with higher profit rates are better placed to face profit-squeeze moments than sectors with lower rates. However, according to neoclassical theory, profit rates across sectors tend to converge in the long run. In this article, we argue and seek to demonstrate that the behavior of profit margins in the several sectors of an economy is quite different and we discuss the relationship between profit rates and exchange rates and how entrepreneurs react when they face a currency appreciation process, mainly when profit rates are sticker. In order to discuss these issues, we suggest a theoretical model to better understand the relationship between the profit rate, the exchange rate and production structure, since we consider that the transmission

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channel from exchange rate to investment, which seeks for the more profitable opportunities, occurs through the influence of exchange rates on profit rates.

Although the new developmentalist theory argues that the appreciation of the exchange rate reduces the profit margin, data show that this relationship not occurred in the countries included in the sample in the analyzed period. One possible explanation for this fact is the reaction of the entrepreneurs in relation to a period of exchange rate appreciation. We suggest that they increase the imported inputs share in the production process to avoid the fall of profit rates, which was not followed by an exports share increase in production – also due to the currency appreciation; this mix can deepen the deindustrialization process in some countries, especially those that have comparative advantages on natural resources, since the profit rates tend to be lower in manufacturing than in primary sectors on them. So, the relationship between profit rates and exchange rates would not be clear in the short term but in the medium term, and it would contribute for the deindustrialization process in these countries.

Section 1 presents a literature review of the relationship between the profit rate and the exchange rate. In section 2 we present our theoretical model of this relationship and the role of imported inputs and exports coefficients in the profit rate determination. Section 3 exhibits profit margins in the countries included in the sample, its relationship with the exchange rate and the evolution of the input-output coefficients of imported and exported inputs. Following, econometric tests are presented in Section 4, in order to check for our hypothesis, which is, changes in the ratio between exports and imported inputs coefficients are influenced by the exchange rate misalignment. Adopting this hypothesis is a way to test how entrepreneurs react to exchange rate misalignment in order to avoid a significant reduction in profit rates, due to an appreciation, or to stimulate a rise in profit margins, due to a depreciation, as it will be explained in the next sections. Then, our concluding remarks are presented.

1. The relationship between profit and exchange rates: A theoretical and empirical review

According to a wide literature, the devaluation of the exchange rate exerts a positive effect on growth and economic development, as argued by Ferrari, Freitas, & Barbosa-Filho (2013), Guzman, Ocampo, & Stiglitz (2018), Rapetti (2016) and Rodrik (2008). These authors emphasize the role of exchange rate level on the expansion of exports and investments. In this article we explore these channels from the perspective of the new developmentalism theory, arguing that the exchange rate is relevant to grant access to domestic and external demand by means of its impact on profit rates and, consequently, on investments.

The exchange rate is one of most important macroeconomics prices to New Developmentalism - along with profit, inflation, interest and wages rates - and also one of least studied prices (Bresser-Pereira, Marconi, & Oreiro, 2016, pp. 7; 51). According to New Developmentalism theory, the exchange rate is an important variable in profit rate determination, therefore, it is also important to determine the level of investments in a country and, as a consequence, to set the pace of their structural change and process of economic development (Bresser-Pereira, 2012, pp. 183–184; Bresser-Pereira et al., 2016, pp. 22; 41; 178). Empirical evidences connecting exchange rate devaluations, investments and growth can be also observed (Dao, Minoiu, & Ostry, 2017). Previous theories such as the Neoclassical, Keynesian, and even the Structuralist did not assign a relevant role for the exchange rate in the explanation of the behavior of profit rates, since they assume that exchange rates fluctuates around the equilibrium level and the deviations from that level are temporary. In this context, the exchange rate fluctuations are not relevant to determine profits and investments since its

equilibrium level prevails. But the New Developmentalist Theory argue that the exchange rate could be quite volatile and remain for prolonged periods of time at a lower level than the necessary to the current account equilibrium (Bresser-Pereira, 2012, p. 189). If the exchange rate would really be more volatile and the currency would stay appreciated for large periods, the entrepreneurs would assign greater weight to this variable in their investment decisions since it would affect the profit rate not only in the short term, but for a period long enough to damage their accumulation. Consequently, the chronic process of exchange rate appreciation, when observed, creates relevant demand constraints to growth, since this appreciation inhibits the reaching of a satisfactory profit rate even if the entrepreneur is efficient, and the firm becomes unable to compete in both markets, domestic and global. In this sense, the exchange rate turns to be a central variable in a world of globalized markets, because its level determines the access to demand by the companies of a certain country, as much to the external market, as to its own domestic market (Bresser-Pereira, 2012, p. 182).

Given that the entrepreneurs have as their main incentive to earn profits, the investment rate, in turn, will depend on lucrative opportunities to access demand (for empirical evidences regarding profitability and investments see Basu & Das, (2017). There is still a need for the exchange rate to remain predictable for a sufficiently long period for investments to take place and profit rate to remain relatively stable over a period of time to compensate investment efforts, which may be hampered by volatility, besides the existence of appreciation tendencies of the exchange rate over time (Bresser-Pereira et al., 2016, pp. 113–123). In this sense, this research is interested to understand deeper the relationship between profit rates and the exchange rate and how this relationship can affect the productive structure.

Initially, it is necessary to step back and look for some studies that can help us to explain the relationship between profit rates, investments and exchange rates besides the New Developmentalist theory. In this article, we follow the traditional assumption that "desired accumulation depend positively on profit rate" and that current profit rate generates internal funding for capital accumulation as it makes easier to firms to access external funding (Lima, 2013, p. 347) . The relationship between profit rates and growth has been studied since the classical authors as well as the link between profits and investments, which has been emphasized after the Keynes' General Theory, but the relationship between exchange rates and profit rates has not been explored as widely as that link. Anyway, it is possible to highlight some studies and researches that have been analyzed this relationship.

Barbosa et al (2011, p.6) argue that the price of tradable goods is a positive function of domestic price of imports and the price of non-tradable goods is defined based on a mark-up on production costs. Given the wage rate and input coefficients, the mark-up and prices of tradable goods are functions of the real exchange rate, so currency depreciations would enlarge the income profit share. Bhalla (2012) argues that current depreciations impact investments through the reduction of the international cost of production and the consequent increase in profitability for entrepreneurs who compare inversion opportunities all over the world. Blecker (2012) develops a model in which is assumed that the firm´s target mark-up rate is an increasing function of the real exchange rate because a depreciation reduces the competition with external firms in the domestic market. Rapetti (2016) also defines an equilibrium exchange rate that allows the labor-intensive tradable sector in developing countries to reach a rate of profit at least equal to the ones obtained by similar firms in developed countries.

The discussion about the relationship between profit rates and exchange rates can be also found in empirical studies. As profit rates are sometimes difficult to calculate in the industry level because there are no sectorial capital stock measurements, many studies use profit

margins as a proxy to it.[7] Studying that relationship has become an important issue along with the introduction of global value chains and to understand profit rate adjustments in the developing economies. Mann (1986) observed how exchange rate pass-through affects import and export prices in US for several individual industries and how foreigners' suppliers profit margin is squeezed by dollar fluctuations. The evidence found by Mann (1986) suggests that profit margins of American export industries fluctuated much less than the margin of foreign suppliers that has absorbed exchange rate changes, a behavior in line with "theoretical models of imperfect competition and macroeconomic uncertainty" (Mann, 1986, p. 378). Therefore, exchange rate fluctuations may not be an issue to US manufacturing exports, since the American currency is the usual in global trade, as it is to US foreigners' suppliers, which can face, consequently, profit squeeze in a situation of dollar depreciation.

Klitgaard (1999) was interested in observing Japanese exporters responses to maintain stable profit margins and sales volume along with Yen fluctuations, what is conflicting due to price elasticity of demand. Furthermore, Klitgaard (1999, p. 41) finds that Japanese firms make a composition between these two goals, passing on part of the appreciation of the Yen to its external prices and partly reducing its profit margin according to how price is seen by US consumers. Hence, the author concludes that such adjustment "makes profit margins an important channel through which exchange rate affects Japan's economy" as New Developmentalism theory argues.

Another remarked study about this issue was addressed by Requena-Silvente & Walker (2007), investigating the impact of exchange rate movements over UK car market´s profit margins. In their study, the authors find that "manufactures have implemented a 'pricing-to-market' strategy that leads exporters to reduce (or increase) profit rates for foreign cars whose currencies have appreciated (or depreciated) against the UK currency" (Requena-Silvente & Walker, 2007, p. 216). Also, in their findings, the exchange rate pass-through is diverse across countries, importers show asymmetric price-to-market behavior with mark-ups changing more pronounced with pound appreciation than depreciation, and finally, that local producers are also sensitive to exchange rate fluctuations, as they try to stabilize local currency prices.

As may be noted, some theoretical and empirical studies have been emphasized the existence of a positive relationship between profits (margins or rate) and the exchange rate. This research advances on this debate in order to analyze this argument, suggesting a theoretical model to deeper understand this issue and bringing empirical evidence about the arguments to be introduced in the next section.

2. Profit rates and exchange rates: the basic model

In order to understand the relationship between profit margins and exchange rates, we built a model[8] that consider three different costs components - labor, domestic and imported inputs and two sources of revenues for the firms – domestic and foreign sales, and that inventories are equal to zero, that is, the production is totally sold, which can be true after a few periods of adjustment in the production. The producer tries to keep a certain profit rate level, necessary to provide accumulation and to stimulate the continuous investment; if he is a price maker, this trial is easier to be reached, otherwise he needs to look more closely to his costs structure. The

[7] Profit rates are measured by the division between total profits and capital stock, and profit margins are measured by the division between total profits and revenues, which is a proxy for the mark-up.

