Structural change in Brazil: rise and fall of industry

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Abstract: This document presents preliminary results of a study about the structural changes occurred within the Brazilian economy from 1947-to 2021. Our objective is to comprehend the elements associated with changes in Brazilian productive structure, and the consequences of different economic policies in terms of industrial labor productivity and Total Factor Productivity (TFP). Our findings indicated that industrial development is positively associated with a competitive real exchange rate, public investment and infrastructure, and an augmented ratio of capital-labor. Our results also suggest a positive and direct influence exerted by these variables on industrial labor productivity and TFP, and an indirect influence via its effects on the productive structure.

Keywords: Structural Change; Economic Policy, Industrial Labor Productivity; Total Factor Productivity; Brazil.
Área Temática para o congresso de Diamantina: ECONOMIA

1- Introduction

Structural change is an important part of the explanation of why some societies are richer than others, or for the cross-countries differences of long-run performance. Industrialized economies are those more developed and with greater economic growth (Kaldor, 1966). Industrialization induces the sectoral integration of economy through backward and forward links a la Hirschman, inducing a pulling effect on the whole economy (Tregenna, 2008). Comparatively, manufacturing activities are more dynamic in terms of capital accumulation and technological progress (Szimai, 2012), as well as better jobs – more qualified and with higher real wages, and more contribution of human capital and institutions' quality to growth (Su and Yao, 2016). Structural change – or diversification of productive structure - toward the industrial sectors instigates creative destruction in the Schumpeterian sense, which is one of the long-run growth's fundaments (Ocampo, 2005). Industrial development increases the labor productivity of the whole economy by absorbing workers from non-industrial activities like primary and services sectors (Ros, 2015).

The objective of this article is to investigate the macroeconomic determinants of structural change - industrialization and deindustrialization - of the Brazilian economy from 1947-to 2021, as well as its consequences in terms of industrial labor productivity and Total Factor Productivity (TFP). First, we performed a set of time-series regressions to explain changes in the composition of the Brazilian productive structure, which is represented by two variables: i- industrial share of GDP and ii- employment in manufacturing activities. Second, we estimated a set of equations to comprehend the association between structural changes in Brazil and the variables industrial labor productivity and TFP. Our equations were estimated using the Autoregressive Distributed Lag cointegration analysis and the ARDL bounds testing approach developed by Pesaran and Shin (1999) and Pesaran et al. (2001).

Our results indicated that the industrialization of the Brazilian economy is positively associated with a competitive real exchange rate (RER), public investment, social infrastructure, and the ratio of capital-labor. In addition, our findings suggest that the development-oriented policies - deliberately adopted as a part of the growth strategy between the 1940s and 1970s, help to explain the Brazilian industrialization. In contrast, there are shreds of evidence that Brazilian deindustrialization is due to the adoption of a non-competitive RER, reduced public investments and infrastructure, and the decline of the ratio of capital-labor adopted after the 1980s. Further, our estimates indicate that the development-oriented policies are directly and positively associated with industrial labor productivity and

