What determined labour productivity in the Brazilian manufacturing industries in the 2000s?

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1. Introduction

- Krugman (1994)

Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.

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A "cliché" from the mainstream's current interpretation on the poor performance of Brazilian economy in the last decades

Low economic growth rates are the result of low labour productivity growth in the last few decades in the Brazilian economy. However, according to the so-called Kaldor-Verdoorn Law, the reciprocal could also be true: the low growth rates of labour productivity in Brazil could be an effect of the low growth rates of the real GDP.

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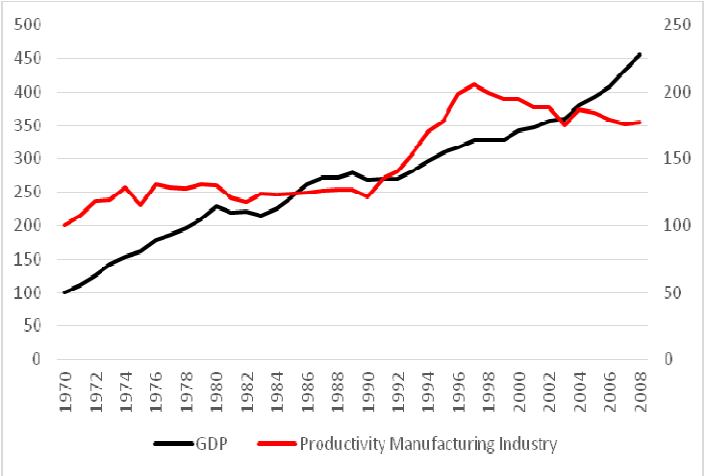
Figure 1: Change in manufacturing labour productivity and real GDP 1970-2008 – in index number: 1970=100



The behaviour of real GDP growth and labour productivity growth was more or less disconnect from each other

Source: ECLAC-PADI database for manufacturing productivity and IPEA data for real GDP.

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Table 1: Yearly growth rates of aggregate labour productivity in Brazil (1961-2012 – in percentage)

Average	Labour productivity
1961-1970	3.5
1971-1980	4.8
1981-1990	(-0.9)
1991-2000	0.7
2001-2012	1.2

Source: Bonelli and Fontes (2013:7)

Labour productivity growth in the Brazilian economy as a whole has been very poor or mediocre since the early-1980s.

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Since the mid-1990s, the technological gap has increased in all industries of the Brazilian manufacturing sector

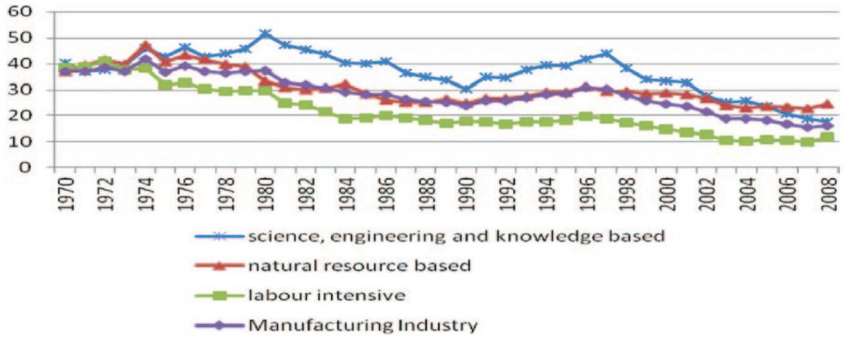

Fig. 6. *The Brazilian technological gap: relative labour productivity in the Brazilian manufacturing sector compared with that of the USA, 1970–2008 (as a percentage).*
Source: ECLAC-PADI

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2. Labour productivity: concept, determinants and a theoretical model

Productivity is the measure of the efficiency of the combination of all inputs in the production process.

- Neoclassical approach: Total Factor productivity (TFP)

Syverson's (2010) argument: Differently from labour productivity, TFP is invariant to the intensity of use of observable inputs.

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Critique to TFP approach

- Nelson (1961): By being based on Solow's theoretical model, TFP treats technological progress in a very simple way. And the Schumpeterian proposition that technological advance (via entrepeneur innovation) and competitive equilibrium cannot coexist is ignored.
- Abramovitz (1986, 1993): Technological progress measured as a residual ("a measure of our ignorance") misses important elements for productivity variation such as education, on-the-job training, research and development (R & D) and so on.

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For estimating the determinants of productivity, we prefer the traditional concept of labour productivity

- (Observed) labour productivity is calculated as the value added per hours worked (or, alternatively, as the ratio value added to numbers of employees)

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Reasons:

- by capturing the intensity of use of the other production factors, labour productivity indirectly incorporates the contribution of all of them
- labour productivity is a reliable measure for evaluating the efficiency at both the microeconomic and macroeconomic levels
- together with the per capita income growth over time, labour productivity has traditionally been used for evaluating economic and social convergence or divergence among countries (see, for instance, Baumol, 1986, León-Ledesma, 2002, and McMillan and Rodrik, 2011).

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In principle:

- The concept of labour productivity could be seen as totally determined by supply-side forces (by definition)
- However, as many theoretical and empirical studies have emphasised, the behaviour of labour efficiency is affected by both supply and demand forces

See, for instance, Dixon and Thirlwall, 1975, DeLong and Summers, 1991, León-Ledesma, 2002, and Syverson, 2010.