[8] See Appendix A

exchange rate affects the profit rate insofar as it changes the cost on imported inputs, the constraints to fix prices in domestic and external markets and the exports revenues (converted to local currency). The capital-labor ratio is considered fixed to simplify our explanation: [9]

$$\pi = 1 - \left[\frac{ULC + \alpha . P_{imp} . E + (1 - \alpha) . P_{nac}}{\beta . P_{int} + (1 - \beta) . P_{exp} . E}\right] . \frac{Y}{K}$$

where
$K = Capital\ Stock \pi = Profit\ rate$
$ULC = Unit\ labour\ cost$
$P_{nac} = Domestic\ Inputs\ price$
$P_{imp} = Imported\ Input\ price\ \ (in\ US\$)$
$P_{int} = Price\ of\ Final\ Goods\ price\ in\ Domestic\ Market$
$P_{exp} = Price\ of\ Final\ Goods\ price\ in\ Foreign\ Market (in\ US\$)$
$E = Nominal\ exchange\ rate$
$Y = Gross\ Output$
$\alpha = imported\ inputs\ coefficent$

$1 - \alpha = domestic\ inputs\ coefficient$

$\beta = domestic\ revenues\ coefficient$

$1 - \beta = exports\ coefficient$

There is a large range of possibilities for trying to keep a relatively stable and desirable profit rate over time. As we argued, if the producer is a price maker, it is easier to react against cost inflation, but if he is a price taker, the constraints are larger, and it is necessary to manage costs more closely. Some of the strategies that producers can adopt, if they cannot raise prices to compensate higher costs, are: a) when unit labor costs or the price of domestic inputs rise, the producer can replace both by imported inputs, which contributes to deindustrialization if the larger imported inputs coefficients (imported inputs/gross output) in many sectors are not followed by a raise in the exports coefficients (exports/gross output) in the same or other sectors; b) he can also try to rise labor productivity, which reduces unit labor costs (trying to raise capital productivity ($\frac{Y}{K}$) is more difficult in the short term).

In turn, when the exchange rate depreciates, the producer rises the exports revenues (quoted in domestic currency) and replace more expensive imported inputs (also quoted in domestic currency) by labor or domestic inputs; as a result, the profit margin can rise and also the profit rate (if the capital productivity remains stable and assuming a reduced pass-through from imported to domestic inputs); he can also reduce the price of goods, quoted in foreign currency), and rise his revenue if the demand for the good is elastic. This is the expected influence of a moderate exchange rate depreciation on profit rates, according to the New Developmentalist theory and other studies previously quoted.[10] If the exchange rate appreciate, we expect the opposite effect in the exports revenues and the constraints to rise domestic prices increases (or the producers even may need to reduce the prices in domestic markets due to the increasing competition with cheaper imported goods, quoted in local currency); both effects

[9] This model is representative of the firm behavior, so it is necessary to consider these three costs components and not only labor and imported inputs, which is the usual supposition for aggregated models.

[10] Certainly, the depreciation cannot be large enough to pressure inflation. If the observed pass-through between exchange rate and domestic prices is large, due, for example, a relevant inertial component of wages and other costs, the constraints to devaluate the exchange rate are broader.

reduce the profit margins and rates. So, we could argue that profit rates and exchange rates will vary in the same direction. If the sector faces a tighter profit rate, the chronic appreciation will lead the producer to reduce investments or even leave its business. If he operates in a high-technology content sector, the production structure undergoes a regression, i.e., it moves towards sectors with lower-technological content, and it means deindustrialization. This process seems to be more frequent and presumable in economies that have comparative advantages in primary sectors, since their profit rates would be larger than in high-technological sectors, and the production structure would move towards the primary ones in the medium and long term.

But there is another possible strategy that can avoid the fall in profit rates even when the process of chronic appreciation is present: the producers can substitute labor and domestic inputs by imported inputs (which, in this situation, are cheaper when quoted in domestic currency) in order to reduce costs, as it was pointed out by Montiel and Agenor (2008). This strategy can sustain a relatively stable profit rate, but also implies in a deindustrialization process, at the expenses of lower demand for domestic inputs and labor. At the long term, the profit rate will decrease due to the consequent reduction in aggregate demand. The difference, in this situation, is that it takes longer to reduce the profit rate, but the deindustrialization can be even more severe, since the supply chains will disintegrate more intensely.

Hence, whether in the short or long term, the profit rates tend to follow the tendency of the exchange rate behavior; but, in the scenario of chronic appreciation, the deindustrialization seems to be larger. This is the argument that sustains the relevance of the maintenance of a competitive real exchange rate to improve the investment and the productive sophistication, mainly in countries with comparative advantages in natural resources. In order to check for these arguments, we bring some empirical evidence about the behavior of the profit margins and exchange rates in a large sample of countries in the next section.

3. Estimation of Profit Margins, the relationship with exchange rates and the exports and imported inputs coefficients

The first section presents a discussion about the relationship between profit rates and exchange rates. Then it is necessary to observe this relationship and, in order to check it, it is necessary, firstly, to estimate the profit margins and to describe its performance and evolution.

3.1.Profit margins

We built some series, as large as possible, to show the evolution of profit margins based on data of the World Output-Input Database (WIOD) available for the period 2000-2014 for 43 countries[11] (Timmer *et al*, 2015).We estimated the profit margin based on the ratio between capital compensation and gross output, so we adopted capital share as a proxy for the estimation of profit margins[12].

[11] Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Mexico, Netherlands, Norway, Poland, Portugal, Republic of Korea, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan, Turkey ,United Kingdom and United States.

[12] Due to the lack of data to estimate the sectorial capital productivity it is not possible to estimate sectorial profit rates and, consequently, we estimate only profit margins as a proxy for profit rates.

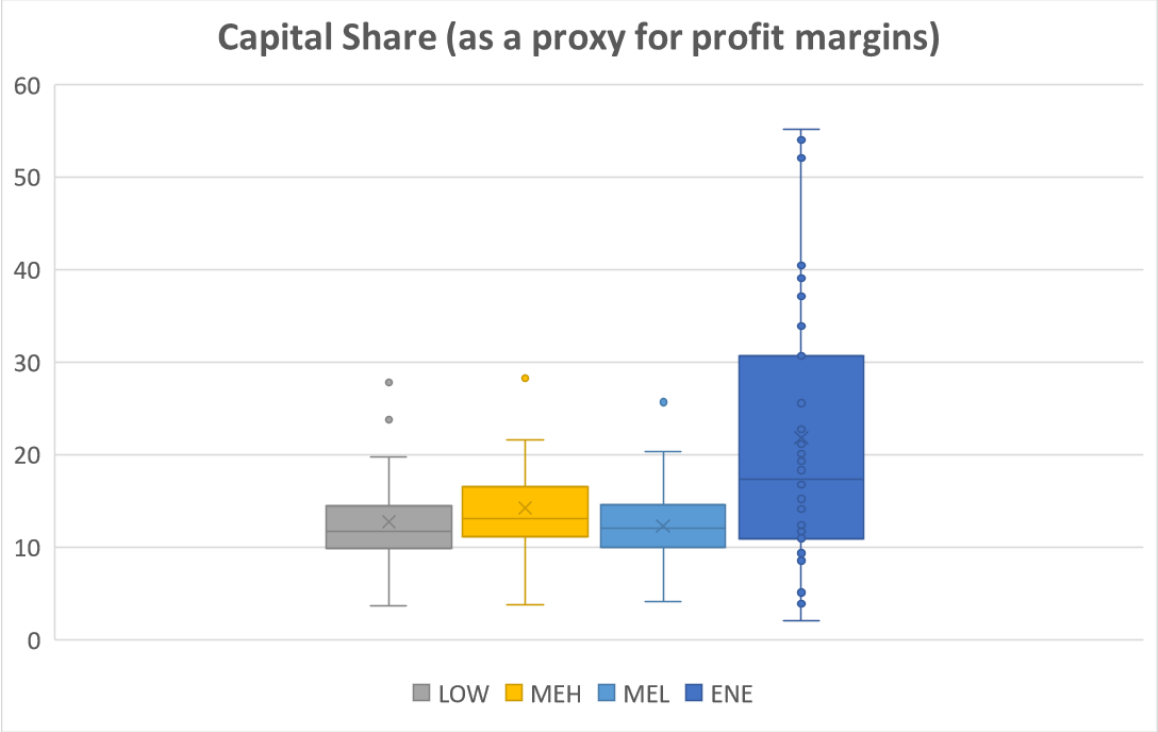
The WIOD database presents the data for the economic sectors classified according to the International Standard Industrial Classification (ISIC), revision 4. On the present analysis we focus only on extractive industries and manufacturing (codes B and C10-33). We group the different sectors based on the criteria put forth by the United Nations Industrial Development Organization (UNIDO)[13]: Energy (ENE), Low Technology (LOW), Medium-Low Technology (MEL) and Medium-High and High Technology (MEH).

Finally, we estimated two coefficients for these four groups (ENE, LOW, MEH and MEL)**.** The first one is the share of imported inputs as a percentage of gross output ("imported inputs coefficient"). A higher share of imported inputs in gross output means that the sector relies heavily on imported inputs in the detriment of inputs produced domestically. The second is the share of exports as a percentage of gross output ("exports coefficient"). In other words, it shows the percentage of domestic output which is exported to foreign countries. Finally, we also calculated the ratio between the two coefficients (exports coefficient divided by imported inputs coefficient).

The boxplots in the Graph 1 below present the average capital share (proxy for profit margins) in the period 2000-2014 for medium-high and high technology (MEH), medium-low technology (MEL), low technology (LOW) and energy sectors (ENE). Apart from energy sectors, the three other groups have comparable distributions on their average capital share. On the energy group, besides its higher values, it is also worth noting an also higher amplitude compared to the other groups; so, it seems that profit margins are more volatile in this group; since energy goods also present more volatile prices, it is possible to suppose that the behavior of profit margins at the energy sector are linked to the variations of commodity prices in the global market, and consequently they are less influenced by exchange rate fluctuations. This hypothesis can be tested in the future. On the other hand, profit margins in low, medium-low and medium-high technology sectors are closer and less volatile, and consequently they can be more affected by macro policies and, specifically, by exchange rate fluctuations. As expected, profit margins are slightly larger in medium-high technology sectors, possibly due to a higher monopoly power.