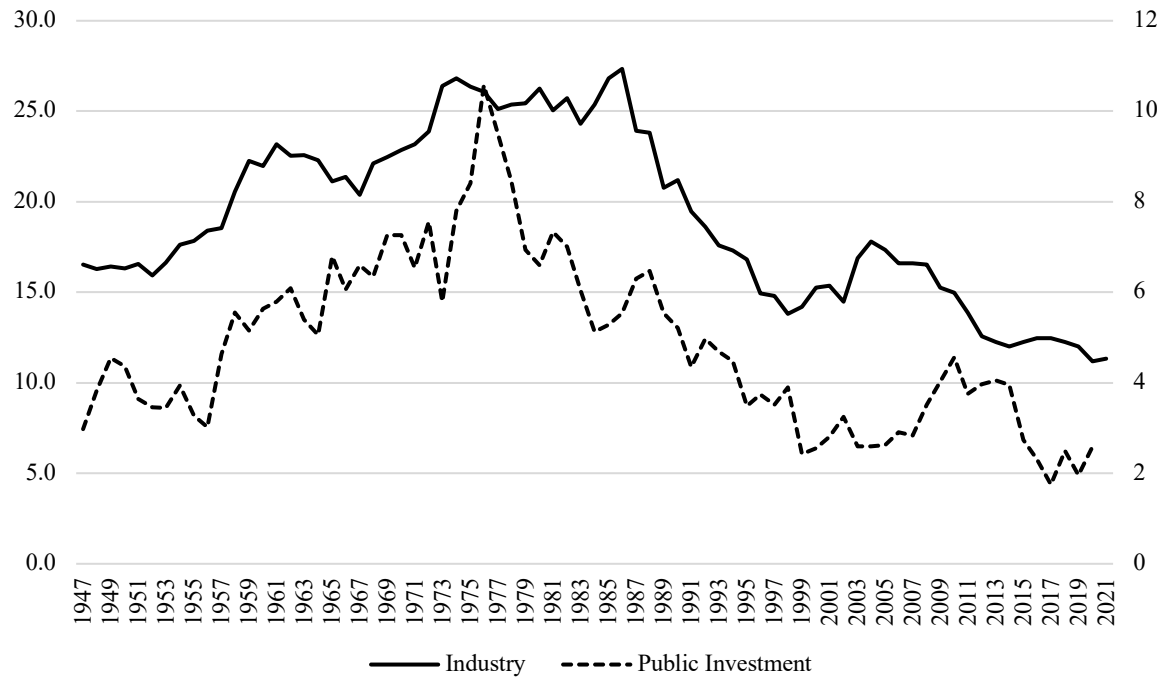
TFP of the Brazilian economy. At last, our regressions point out an indirect and positive effect of development-oriented policies over these variables via changes in the Brazilian productive structure toward manufacturing activities.

This article has four sections, besides this introduction. Section two delivers a very brief discussion on the stylized facts of structural change in the Brazilian economy. Section three presents our empirical strategy. Section four discusses our findings. Section five closes the study with its preliminary conclusions.

2- Structural change in Brazil: stylized facts

The industrialization of the Brazilian economy was a social phenomenon that occurred from the 1940s-to the mid-1980s. Although it was not a linear process, or it has encompassed the sectoral development of manufacturing differently over time, literature is unanimous in affirming that it has occurred a structural change within the Brazilian economy toward industrial activities. The rise of such a process took place over the period when developmentalism policies – embodied in greater interventions of the state in the economy through public investment, were adopted. Graph 1 presents the industrial GDP as a and the public investment as a percentage of GDP for the period between 1947 and 2021.

Graph 1- Structural Change and Public investment in Brazil (1947-2021)



The peak of industrialization of the Brazilian economy occurred in the first half of the 1980s when 27% of GDP was compounded by industrial production. From the 1980s onwards, there has been a consistent decline in this variable, reaching its minimum value of 11% in 2021. In other words, a deindustrialization process has been occurring since the 1980s. It is possible to identify the existence of two periods of intense deindustrialization: i- one between the mid-1980 and the end of the 2000s, and ii- the other one which has been occurring since 2009 (Morceiro, 2018). Complementarily, Graph 1 also points out a favorable evolution of public investment until the end of 1970s when its maximum value was reached 10%, and a sharp decline after this decade, reaching its lower value in 2017, 1,7%, and 2,5% in 2021. Graph 1 suggests a possible positive association between both industrialization of the Brazilian productive structure and the evolution of public investment.

In this regard, Carneiro (2002) argues that the Brazilian economy's first period of intense deindustrialization is connected with the end of the period when developmentalism policies were adopted, which is due to the weakening of the state's capacity of maintaining the development-oriented economic policies because of its fiscal crisis, nationalization of external debt, the use of public tariffs to control inflation and efforts to increase the international reserves (Carneiro, 2002). The objective of industrializing the Brazilian productive structure was replaced by efforts for the control fiscal problems, the external crisis, and the hyperinflation of the 1980s (Carneiro, 2002).

In its turn, the 1990s were characterized by a replacement of development-oriented policies and institutions by the prescriptions of the Washington consensus (Carneiro, 2002). There were an abrupt commercial and financial openness, privatization of public companies, denationalization of national firms and weakening of public banks (Coutinho, 1997; Carneiro, 2002; Nassif et al., 2020). Graph 1 illustrates the deconstruction of developmentalist tools and institutions associated with government interventions over the 1990s, by showing the sharp decline of public investment over this period.