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The theoretical model: a modified version of Leon Ledesma's model

$$r = a + \alpha\, y + \beta \left(\frac{I}{VA} \right) + \varphi\, Innov$$

r is the labour productivity growth;

a is the constant term;

y is the real GDP growth;

I/VA is the investment ratio (the ratio of the gross investment to the value added);

and *Innov* is a variable associated with innovation

$\propto$, β and φ are positive coefficients.

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3. Labour productivity: empirical evidence for the Brazilian manufacturing industries in the 2000s

- Econometric model:

$$r_{it} = \alpha + \alpha y_t + \beta \left(\frac{I}{VA} \right)_{it} + \varphi Innov_{it} + e_{it}$$

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Sectoral data for 21 industries of the Brazilian manufacturing sector (2000-2008)

- Labour productivity by industry: ECLAC-PADI
- Real GDP: IBGE
- Ratio Gross Investment to value added by industry (Miguez et.al.,2014)
- Proxy for innovation by industry: Ratio of expenditures in R&D to total of net revenues with sales of goods and services (Pintec-IBGE)

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Issue:

- Industrial Technological Surveys (PINTEC) are available only for few years (2000, 2003, 2005, 2008
- So have several econometric models: one with a larger sample without the variable related to innovations;

and two non-balanced panel models capturing the variable associated with innovation – issue: a smaller sample

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Some advantages of estimating by panel data models:

- the use of a larger amount of information by combining sectoral data with time series, so that the available productivity data for the 21 sectors of the Brazilian manufacturing industry could be related to the explanatory variables between 2000 and 2008
- 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;
- the reduction of the risk of multicollinearity, since data from the different sectors of the manufacturing industry have different structures;
- the introduction of dynamic adjustments, which the cross-section analysis would not allow

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Hausman test: Data with ramdon effects are best fitted

- **First econometric results**

Table 2: Labour productivity determinants - The static model

	Random effect (1)	Random effect (2)	Random effect (3)
Y_t	1.48***	1.90***	5.69***
	(3.96)	(2.98)	(4.91)
$(I/VA)_{it}$	-0.004	-0.005	
	(-0.42)	(-0.31)	
$I/VA_{i(t-1)}$			0.044**
			(2.09)
$Innov_{it}$		0.044*	0.071**
		(1.92)	(2.51)
a	-0.08***	-0.14	-0.23**
	(-3.15)	(-3.23)	-(3.05)

Note: *t* test in brackets, *** significant at 1%, ** significant at 5% and * significant at 10%

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Endogeneity issues

- Solution: A dynamic panel data with the Generalized Method of Moments (GMM) as proposed by Arellano and Bond (1991)

$$r_{it} = a + \mu r_{i(t-1)} + \alpha y_t + \beta(I/VA)_{it} + e_{it}$$

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- **Second econometric results:**

Table 3: Labour productivity determinants – The dynamic model

y_t	2.15***
	(4.71)
$(I/VA)_{it}$	-0.047
	(-1.17)
a	-0.19**
	(-2.44)
$r_{i\,(t-1)}$	-0.18**
	(-2.22)

Note: t test in brackets, *** significant at 1%, ** significant at 5% and * significant at 10%

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Descriptive statistics analysis:

Table 4: Gross capital formation - Real average growth rates (2000-2008 – in percentage)

	2000-03	2003-05	2005-08	2000-08
Infrastructure	-3.9	7.3	21.2	7.8
Families	1.2	0.8	5.9	2.8
Natural Resources	0.3	9.1	10.7	6.3
Mass Consumption	-8.0	6.2	13.2	3.1
Capital Goods and Intermediate Goods Industries	-8.6	16.3	8.6	3.5
Total Economy	-3.2	6.4	12.4	4.8

Source: Bielschowsky *et al* (2014), Table 2

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4. Conclusion and policy implications

- In the several econometric models we ran, the real GDP growth was the most significant variable to explain the behaviour of labour productivity in the manufacturing industries in Brazil in the 2000s.
- In most models we ran, the gross investment was not significant to explain the behaviour of the labour productivity in the manufacturing industries in Brazil throughout the 2000s.

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- The investment only showed to be significant when it was included into the model with a lag of one period and when innovation was incorporated as one of the explanatory variables of the labour productivity. Although this result seems to be consistent with theoretical expectations, it must be carefully analysed because, as innovation data is available for only few years, the number of observations is too few to make the empirical conclusion robust.
- Rather than concluding that, in general terms, gross investment is not important for boosting labour productivity in the economy, our results suggest that, in the case of Brazil in the 2000s, gross capital formation grew at very low rates – in fact, at rates lower than those of the economy as a whole – in sectors with a high capacity of technological innovation and a high capacity to spill over their gains from productivity to the economy as a whole.

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- These results are also consistent with several recent studies which show empirical evidence that early de-industrialisation in Brazil intensified in the 2000s (Oreiro and Feijo, 2013; Nassif, Feijo and Araujo, 2013; Bacha, 2013, among others)

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Policy implications

Although suggestions of economic policies go further than the scope of this paper, even so any attempt for boosting labour productivity and real GDP growth rates in Brazil should include instruments that contribute to reaching three important goals:

- i) the reduction of the high degree of uncertainty that still prevails in the economy (at the time of finalising this paper in July 2014);
- ii) the decrease of the high real interest rates;
- and iii) the elimination of the long-term real overvaluation trend of the Brazilian *real*, a phenomenon that has been observed since the mid-1980s in Brazil

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THANK YOU!

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