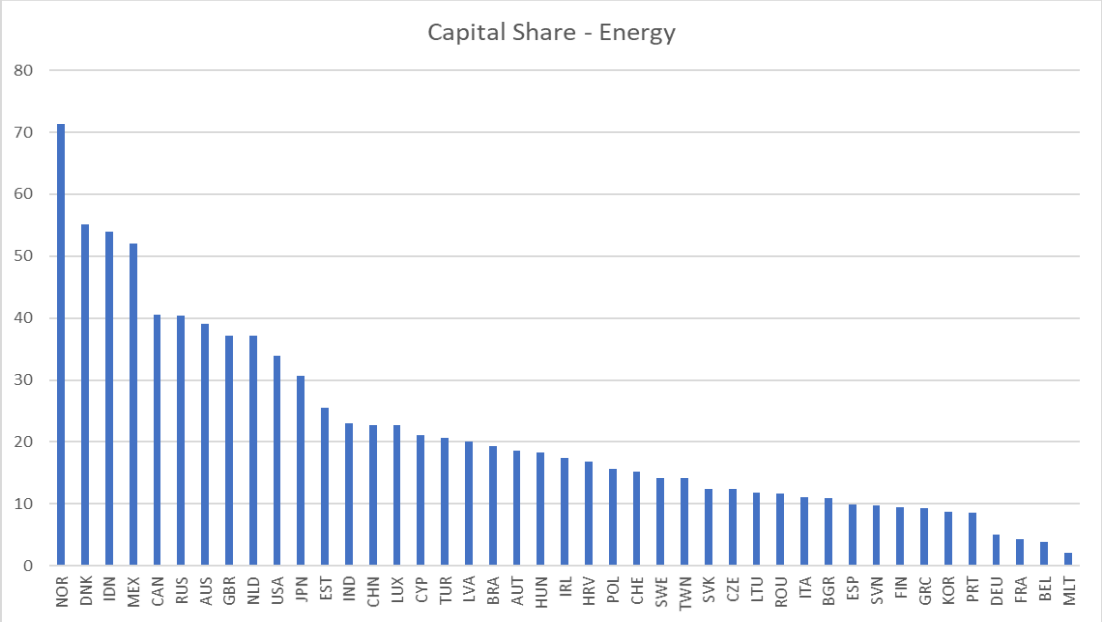
Graph 1

[13] See appendix B.

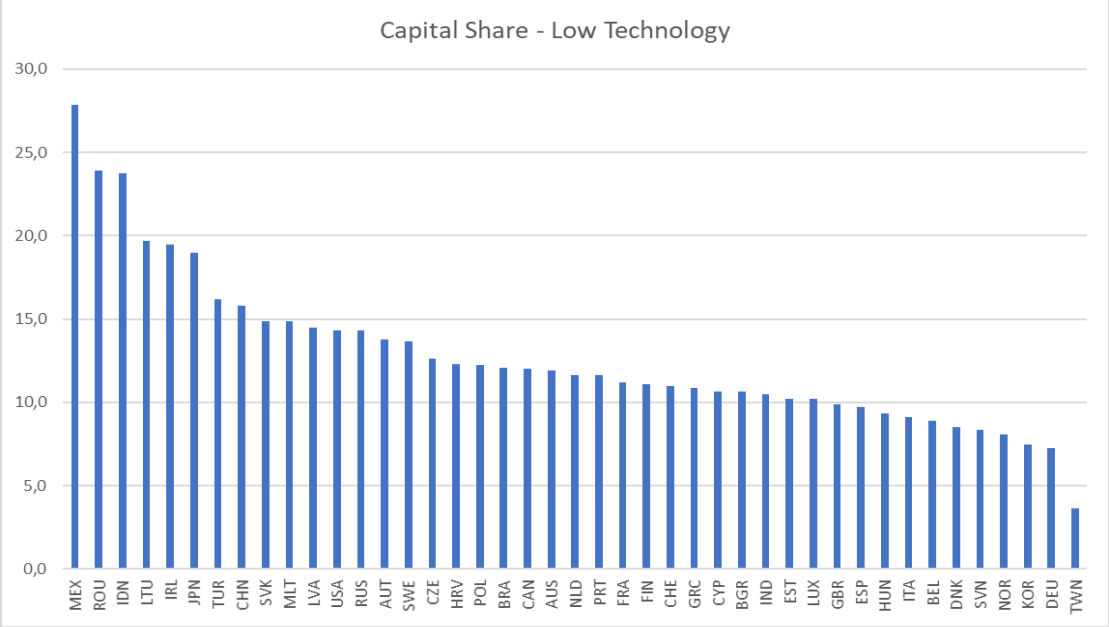


Graphs 2 to 5 show the average profit margins for every country in each group sector. Again, it is possible to notice the volatility of those margins in the energy sector and the slight advantage of margins in the medium-high technology sectors. But it is possible to notice that the rank of countries is not similar for each group; the correlation of ranks is weak between energy and other sectors, and larger, although not relevant, between MEH and MEL sectors and MEL and LOW sectors (see Table 1). The correlation of countries' profit margins between groups follows the same tendency (see Table 2). Therefore, it is possible to state that average profit margins for the period 2000-2014 in energy sectors are not correlated with the average profit margins in the other sectors, as it would be expected, but the average profit margins in other sectors are just moderately correlated and it is not possible to define a common behavior for them.

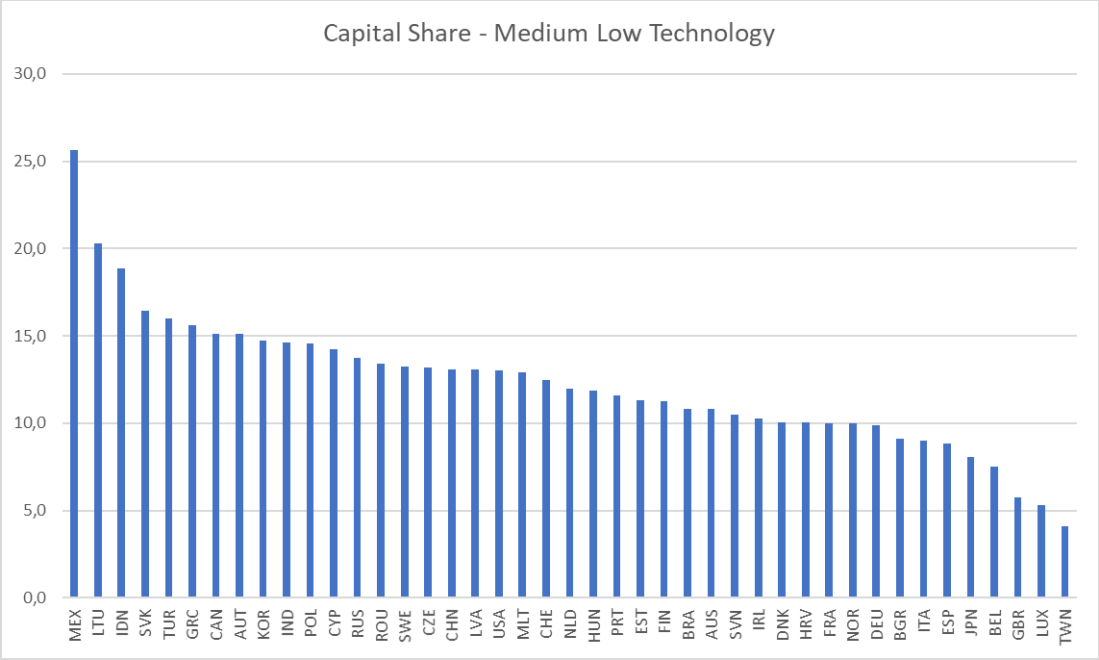
Graph 2



Graph 3



Graph 4



Graph 5

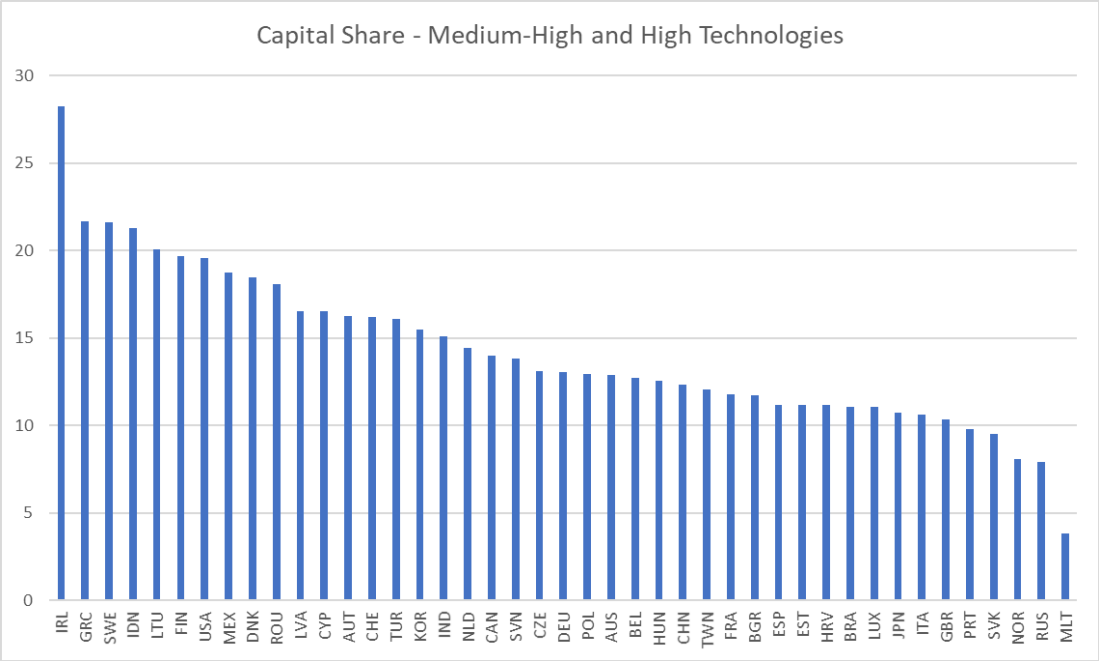


Table 1

Correlation between profit margin ranks	
MEH - MEL	0,4876
MEH - LOW	0,2726
MEL - LOW	0,5738
MEH-ENE	0,0550
MEL - ENE	0,1540
LOW-ENE	0,2188

Table 2

Correlation between profit margin levels	
MEH - MEL	0,3923
MEH - LOW	0,3982
MEL - LOW	0,6634
MEH-ENE	0,0559
MEL - ENE	0,1893
LOW-ENE	0,2308

3.2.The relationship between profit margins and exchange rates

After describing the evolution of profit rates, it is necessary to check for the existence and the magnitude of the relationship between the evolution of that variable and the exchange rates. We performed a simple correlation test between the profit rates and misalignment series for each country and group sector, for the period 2000-2014. First, we estimate the correlation for each country and then we calculate the average correlation for the countries included in the sample, for each sector group. Table 3 shows these average correlations for each sector group. The correlation between the profit rates and the lagged misalignment present similar results.