Associated with the decline of public investment, there was a change in the monetary and exchange rate policies after the Real Plan, in 1994. The RER became to be used as a nominal anchor, in a manner that higher real interest rates were employed to attract capital inflows in order to reach a stable and overvalued RER. In a context of abrupt and intense commercial openness, was an economy less diversified and a deindustrialized productive structure (Coutinho, 1997; Nassif and Castilho, 2020). The Brazilian productive structure has specialized in primary exports, services, and low-tech productions. National firms did not have enough conditions to compete with foreign firms for domestic market, and let alone for expand exports (Coutinho, 1997). Such an anti-production bias resulted in the replacement of national production by imports. As a result, in the end of the 1990s, the Brazilian economy became more dependent of imports, more exposed to competition with foreign firms and less associated with exports (Coutinho, 1997; Carneiro, 2002; Britto, 2002).

Many authors stress the importance of RER to the comprehension of the deindustrialization of Brazilian productive structure over the 2000s. The combination of increasing real wages and an overvalued RER – a result of the Dutch disease (Bresser-Pereira, 2016), helps to explain the second period of intense deindustrialization of the Brazilian economy (Nassif et al. 2017; Oreiro, et al. 2018; Oreiro, et al. 2020). Such a combination intensified the process of weakening the manufactured exports in the detriment of imports of industrialized products. By making the imported inputs cheaper, the overvalued RER has offset the augmented labor costs and the low profitability as firms increased the imports of inputs (Marconi and Rocha, 2014). The outcome was premature deindustrialization, decline in industrial investments and in exports diversification, and a slowdown in labour productivity growth (Nassif et al. 2017; Oreiro, et al. 2018; Nassif et al., 2020).

After this very brief discussion, the next section presents the empirical strategy employed in our regressions.

3- Empirical procedures

The empirical strategy consists of estimating a set of time-series regressions to explain the structural change of Brazilian productive structure, which is represented by manufacturing GDP as a share of total GDP (Industry) and employment in manufacturing activities (Employment), and a set of time-series regressions to understand the consequences of the structural change and the adoption of different policies regarding public investment, investments in infrastructure, and RER on Total Factor Productivity (TFP) and labor productivity of manufacturing activities (Productivity). The variable Industry was calculated by the authors using data from Brazilian Institute of Geography and Statistics (IBGE). The variable Employment was also provided by the authors using information from different sources. In turn, the variable TFP comes from the Penn World Table 10.0, while Productivity was calculated using different sources of data. Our variables have different time spans. We strive to maximize the number of years contained in our sample. Table 1 presents our variables.

Table 1- Variables

Variable	Definition and sample	Source
Industry	Manufacturing GDP as a share of total GDP for the period between 1947 and 2021	Calculated by Morceiro (2021) using data from Brazilian Institute of Geography and Statistics (IBGE)
Employment	Employment in manufacturing activities	Calculated by authors by applying the manufacturing employment's annual rate of change from various sources to the 2019 manufacturing employment. Sources of annual variation for each period are: 1950-1976 (Timmer, De Vries, & De Vries, 2016), 1977-1990 (IBGE, 2006), 1991-2000 (IBGE, 2004) e 2001-2019 (IBGE, 2021)
TFP	Total Factor Productivity for the period between 1954 and 2019	Penn World Table 10.0
Productivity	Manufacturing labor productivity	Authors' calculations using IBGE National Accounts data for the value-added variable. See the previous for the employment variable

RER	Real Exchange Rate for the period between 1960 and 2020: negative (positive) values mean a devalued (overvalued) RER	Darvas (2021)
Infrastructure a	Gross fixed capital formation in infrastructure	Júnior and Cornelio (2020)
Infrastructure b	Public investment as a share of GDP	Pires (2022)
Infrastructure c	Investment in construction as a share of GDP	Júnior and Cornelio (2020)
K/L	Ratio of investment in machinery and industrial employment for the period between 1950 and 2017	Júnior and Cornelio (2020) for the value-added variable. See the previous for the employment variable
Infl	Inflation rate for the period between 1947 and 2021: general price index (IGP)	Institute of Applied Economic Research (IPEA)
TOT	Terms of trade: the ratio of prices of exports and of imports for the period between 1947 and 2021	Institute of Applied Economic Research (IPEA)