Table 3

Correlation between profit rates and exchange rates	
ENE	-0,0922
LOW	0,1682
MEL	0,2208
MEH	0,1900

The results are similar for the three sectors other than Energy (which is even lower), showing that there is a weak correlation between profit rates and exchange rates. Facing these results, we need to seek for an explanation for the fragile relationship between these variables. As it was suggested in the theoretical session, we can argue that the entrepreneurs try to defend their profit margins when the exchange rate is overvalued by a rise in the imported input coefficients and the substitution of foreign by domestic sales; by consequence, the evolution of profit margins do not present a significant correlation with the behavior of exchange rates. So, we will introduce the discussion about the behavior and evolution of the exports and imported inputs coefficients and later we will test the relationship between these coefficients and the exchange rate misalignments.

3.3.Estimation of Export and Imported Inputs Coefficients

A relevant part of the demand for manufacturing goods comes from manufacturing itself as intermediate inputs. In almost every country the process of industrialization was a process of increasing domestic linkages between sectors. The higher those linkages are, the higher are the impacts on employment and demand on other sectors (Hirshmann, 1958; 1968) and consequently on total demand as well.

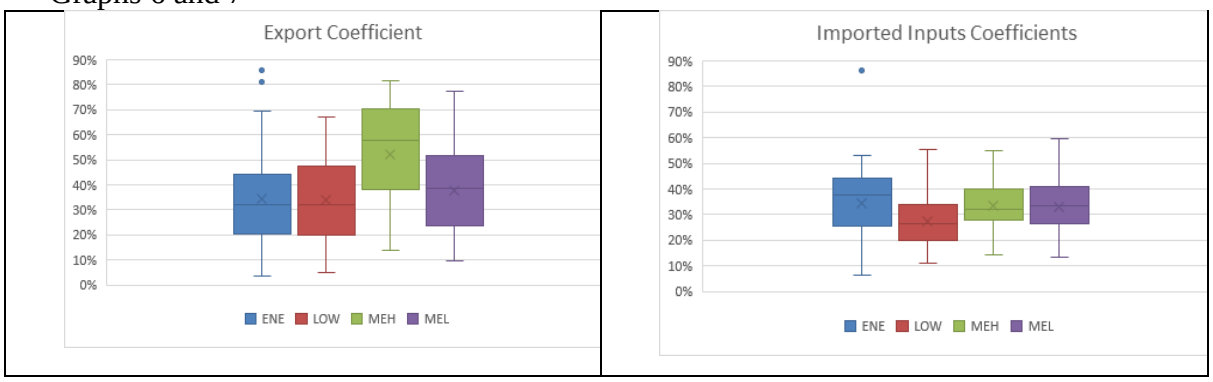
Nevertheless, the increasing participation of countries in Global Value Chains (GVC) has been changing the *rationale* behind this process. Due to the reduction of transportation costs, the increasing facility of communication boosted by the ICT revolution and to countries' reduction of import barriers, goods are increasingly been produced through fragmented

processes in which each country contributes in different stages of value chains (Gereffi, 1994). On the one hand, these changes in production processes make it possible for low and middle-income countries to have access to technologies that would be inaccessible if they were producing as isolated as before. On the other hand, they are increasingly forced to specialize in processes they have local comparative advantages, which tend to be less complex as they do not have all capabilities the high-income countries have. Therefore, developing countries that succeed in this context are those capable of producing in the most complex stages – those stages that generate higher technological spillovers and more qualified jobs (Gereffi, Humphrey & Sturgeon, 2005).

Therefore, it makes sense to take a closer look to export and imported input coefficients for the different groups of sectors in order to have a clearer view of how the countries have been participating in the Global Value Chains in the period 2000-2014. Based on WIOD database (Timmer *et al*, 2015), we estimated those coefficients: The first one is the share of imported inputs as a percentage of total production ("imported inputs coefficient"). Therefore, a higher share of imported inputs means that the sector relies heavily on imported inputs to the detriment of inputs produced domestically. The second is the share of exports as a percentage of total production ("exports coefficient"). In other words, it shows the percentage of domestic output which is exported to other countries.

The boxplots included in Graphs 6 and 7 present the average export and imported inputs coefficients for that period and the sectors segmented in the different groups MEH, MEL, LOW and ENE. In general terms, MEH sectors present higher average export coefficients than the other sector groups, followed by MEL. Regarding the imported inputs coefficients, LOW has lower coefficients than the other groups; low technological sectors adopt proportionally more domestic inputs, and the opposite can be observed in high technological sectors, which seems to be logical; it is easier to produce a large variety of low-tech inputs than a diversified range of high tech inputs in a country, so the imported inputs should be larger for the more technological content sectors.

Graphs 6 and 7

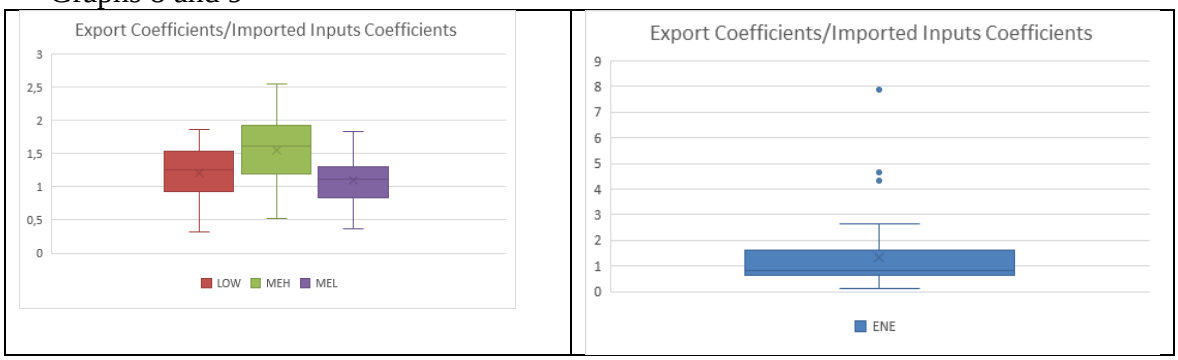


However, a high imported input coefficient is not necessarily bad news, because it can be compensated by an even higher export coefficient, meaning that the sector is using imported inputs, but it is also exporting more. Therefore, in order to stablish a clear analysis of the coefficients magnitude, it is worth to calculate a ratio index between both coefficients (the export coefficient by the imported inputs coefficient).

The boxplots for LOW, MEH and MEL in Graphs 8 and 9 show that the ratio between export and imported inputs coefficients is usually higher for MEH, followed by LOW and MEL. For ENE, the ratios are more spread out, with a few considerable higher outliers. The results indicate that possibly medium-high technology sectors are more integrated in GVC or,

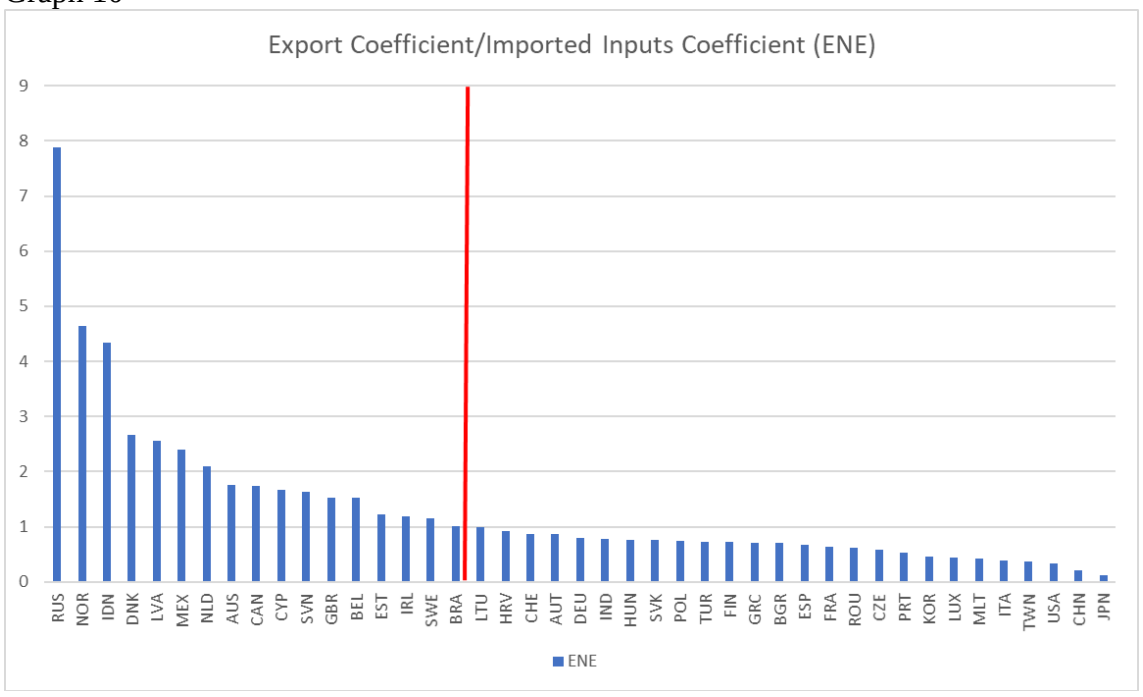
al least, more integrated in the global trade in a favorable direction towards the lines of economic development.

Graphs 8 and 9

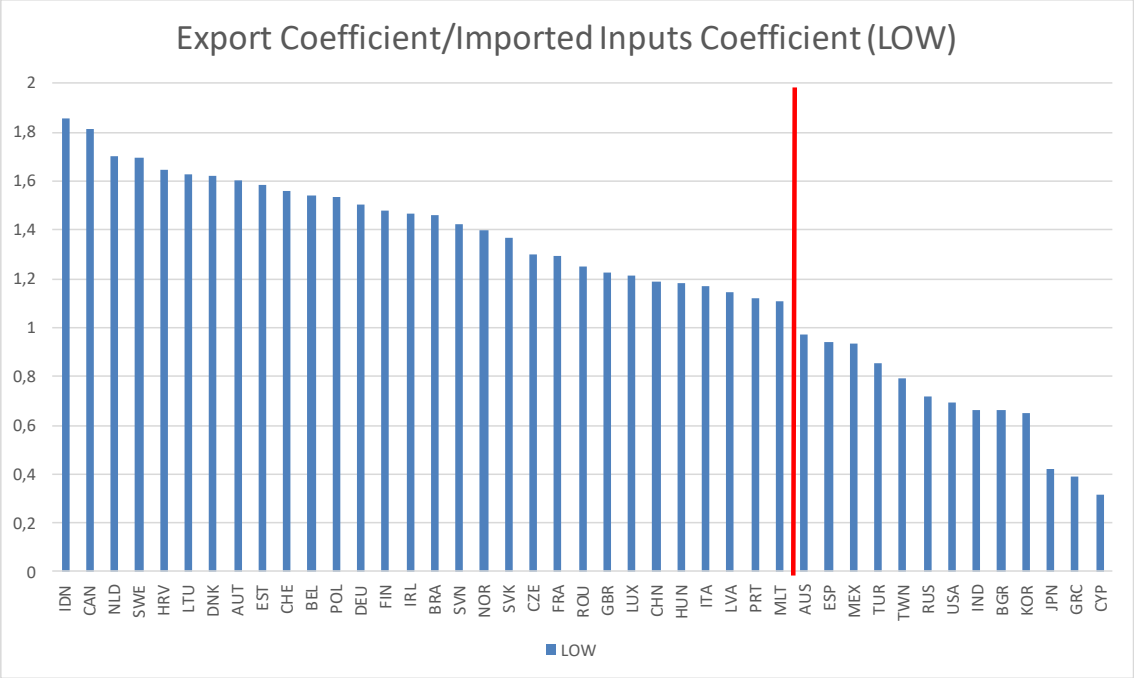


Graphs 10 to 13 show the ratio between the average exports and imported input coefficients for the period with data available (2000-2014), for each country and each sector group. Countries on the left of the red line have higher export coefficients than imported inputs coefficients (ratio > 1). It is possible to observe that a large number of countries exhibit a ratio > 1 for high tech sectors, which confirms that they are not only integrated into the global trade, but they also take advantages of their inputs imports to perform their exports.