Source: authors

We estimate a log-linear functional specification to explain the variables associated with structural change of Brazilian economy is presented below:

$$Industry_t = c + b_1RER + b_2Infra + b_3K/L + b_4Infl + b_5Productivity + b_6TOT + \varepsilon_t \quad (1)$$

$$Employment_t = c + b_1RER + b_2Infrastructure + b_3K/L + b_4Infl + b_5TOT + \varepsilon_t \quad (2)$$

In its turn, the log-linear functional specification used in our empirical estimates to explain TFP and Productivity is:

$$TFP_t = c + b_1RER + b_2Infrastructure + b_3K/L + b_4Industry + \varepsilon_t \quad (3)$$

$$Productivity_t = c + b_1RER + b_2Infrastructure + b_3K/L + b_4Industry + \varepsilon_t \quad (4)$$

where c is a constant, RER is the measure of real exchange rate, represented by the logarithm of original values divided by 100, so that negative (positive) values mean a devalued (overvalued) RER in relation to the year-base; Infrastructure is our proxy variable representative of changes in the stock of social infrastructure, we used three different

variables for this purpose - Infrastructure a (gross fixed capital formation in infrastructure), Infrastructure b (public investment as a share of GDP), Infrastructure c (investment in construction as a share of GDP); K/L is the ratio of investment in machinery and industrial employment; Inflation is the general price index; and, TOT is terms of trade. Table 1 presents our dependent variables.

We use the Autoregressive Distributed Lag (ARDL) cointegration analysis and the ARDL bounds testing approach developed by Pesaran and Shin (1999) and Pesaran at al. (2001) to estimate the equations (1)-(4). Such a methodology has several advantages in relation to cointegration methods of Engle and Granger (1987), and Johansen (1988): i- the ARDL approach is an appropriated method when variables are I(0), I(1), or a combination of I(0) and I(1) variables[1]; ii- the ARDL estimates are appropriated to investigate the long-run relationship for a small sample; iii- variables are used in different lags, which improves the efficiency of estimates; iv- the short- and long-run relationships are estimated within a single equation, instead of a system of equations. Generically, equations (1)-(4) can be represented in the ARDL form:

$$\Delta y_t = \alpha + \sum_{i=1}^{k} \Delta x_{t-i} + \delta x_{t-1} + v_t \quad (5)$$

where y_t is the vector of dependent variable, x_t represents a vector of dependent variables, and v_t is the error-term. The appropriated number of lags is chosen according to the Akaike Information Criterion (AIC). Once estimated the ARDL equation, we test the existence of a long-run relationship using the bounds testing procedure, which is a Test-F with a null hypothesis of no cointegration (H_0: $\delta=0$) against the alternative of cointegration (H_1: $\delta\neq0$). In the case of not accept the null hypothesis – that is, there is a long-run relationship between our variables, the long-run multipliers are represented by estimated coefficients for the dependent variables in level, while the short-run multipliers are the estimated coefficients for the dependent variables in first difference. The parameter for the speed of adjustment towards long-run equilibrium (error correction term) should be negative and statistically significant.

Our econometric regressions were performed using different combinations of dependent variables to check their robustness. It should be noticed that not all combinations are associated with a cointegration relationship between our variables, which is required to obtain meaningful estimates. Thus, we presented only regressions that rejected the bounds

[1] Although literature suggests no need for unit root tests, we provide a Table with the usual tests in appendix. No variable has shown I(2).

testing procedures' null hypothesis. The next section presents our estimates for equations (1)-(4).

4- Empirical findings

Our empirical findings are discussed in what follows. All estimates have fitted well. The lag number of variables was chosen according to AIC. The Breusch Pagan test indicated a non-correlated error term. The bounds testing procedure pointed out the existence of a long-run relationship between our variables at least at 5% of critical values (at 1% for most of our regressions). The estimated parameter for the speed of adjustment towards equilibrium was negative and statistically significant in all regressions.

4.1- Structural change

Table 2 presents six different regressions performed to explain the variable Industry. Regarding the long-run multipliers, our findings indicated the importance of RER, investment in infrastructure, and the ratio of investment in machinery and industrial employment to explain the composition of the Brazilian productive structure in terms of manufacturing GDP as a share of total GDP, since only these variables were statistically significant. In contrast, the variables inflation, productivity, and TOT were not statistically significant.