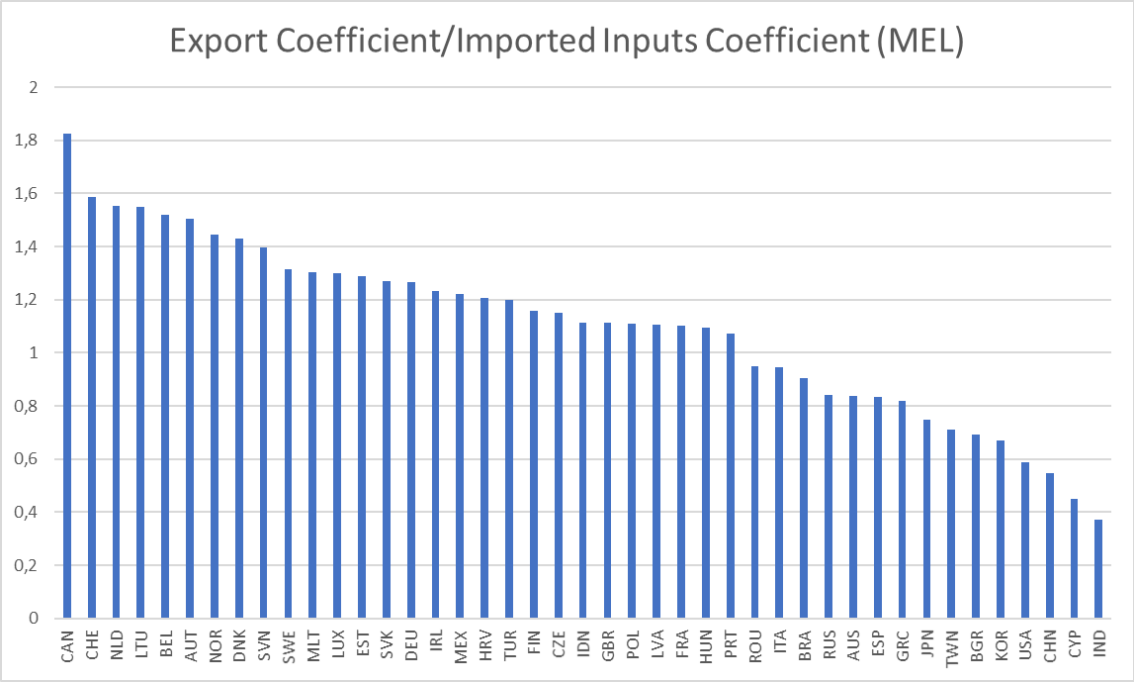
Graph 10



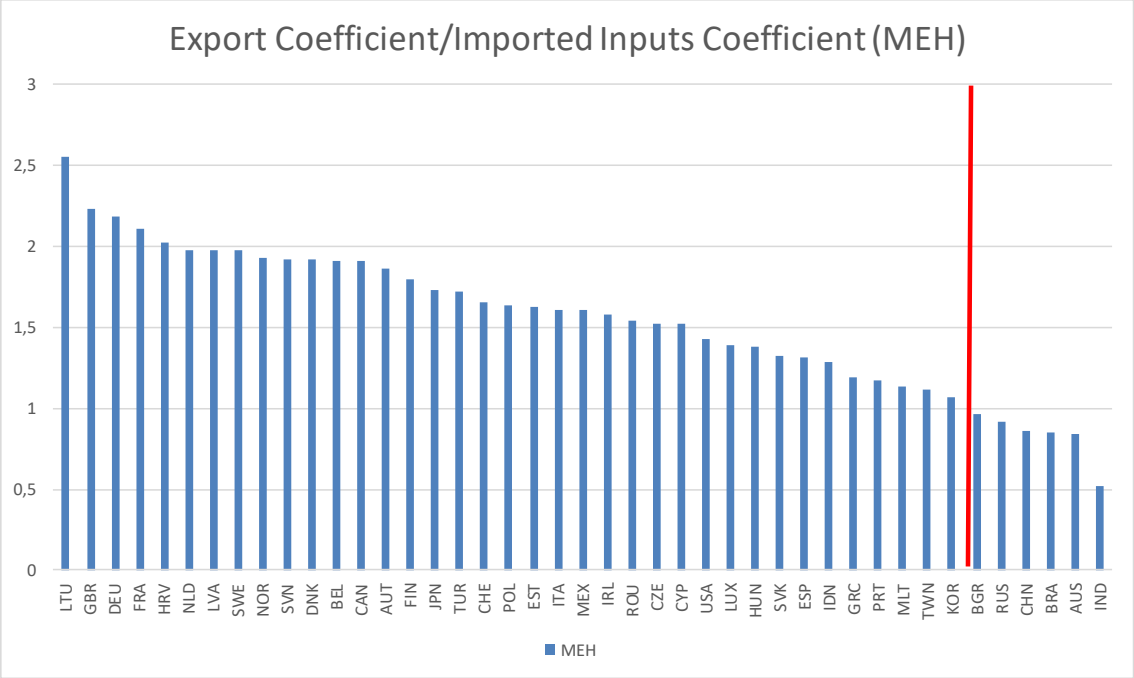
Graph 11



Graph 12

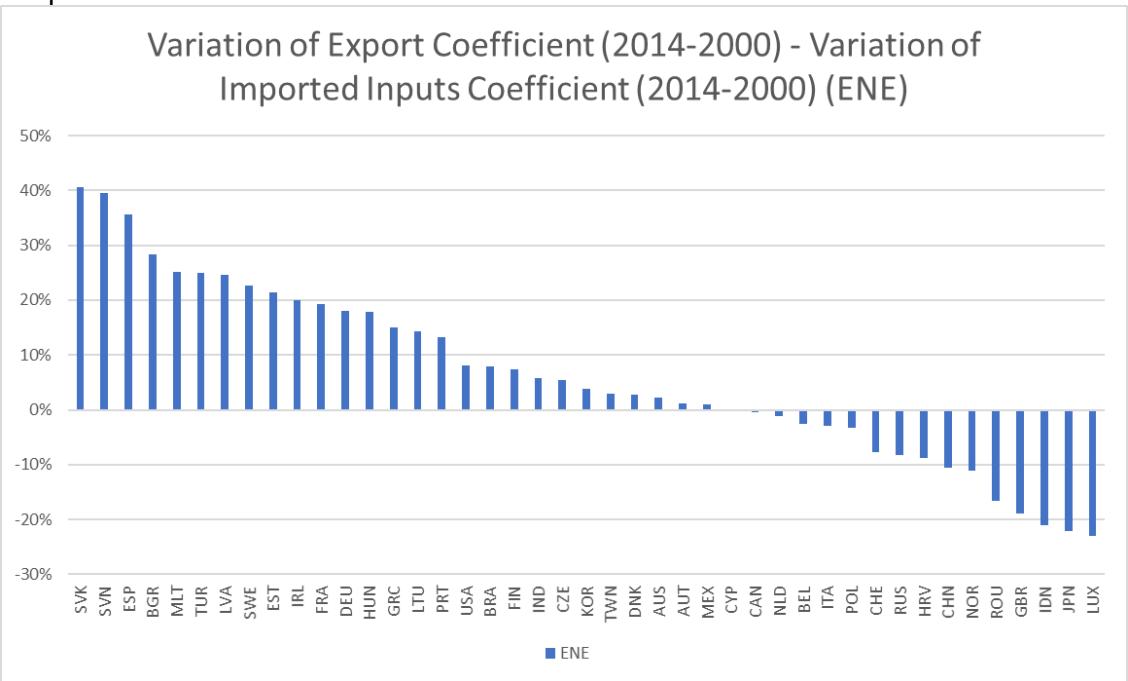


Graph 13

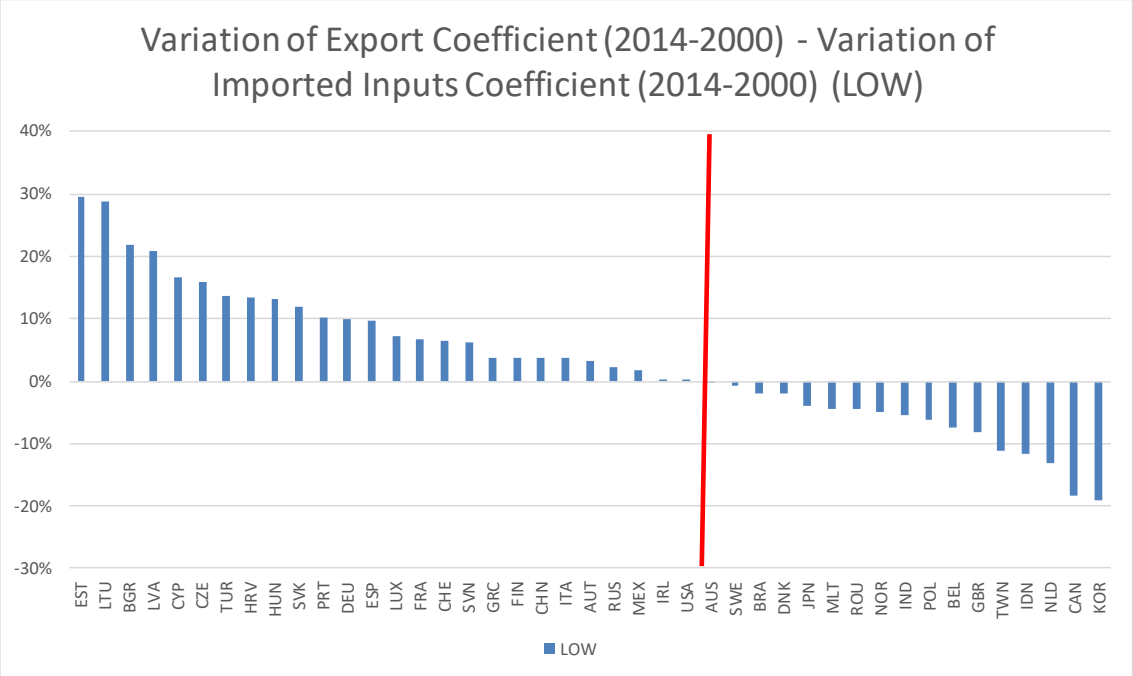


However, the coefficients varied significantly during this period. In order to have a clearer view of how the ratio between the coefficients changed from 2000 to 2014, we calculated the variation of export coefficients between 2000 and 2014 and the variation of imported inputs coefficients in the same period and then the absolute difference between the variations. A positive result means that the variation in the export coefficient in the period was larger than the variation in imported inputs coefficient, so the increase in the imported inputs coefficients was more than compensated by a larger increase in the export coefficient. Again, we can observe in Graphs 14 to 17 that there is a large number of countries that exhibit a positive result (for the absolute difference between coefficient variations) in the high-tech group sectors than in other groups, as we observed in the previous analysis.

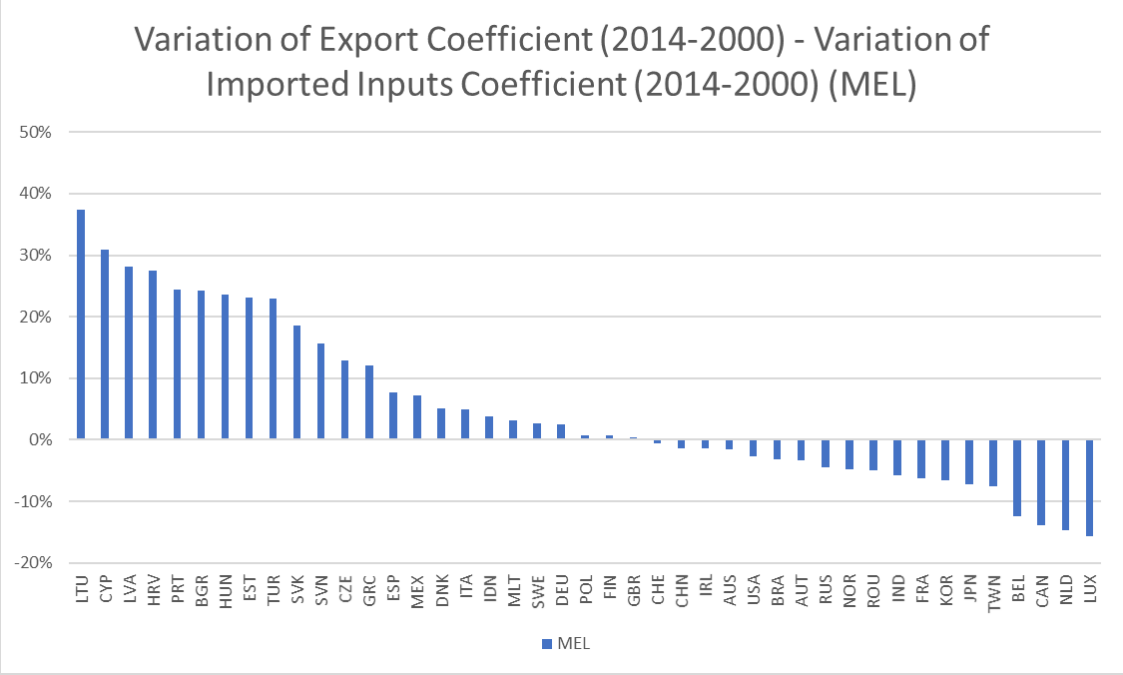
Graph 14



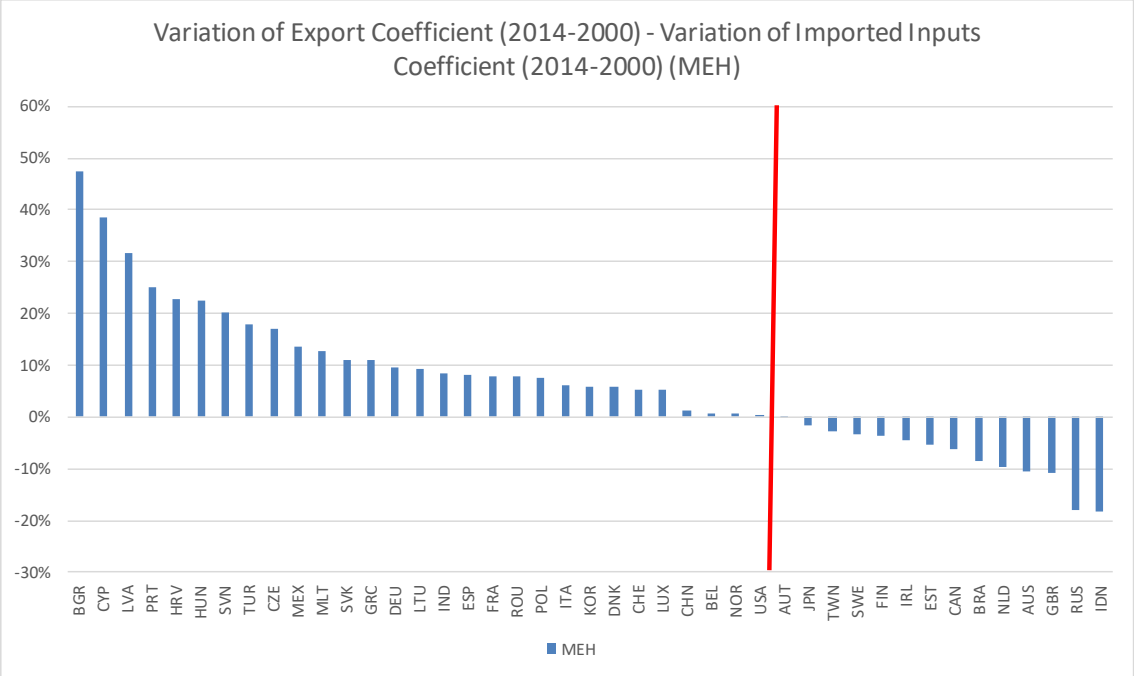
Graph 15



Graph 16



Graph 17



As we previously affirmed, in the next section we will test the hypothesis about a possible strategy that entrepreneurs can adopt in order to remain the profit margins relatively stable in response to a currency appreciation, which could explain the weak correlation between profit margins and exchange rates, that is, the substitution of local by imported inputs and foreign by domestic sales. We analyze in the next section if this option was chosen by the countries included in the sample, through a test of the relevance of exchange rate misalignments to explain the variations in the ratio between exports and imported inputs coefficients.

4. Exchange rate misalignment and the ratio between export and imported inputs: some empirical evidences

The aim of this section is to estimate the relationship between the variations in the ratio of exported and imported inputs and the exchange rate misalignment for 43 countries, in the 2000-2014 period. To perform our estimation, we start from the following standard econometric specification:

$$\Delta ratio_{it} = \alpha y_t + \beta_1 mis_{it} + \varepsilon_{it} \quad (1)$$

where subscript *i* represents the country, *t* refers to the period of observation of the variable (in our case, one year), *a* is the constant term and *e* is the error variable. The dependent variable (**razao1**) is the ratio between the exports coefficient and the imported inputs coefficient, both estimated based on the WIOD database (Timmer et al, 2015) and the explanatory variable (**mis_average**) is the exchange rate misalignment extracted from EQCHANGE (Couharde et al 2017), a global database of indicators on exchange rates, created by the Centre d'Études Prospectives et d'Informations Internationales (CEPII). For our estimations we used the data on misalignments correspondent to averages over the different models and weighting systems available, considering 186 trading partners. As control variables in the following regressions we have used the ratio of Investments to GDP (***inv***); an index of human capital accumulation (***hc***); the number of resident patents in a period (***patent***); and the degree of trade openness

(***openness***). All control variables were extracted from the World Developing Indicators (WDI) of the World Bank. Data corresponds to the period between 2000 and 2014 for all countries that are in WIOD database (footnote 11), except for Taiwan and Malta, whose data is not included in EQCHANGE database, therefore they are not considered in the regressions.