The estimated parameter for the variable RER was negative and statistically significant at 1% of critical values in all regressions. Such a result indicates that a more competitive RER is associated with a structural change in direction of a more industrialized productive structure, whereas the adoption of a non-competitive RER is part of the explanation for the deindustrialization of the Brazilian economy. In its turn, the estimates suggest a positive parameter for the variables Infrastructure a[2] and K/L. This piece of evidence indicates that greater investments in infrastructure and an enhanced capital-labor ratio are positively associated with industrial development, and vice-versa. Table 2 is presented below.

Table 2- Structural change (dependent variable: Industry)

Model	(1)	(2)	(3)	(4)	(5)	(6)
			Econometric tests			
Best model	(2, 3, 0)	(1, 0, 2)	(1, 0, 0)	(1, 0, 1, 0)	(1, 0, 1, 0)	(1, 1, 1, 0, 2, 0, 0)

[2] We have performed estimates using the variables Infrastructure b and/or Infrastructure c. However, the Bound F-test of these regressions did not fit well.

(Aic)	-187.0	-196.5	-191.7	-186.7	-185.1	-190.2
BG test (p-value)	0.46	0.33	0.26	0.64	0.97	0.62
Bound F-test (p-value)	F= 7.57 0.00	F= 8.31 0.00	F= 4.90 0.03	F= 5.87 0.00	F= 5.45 0.00	F= 4.46 0.00
Short-run multipliers						
RER	-0.72*** [0.18]	-1.06*** [0.29]	-1.40* [0.72]	-0.66*** [0.18]	-0.63*** [0.21]	-0.70** [0.30]
Infrastructure a	0.61*** [0.07]			0.45*** [0.10]	0.49*** [0.06]	0.29 [0.19]
K/L		1.25*** [0.20]				0.79* [0.43]
Inflation			-0.07 [0.06]			-0.02 [0.02]
Productivity				0.32 [0.23]		-0.03 [0.34]
TOT					-0.13 [0.16]	0.05 [0.28]
Long-run multipliers						
RER	-0.72*** [0.18]	-1.06*** [0.29]	-1.40* [0.72]	-0.66*** [0.18]	-0.63*** [0.21]	-0.70** [0.30]
Infrastructure a	0.29*** [0.07]			0.16 [0.16]	0.25*** [0.06]	0.05 [0.19]
K/L		0.59*** [0.20]				0.46 [0.43]
Inflation			-0.07 [0.06]			-0.03 [0.02]
Productivity				0.32 [0.23]		-0.03 [0.34]
TOT					-0.13 [0.16]	-0.48 [0.28]
Speed of Adjustment towards equilibrium						
Ect. (p-value)	-0.24*** [0.18]	-0.15*** [0.04]	-0.09*** [0.04]	-0.24*** [0.05]	-0.25*** [0.07]	-0.21*** [0.08]

Notes: a- standard errors between brackets; b- regressions of Table 2 were performed with the introduction of a time trend; c- intercept and trend parameter are not presented due the limited space, which is available upon request; d- *, ** and *** mean, respectively, statically significant at 10%, 5% and 1% respectively; e- all regressions were performed using the option max lag(3) according to the Akaike information criterion (Aic).

Table 2 also pointed out the existence of a positive association between a competitive RER, investments in infrastructure, and a greater capital-labor ratio with industrial development in a short-run perspective for the Brazilian economy.

Table 3, below, reports the regressions performed to explain the variable Employment. Its findings are in line with Table 2's results. The long-run multipliers indicated the importance of variables RER and investment in infrastructure to explain changes in employment in manufacturing activities. The estimated parameter for RER was statistically significant at least at 5% of critical values and negative in all regressions, which points out that a competitive (non-competitive) RER expands (harms) the manufacturing work. In its turn, the estimated parameter for the variable Infrastructure a is positive and statistically significant at 1% of critical values in all estimated equations of Table 3. Therefore, this is an indication that expansions (reductions) of investments in infrastructure spark (impair) the creation of jobs in manufacturing activities. Put differently, economic policies associated with pursuing a competitive RER and greater values of investments in infrastructure unleash a structural change in the Brazilian economy by transferring workers from non-industrial activities to manufacturing a la Lewis (1954).

Table 3- Structural change (dependent variable: employment in manufacturing activities)

Model	(1)	(2)	(3)	(4)	(5)
Econometric tests					
Best model	(1, 1, 1)	(1, 1, 1, 0)	(1, 0, 1, 0)	(1, 0, 1, 0, 0)	(1, 1, 1, 0, 0, 2)
(Aic)	-211.5	-209.9	-211.2	-209.5	-220.7
BG test (p-value)	0.41	0.21	0.86	0.39	0.45
Bound F-test	F= 10.7	F= 8.01	F= 10.5	F= 8.36	F= 8.49
(p-value)	0.00	0.00	0.00	0.00	0.00
Short-run multipliers					
RER	0.75	0.70	0.66	0.70	0.40
	[0.59]	[0.81]	[0.52]	[0.54]	[1.18]
Infrastructure a	1.43***	1.41***	0.84***	0.92***	1.60***
	[0.15]	[0.24]	[0.14]	[0.21]	[0.32]
K/L		0.30		-0.24	-0.01
		[0.53]		[0.47]	[0.64]
Inflation			-0.04	-0.05	-0.02
			[0.03]	[0.04]	[0.05]
TOT					2.75***
					[0.91]
Long-run multipliers					
RER	-1.47**	-1.71**	-1.45***	-1.32**	-2.46**
	[0.59]	[0.81]	[0.52]	[0.54]	[1.18]
Infrastructure a	0.87***	0.76***	0.84***	0.92***	0.99***
	[0.15]	[0.24]	[0.14]	[0.21]	[0.32]
K/L		0.30		-0.21	-0.01

		[0.53]		[0.47]	[0.64]
Inflation			-0.04	-0.05	-0.02
			[0.03]	[0.04]	[0.05]
TOT					0.89
					[0.91]
Speed of Adjustment towards equilibrium					
Ect.	-0.06***	-0.06***	-0.07***	-0.07***	-0.05***
(p-value)	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]

Notes: a- standard errors between brackets; b- intercept is not presented due the limited space, which is available upon request; c- *, ** and *** mean, respectively, statically significant at 10%, 5% and 1% respectively; d- all regressions were performed using the option max lag(3) according to the Akaike information criterion (Aic).

Furthermore, Table 3's results indicate that only the influence of investment in infrastructure is statistically significant for the short-run dynamic of the Brazilian economy in a manner that greater values of this variable expand the manufacturing jobs.

4.2- Total factor productivity and labor productivity of manufacturing activities

Table 4 displays the regressions performed to explain the variable TFP. The results of the long-run multipliers delivery robust evidence that investments in infrastructure, greater values of the ratio capital-labor, and industrialization of the productive structure are associated with gains in TFP, and vice-versa.

The estimated parameters for the variables Infrastructure b and Infrastructure a[3] are statistically significant at 1% of critical values and positive in all regressions. This shred of evidence is suggestive that expansions (reductions) of infrastructure and public investment (as a share of GDP) exert a positive (negative) influence on TFP. Complementarily, the estimated parameter for the variable Industry was statistically significant at 1% of critical values and positive. This suggests that gains/losses of Brazil's TFP are associated with the composition of its productive structure. In other words, considering the period under consideration of this study, promoting a structural change towards manufacturing activities expands Brazilian TFP, whilst a deindustrialization process – specialization in services and primary activities, lowers its TFP. Further, our results also indicate that expansions in capital-labor ratio exert a positive influence on TFP. In contrast, our findings have not provided robust evidence that RER directly exerts influence on TFP, since this variable was statistically significant in only one of Table 4's regressions. Table 4 is presented below.

[3] Once again it should be stressed that we have performed various estimates with different combination of the variables Infrastructure a, Infrastructure b, and Infrastructure c. However, not all Bound F-test have fitted well.