The econometric estimate uses panel data models in the static and dynamic versions. Panel data models present important advantages for our empirical exercises such as: i) the use of a larger amount of information by combining country data with time series; ii) the use of a larger number of observations, which, in turn, ensures the asymptotic properties of the estimators and increases the degrees of freedom of the estimates; iii) the reduction of the risk of multicollinearity, since data from the different countries have different structures and iv) the introduction of dynamic adjustments, which the cross-section analysis would not allow.[14] Yet dynamic panel data models, by using the lags of the dependent variable as explanatory variables, are powerful at correcting endogeneity problems, as suggested by Arellano and Bond (1991).

Tables 4 and 5 show our econometric results in static and dynamic models, respectively, for the whole manufacturing sector (except fuels), that is, in this test we aggregate low, medium and high-tech sectors:

Table 4 – Coefficient of export and imported inputs and exchange rate – manufacturing sector – static model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1
mis_average	0.068**	0.087**	0.089***	0.096***	0.094***	0.097***	0.099***
	(0.034)	(0.035)	(0.033)	(0.034)	(0.033)	(0.033)	(0.033)
L.lninv		0.061**		0.024			
		(0.028)		(0.028)			
D.lninv			-0.251***	-0.240***	-0.252***	-0.246***	-0.204***
			(0.047)	(0.049)	(0.047)	(0.047)	(0.047)
D.lnhc					2.335	2.641*	2.814*
					(1.419)	(1.489)	(1.462)
D.lnpatents						0.003	0.003
						(0.018)	(0.018)
D.lnopeness							-0.190***
							(0.042)
Constant	0.009***	0.100**	0.010***	0.046	-0.004	-0.006	-0.005
	(0.003)	(0.042)	(0.003)	(0.042)	(0.009)	(0.010)	(0.010)
Observations	574	574	574	574	574	555	555
R-squared	0.008	0.016	0.058	0.059	0.063	0.065	0.101
Number of country	41	41	41	41	41	41	41
Standard errors in parentheses							
*** p<0.01, ** p<0.05, * p<0.1							

Table 5 – Coefficient of export and imported inputs and exchange rate – manufacturing sector – dynamic model

[14] See Wooldridge (2010).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1
LD.lnrazao1	-0.126***	-0.127***	-0.133***	-0.133***	-0.136***	-0.109**	-0.104**
	(0.047)	(0.047)	(0.046)	(0.046)	(0.046)	(0.047)	(0.045)
mis_average	0.201***	0.212***	0.229***	0.229***	0.230***	0.223***	0.244***
	(0.062)	(0.062)	(0.061)	(0.061)	(0.061)	(0.061)	(0.058)
L.lninv		0.093**		0.033			
		(0.043)		(0.043)			
D.lninv			-0.209***	-0.195***	-0.208***	-0.193***	-0.108*
			(0.058)	(0.062)	(0.058)	(0.057)	(0.057)
D.lnhc					1.903	1.806	2.748
					(2.381)	(2.596)	(2.487)
D.lnpatents						0.018	0.021
						(0.020)	(0.020)
D.lnopeness							-0.259***
							(0.047)
Constant	0.015***	0.154**	0.017***	0.065	0.005	0.005	0.004
	(0.004)	(0.064)	(0.004)	(0.065)	(0.015)	(0.017)	(0.016)
Observations	492	492	492	492	492	472	472
Number of country	41	41	41	41	41	41	41
Standard errors in parentheses							
*** p<0.01, ** p<0.05, * p<0.1							

Regarding to the static panel data model, it was presented only the fixed effects as the Hausman test (Hausman, 1978) showed that the data were best fitted with fixed effects, that is, the null hypothesis that the difference in coefficients are not systematic was reject for the models.

The dynamic panel data model was implemented to face the possibility of endogeneity bias. Although, to check the consistency of this estimator, it is necessary that the instruments used in the model are valid. For this, Arellano and Bond (1991) suggest the Sargan test, whose null hypothesis is that the instruments are valid. The application of this test indicated that the restrictions of some of our models are not valid.

As the possibility of endogeneity in our model is small, the static models are robust for our analysis. Moreover, the results of the static and dynamic model estimates are very close, which validates the results of our research.

In Tables 4 and 5, the results of the estimations show that the variable misalignment, which is positive when the exchange rate is depreciated, is significantly positive to explain the variations in the ratio between export and imported inputs. These results corroborate our initial hypothesis that periods of overvalued currency have promoted a substitution of domestic inputs for imported inputs, as well as it has de-stimulated exports. The results remain in all estimated models and do not change even with the inclusion of control variables, which are lagged because we suppose that they influence the ratio between exports and imports coefficients after some period.

The signal of the lagged value of the variable investment is positive and significant, which support the assumption that, after a certain period, the increase in fixed capital can stimulate productivity and then the exports or the local production of inputs. However, the inclusion of the current variation of the investment in the tests shows that this effect is more relevant (the lagged investment becomes not significant) and exhibits a negative signal. This result possibly means that the increase in investment stimulate, at a first moment, the imports of inputs, before its substitution by local production, or it rises the domestic aggregate demand; consequently,

a larger portion of domestic production that would be targeted for exports is sold in the domestic market, which would reduce the exports coefficient.

The control variable related to human capital accumulation is positive, as it is expected, but it is significant in a few model specifications only. The variable related to number of patents is not significant for the countries and period analyzed and the variable "degree of openness" is statistically significant and it presents a negative signal, supporting the hypothesis that the openness benefits the imports more than exports.

As the manufacturing sector is very heterogeneous, we decided to disaggregate this sector into different degrees of technological intensity, that is, into goods of low and medium-low and medium-high and high technological intensity, in a closer classification to the one adopted in the descriptive section. Tables 6 and 7 summarizes the estimates using static and dynamic panel data models, respectively, of the relationship between changes in the ratio exports / imported inputs and exchange rate misalignments for medium-low and low technology sectors.

Table 6 – Coefficient of export and imported inputs and exchange rate – medium low and low technology sectors -static model

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1
mis_average	0.068	0.081*	0.097**	0.104**	0.114***	0.117***
	(0.043)	(0.044)	(0.042)	(0.042)	(0.040)	(0.040)
L.lninv		0.043				
		(0.035)				
D.lninv			-0.348***	-0.349***	-0.337***	-0.295***
			(0.059)	(0.059)	(0.057)	(0.057)
D.lnhc				2.990*	3.405*	3.579**
				(1.791)	(1.793)	(1.771)
D.lnpatents					0.043**	0.043**
					(0.022)	(0.021)
D.lnopeness						-0.191***
						(0.051)
Constant	0.011***	0.075	0.013***	-0.006	-0.010	-0.008
	(0.004)	(0.053)	(0.004)	(0.012)	(0.012)	(0.012)
Observations	574	574	574	574	555	555
R-squared	0.005	0.007	0.065	0.070	0.083	0.108
Number of country	41	41	41	41	41	41
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Table 7 – Coefficient of export and imported inputs and exchange rate – medium-low and low technology sectors - dynamic model

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1
LD.lnrazao1	-0.194***	-0.194***	-0.202***	-0.207***	-0.179***	-0.170***
	(0.048)	(0.048)	(0.046)	(0.047)	(0.045)	(0.043)
mis_average	0.190**	0.190**	0.235***	0.238***	0.232***	0.255***
	(0.075)	(0.075)	(0.074)	(0.073)	(0.068)	(0.066)
L.lninv		0.035				
		(0.053)				
D.lninv			-0.320***	-0.318***	-0.287***	-0.186***
			(0.071)	(0.071)	(0.066)	(0.066)
D.lnhc				3.526	4.592	5.758**
				(3.174)	(3.044)	(2.930)
D.lnpatents					0.075***	0.078***
					(0.024)	(0.023)
D.lnopeness						-0.297***
						(0.056)
Constant	0.017***	0.069	0.020***	-0.002	-0.011	-0.013
	(0.005)	(0.080)	(0.005)	(0.020)	(0.020)	(0.019)
Observations	492	492	492	492	472	472
Number of country	41	41	41	41	41	41
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Results are similar to the ones obtained for the aggregate manufacturing. It seems that there is no specific characteristic of medium-low and low tech sectors that would induce a different relationship between changes in the ratio between export and imported inputs coefficients and exchange rate misalignments, which remains positive and statistically significant. The results for control variables are similar, except for the lagged investment, that is not significant and indicates that this variable seems to be irrelevant to determine the evolution of exports and imported inputs or, at least, influence both in a similar magnitude. The variable related to the number of resident patents turns positive and statistically significant.

Finally, Tables 8 and 9 present the estimates of the relationship between the ratio of export and imported inputs and exchange rate misalignments for medium-high and high technology sectors, using static and dynamic panel data, respectively.