Table 4- Total factor productivity

Model	(1)	(2)	(3)	(4)	(5)	(6)
Econometric tests						
Best model	(1, 0, 0)	(1, 0, 0, 1)	(1, 0, 0)	(1, 0, 0, 1)	(1, 0, 0, 0)	(1, 1, 1, 0)
(Aic)	-249.1	-261.4	-253.1	-263.9	-239.8	-252.2
BG test (p-value)	0.78	0.76	0.17	0.90	0.66	0.95
Bound F-test	F= 5.80	F= 7.11	F=7.49	F= 8.00	F= 6.61	F= 4.55
(p-value)	0.01	0.00	0.00	0.00	0.00	0.03
Short-run multipliers						
RER	-0.17	-0.35***	0.08	-0.13	0.04	0.05
	[0.15]	[0.12]	[0.15]	[0.11]	[0.09]	[0.15]
Infrastructure b	0.21***	0.18***				
	[0.06]	[0.04]				
K/L		0.94***		0.75***		
		[0.07]		[0.06]		
Industry			0.44***	0.35***	0.36***	1.12***
			[0.12]	[0.07]	[0.07]	[0.12]
Infrastructure a					0.10***	
					[0.03]	
Infrastructure c						0.49**
						[0.18]
Long-run multipliers						
RER	-0.17	-0.35***	0.08	-0.13	0.04	0.05
	[0.15	[0.12]	[0.15]	[0.11]	[0.09]	[0.15]
Infrastructure b	0.21***	0.18***				
	[0.06]	[0.04]				
K/L		0.18**		0.22***		
		[0.07]		[0.06]		
Industry			0.44***	0.35***	0.36***	0.35***
			[0.12]	[0.07]	[0.07]	[0.12]
Infrastructure a					0.10***	
					[0.03]	
Infrastructure c						0.02
						[0.18]
Speed of Adjustment towards equilibrium						
Ect.	-0.14***	-0.17***	-0.15***	-0.20***	-0.26***	-0.15***
(p-value)	[0.04]	[0.04]	[0.03]	[0.04]	[0.06]	[0.05]

Notes: a- standard errors between brackets; b- intercept and trend parameter are not presented due the limited space, which is available upon request; c- *, ** and *** mean, respectively, statically significant at 10%, 5% and 1% respectively; d- all regressions were performed using the option max lag(3) according to the Akaike information criterion (Aic).

Table 4's results also indicate that expansions in all dependent variables – except for RER, exert a positive influence on TFP of Brazilian economy for its short-run dynamic.

Table 5 presents our regressions performed to explain the labor productivity of manufacturing activities. Our findings regarding the long-run multipliers suggest that the estimated parameter for the variable RER is statistically significant at 1% of critical values in most regressions and negative, which indicates that a competitive (non-competitive) RER is associated with a greater (lower) industrial work productivity. In its turn, the variable K/L has also been shown statistically significant at 1% of critical values, with a positive parameter, indicating that as higher (lower) is the capital-labor ratio, the greater (smaller) is the industrial work productivity. Further, we performed various regressions with several combinations of our three variables proxy for infrastructure. Yet, only the equations employing the variable Infrastructure c provided consistent estimations according to the ARDL bounds testing approach. Thus, we have focused on these estimates. The estimated parameter for the variable Infrastructure c was statistically significant at 1% of critical values and positive in all regressions. Consequently, this evidences that expansions of investment in construction (as a share of GDP) are positively associated with manufacturing labor productivity. Table 5 is presented below.

Table 5- Manufacturing labor productivity

Model	(1)	(2)	(3)	(4)
Econometric tests				
Best model	(1, 1, 0, 1)	(1, 1, 0, 0, 1)	(1, 1, 0, 0, 1)	(1, 2, 0, 0, 1)
(Aic)	-214.7	-214.1	-207.9	-214.3
BG test (p-value)	0.48	0.65	0.68	0.70
Bound F-test	F= 4.87	F= 4.15	F= 3.67	F= 4.57
(p-value)	0.02	0.04	0.08	
Short-run multipliers				
RER	-0.46***	-0.44***	-0.48***	-0.26
	[0.15]	[0.16]	[0.16]	[0.16]
Infrastructure b		0.08		
		[0.08]		
K/L	1.68***	1.84***	1.76***	1.59***
	[6.36]	[0.11]	[0.18]	[0.09]
Industry				0.18
				[0.12]
Infrastructure a			-0.02	
			[0.11]	
Infrastructure c	-0.12	-0.28*	-0.11	-0.20