Table 8 – Coefficient of export and imported inputs and exchange rate – medium-high and high technology sectors – static model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1
mis_average	0.063*	0.083**	0.077**	0.089**	0.081**	0.083**	0.085**
	(0.035)	(0.036)	(0.035)	(0.036)	(0.035)	(0.036)	(0.035)
L.lninv		0.065**		0.042			
		(0.029)		(0.030)			
D.lninv			-0.173***	-0.154***	-0.173***	-0.164***	-0.125**
			(0.050)	(0.051)	(0.050)	(0.050)	(0.051)
D.lnhc					1.691	1.880	2.041
					(1.497)	(1.591)	(1.570)
D.lnpatents						-0.014	-0.014
						(0.019)	(0.019)
D.lnopeness							-0.177***
							(0.045)
Constant	0.008**	0.105**	0.009**	0.071	-0.002	-0.003	-0.001
	(0.004)	(0.043)	(0.004)	(0.045)	(0.010)	(0.010)	(0.010)
Observations	574	574	574	574	574	555	555
R-squared	0.006	0.015	0.028	0.032	0.030	0.031	0.059
Number of country	41	41	41	41	41	41	41
Standard errors in parentheses							
*** p<0.01, ** p<0.05, * p<0.1							

Table 9 – Coefficient of export and imported inputs and exchange rate – medium-high and high technology sectors – dynamic model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1	D.lnrazao1
LD.lnrazao1	-0.070	-0.075	-0.072	-0.076	-0.073	-0.043	-0.049
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.048)	(0.047)
mis_average	0.194***	0.194***	0.206***	0.201***	0.206***	0.203***	0.227***
	(0.069)	(0.069)	(0.069)	(0.069)	(0.069)	(0.070)	(0.068)
L.lninv		0.112**		0.086*			
		(0.046)		(0.046)			
D.lninv			-0.131**	-0.097	-0.131**	-0.118*	-0.054
			(0.062)	(0.065)	(0.062)	(0.062)	(0.063)
D.lnhc					0.889	0.346	1.162
					(2.420)	(2.789)	(2.711)
D.lnpatents						-0.010	-0.005
						(0.022)	(0.022)
D.lnopeness							-0.204***
							(0.052)
Constant	0.014***	0.180***	0.014***	0.141**	0.009	0.012	0.011
	(0.005)	(0.068)	(0.005)	(0.069)	(0.016)	(0.018)	(0.017)
Observations	492	492	492	492	492	472	472
Number of country	41	41	41	41	41	41	41
Standard errors in parentheses							
*** p<0.01, ** p<0.05, * p<0.1							

Again, results exhibit a positive and significant relationship between changes in coefficients ratio and exchange rate misalignments, which supports our main hypothesis, that is, the entrepreneurs react to exchange rate overvaluations through the substitution of domestic by imported inputs and foreign by domestic sales of final goods, or a combination of both effects. The opposite occurs when the exchange rate depreciates. The behavior of controls is quite

similar to the previously observed. So low and high tech manufacturing sectors do not present distinct reactions, in terms of trade coefficients, to exchange rate misalignments. It is not a surprising result, since the level of their profit margins, as we have showed, are reasonably similar.

5. Final remarks

This article brings the argument that the transmission channel from exchange rate to investment occurs through the influence of exchange rates on profit rates. The initial supposition was the existence of a positive correlation between these variables, but data showed that it is actually very weak (we adopted profit margins as a proxy for profit rates). So, in order to comprehend this result, we supposed that the entrepreneurs try to keep quite stable profit rates through changes in trade coefficients when the exchange rate is misaligned; when it appreciates, entrepreneurs take advantage of cheaper imported inputs (quoted in domestic currency) to maintain their competitiveness and profitability in the domestic market, and substitute foreign by domestic sales since exports turns less profitable. A currency depreciation will imply in the opposite behavior of entrepreneurs. Our tests showed that the ratio between exports and imported inputs coefficients responds to exchange rate misalignments, and this result is compatible with the arguments explained immediately above. So, it seems that this is a possible strategy adopted by entrepreneurs.

Acting in this way, they can be successful in avoiding a profit rate volatility. The strategy related to a depreciation scenario do not imply in subsequent problems for them; by the contrary, it can increase profits and investments, but the strategy adopted in appreciation scenarios has deleterious consequences. When entrepreneurs decide to substitute domestic by imported inputs and also substitute exports by domestic sales through a defensive reaction, they are moving towards a trap, since they contribute to disintegrate the productive chains, reduce the interindustry demand and, as a consequence, the proper demand for final goods in the manufacturing. The extension of this strategy implies in deindustrialization and all the recognized consequences of this process. Consequently, a large period of currency appreciation should be avoided. It will possibly damage the production structure and inhibit the catching-up process, which is understood as a process that should imply in productive sophistication (or economic complexity).

Future researches should analyze the asymmetry between the effects of appreciations and depreciations, in order to check if the reactions to misalignments in both directions is equally fast. It is an important issue because, according to the results of this new study, it is possible to suppose that prolonged appreciation periods can even imply in worse consequences for the manufacturing and the catching-up process.

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Appendix A

The following definitions are necessary:

$RT = Gross\ revenue = Y = Gross\ output$
$Y_{int} = Domestic\ Gross\ Revenue$
$X = Exports\ Revenue\ (in\ R\$)$
$Rme = Average\ Revenue$
$P_{int} = Price\ of\ Final\ Goods\ in\ Domestic\ Market$
$Q_{int} = Amount\ of\ goods\ sold\ in\ Domestic\ Market$
$P_{exp} = Price\ of\ Final\ Goods\ in\ Foreign\ Market (in\ US\$)$
$E = Nominal\ Exchange\ Rate$
$Q_{exp} = Amount\ of\ goods\ sold\ in\ Foreign\ Market$
$Q_v = Toal\ amount\ of\ sold\ goods$
$Q_p = Total\ amount\ of\ produced\ goods$
$Y = Value\ of\ Output\ = RT + \Delta S$
$\Delta S = Stock\ Variation$
$CT = Total\ Cost$
$CMe = Average\ Cost$
$C_{imp} = Imported\ Inputs\ cost\ (in\ R\$)$
$P_{imp} = Imported\ Inputs\ price\ \ (in\ US\$)$
$Q_{imp} = Amount\ of\ imported\ inputs$
$C_{nac} = Domestic\ Inputs\ cost$
$P_{nac} = Domestic\ Inputs\ price$
$Q_{nac} = Amount\ of\ domestic\ inputs$
$W = Total\ Wages\ (labor\ cost)$
$N = Amount\ of\ workers$
$W_m = Average\ Wage = \frac{W}{N}$
$\lambda = \frac{Q_p}{N} = Labor\ Productivity$
$\frac{W_m}{\lambda} = \frac{\frac{W}{N}}{\frac{Q_p}{N}} = \frac{W}{Q_p} = Nominal\ Unit\ Labor\ Cost\ (ULC)$
$L = Total\ profit$
$K = Capital\ Stock$
$\pi = Profit\ Rate$
$m = Profit\ Margin$

The costs and revenues equations are:

$$CT = W + C_{imp} + C_{nac}$$

$$CT = W_m . N + P_{imp} . E . Q_{imp} + P_{nac} . Q_{nac}$$

$$RT = Y_{int} + X$$

$$RT = P_{int} . Q_{int} + P_{exp} . E . Q_{exp}$$

$$CMe = \frac{(W_m.N)}{Q_p} + \frac{(P_{imp}.E.Q_{imp})}{Q_p} + \frac{P_{nac}.Q_{nac}}{Q_p}$$

$$Rme = \frac{(P_{int}.Q_{int})}{Q_v} + \frac{(P_{exp}.E.Q_{\exp})}{Q_v}$$

Considering that:

$$\frac{Q_{imp}}{Q_P} = \alpha = imported\ inputs\ coefficent$$

$$\frac{Q_{nac}}{Q_p} = 1 - \alpha = domestic\ inputs\ coefficient$$

$$\frac{Q_{int}}{Q_v} = \beta = domestic\ revenues\ coefficient$$

$$\frac{Q_{exp}}{Q_v} = 1 - \beta = exports\ coefficient$$

Since,

$$Q_v = Q_{int} + Q_{exp}$$

$$Q_p = Q_{imp} + Q_{nac}$$

And, in order to simplify, that

$$Q_p = Q_v$$

It is possible to redefine the average costs and revenues equations and to determine the profit margin and rate equations:

$$CMe = \frac{W_m}{\lambda} + \alpha.P_{imp}.E + (1 - \alpha).P_{nac}\ ,\ \text{or}$$

$$CMe = CUT + \alpha.P_{imp}.E + (1 - \alpha).P_{nac}$$

$$RMe = \beta.P_{int} + (1 - \beta).P_{exp}.E$$

$$\frac{LMe}{RMe} = \left[\frac{\beta.P_{int} + (1 - \beta).P_{exp}.E}{\beta.P_{int} + (1 - \beta).P_{exp}.E}\right](-)\left[\frac{ULC + \alpha.P_{imp}.E + (1 - \alpha).P_{nac}}{\beta.P_{int} + (1 - \beta).P_{exp}.E}\right]$$

$$m = 1 - \left[\frac{ULC + \alpha.P_{imp}.E + (1 - \alpha).P_{nac}}{\beta.P_{int} + (1 - \beta).P_{exp}.E}\right]$$

$\pi = m.\frac{Y - \Delta S}{K}$, since we consider $Q_p = Q_v,\ \Delta S = 0,$ so $\pi = m.\frac{Y}{K}$

$$\pi = 1 - \left[\frac{ULC + \alpha.P_{imp}.E + (1 - \alpha).P_{nac}}{\beta.P_{int} + (1 - \beta).P_{exp}.E}\right].\frac{Y}{K}$$

Appendix B

Initials	Groups (Based on UNIDO)	Sectors (ISIC, revision 4)
ENE	Energy Production Sectors	- Mining and quarrying - Manufacture of coke and refined petroleum products
LOW	Low Technology Manufacturing	- Manufacture of food products, beverages and tobacco products - Manufacture of textiles, wearing apparel and leather products - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials - Manufacture of paper and paper products - Printing and reproduction of recorded media - Manufacture of furniture; other manufacturing
MEL	Medium-Low Technology Manufacturing	- Manufacture of rubber and plastic products - Manufacture of other non-metallic mineral products - Manufacture of basic metals - Manufacture of fabricated metal products, except machinery and equipment
MEH	Medium-High and High Technology Manufacturing	- Manufacture of chemicals and chemical products - Manufacture of basic pharmaceutical products and pharmaceutical preparations - Manufacture of computer, electronic and optical products - Manufacture of electrical equipment - Manufacture of machinery and equipment n.e.c. - Manufacture of motor vehicles, trailers and semi-trailers - Manufacture of other transport equipment - Repair and installation of machinery and equipment