	[0.15]	[0.16]	[0.17]	[0.14]
Long-run multipliers				
RER	-0.46*** [0.15]	-0.44*** [0.16]	-0.48*** [0.16]	-0.26 [0.16]
Infrastructure b		0.08 [0.08]		
K/L	0.37*** [0.10]	0.38*** [0.11]	0.41*** [0.18]	0.40*** [0.09]
Industry				0.18 [0.12]
Infrastructure a			-0.02 [0.11]	
Infrastructure c	0.46*** [0.15]	0.46*** [0.16]	0.48*** [0.17]	0.55*** [0.14]
Speed of Adjustment towards equilibrium				
Ect. (p-value)	-0.19*** [0.04]	-0.18*** [0.04]	-0.18*** [0.05]	-0.21*** [0.04]

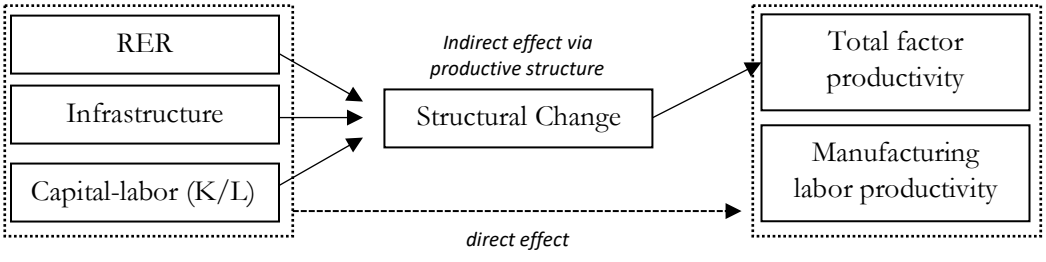
Notes: a- standard errors between brackets; b- intercept and trend parameter are not presented due the limited space, which is available upon request; c- *, ** and *** mean, respectively, statically significant at 10%, 5% and 1% respectively; d- all regressions were performed using the option max lag(3) according to the Akaike information criterion (Aic).

The estimated parameters of the short-run multiplier of Table 5 indicate that a competitive RER and greater values of the variable K/L are positively associated with the short-run dynamic of industrial labor-productivity of the Brazilian economy.

5- Concluding remarks

This article – a result of ongoing research, is an effort to comprehend the drivers of structural changes within the Brazilian productive structure, and its consequences in terms of industrial labor productivity and TFP. Our results reveal that economic policies associated with RER, public investment and social infrastructure, and the ratio of capital-labor employed in the manufacturing process are intrinsically associated with the structural change of Brazilian economy. We identified two channels through which these policies may influence its economic performance, as it is described by Figure 1, below:

Figure 1- Triggers of structural change and its consequences



Source: authors

In a hand, our findings suggest that managing the RER's policy influences the Brazilian productive structure. Pursuing a competitive RER explains, in parts, its industrialization process, while a non-competitive RER is part of the explanation for its remarkable deindustrialization. Moreover, there are shreds of evidence suggestive that expansions of public investment and a better infrastructure also help to understand why Brazilian manufacturing has developed during periods of developmentalism periods, and why reductions in public investment and a worse infrastructure are associated with deindustrialization after the 1980s. Further, changes in the ratio of capital-labor employed in productive activities have also been proved part of the explanation for the rise and fall of the Brazilian industry. In a manner that fostering the capital accumulation in relation to employed workers fosters industry. Our estimates confirmed these aspects for our two different variables representative of changes of productive structure: i- manufacturing share of GDP, and ii- employment in manufacturing activities. This primary outcome occurs via the composition of productive structure, which exerts an indirect effect over the Brazilian economy's TFP. Put differently, there is an indirect effect of the developmentalist policies that, by promoting the industrialization of the Brazilian economy, results in a greater TFP.

On the other hand, our estimated equations also point out the existence of a direct effect of developmentalist policies on TFP and manufacturing labor productivity. Pursuing a competitive RER, the adoption of greater public investments and better infrastructure, and augmenting the proportion of machinery in relation to employed workers in manufacturing push up both variables. Therefore, adopting a set of developmentalist policies helps to explain the rise of Brazilian industry and its consequences in terms of enlarged TFP and manufacturing labor productivity, whereas the adoption of an agenda associated with non-competitive RER, reduction of statal intervention in the Brazilian economy is a substantive part of the reasons why it has been occurring deindustrialization in its productive structure.

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