Labour productivity in Vertically Integrated Sectors: An empirical study for the case of Brazil

José Bruno Fevereiro[†]
Carlos Pinkusfeld Bastos[*]
Fábio Freitas[*]

Abstract:

This article proposes an analysis of the evolution of labour productivity in the perspective of vertically integrated sectors (VIS), based on the framework originally proposed by Pasinetti (1973). The paper argues that the analysis of labour productivity in terms of VIS avoids capture, as increased productivity, effects arising from mere outsourcing of activities, as is the case of the direct labour productivity measure (physical output per worker), or change in relative price, as it happens with the apparent labour productivity measure (value added per worker). The work than makes an application of the proposed methodology for the Brazilian economy in the 2000-2008 period by analysing the performance of the VIS and comparing the results obtained with the traditional measures. Overall, the results shows a better performance of labour productivity of the VIS associated with final goods in the manufacturing industry vis-à-vis the measure of direct labour productivity of the activities of the manufacturing industry. These results indicate that significant productivity gains occurred in suppliers activities of intermediate inputs used in the production of manufacturing final goods.

[†] MRes candidate at The Open University Business School, United Kingdom, and MsC in economics by the Institute of Economics of the Federal University of Rio de Janeiro (IE/UFRJ)
* Professor at the Economics Institute of the Federal University of Rio de Janeiro (IE/UFRJ)

Introduction

The first decade of the twenty-first century was characterized as an important period in the trajectory of the Brazilian economy. Major changes in economic policy occurred from 1999 onwards with the implementation of the inflation targeting, floating exchange rates and high targets of primary surplus balance for the public sector. New substantial discoveries of high quality deep-water oil coupled with a commodity mini-cycles with expansion of prices and international were key factors relaxing the external constraint. A factor which had been a binding aspect of the country's economic performance in the previous decades, which had led the country to pursue multiples bailouts with the IMF in the period after 1979, the last time being in 1999. The combination of favourable international conditions with policies of income redistribution and expansion of credit introduced after 2004 produced the conditions for an acceleration of the economic growth, which was further enhanced by an expansive fiscal policy based on the expansion of public investment after 2006 (Serrano and Summa, 2011). After two decades of sluggish economic growth[1], GDP per capita increased at an average rate of 2.7% p.a. between 2000 and 2008, the run up to the international financial crisis. Inflation targets were met by the Central Bank after 2004 at the cost of a continual appreciation of the exchange rate, driven by capital flows attracted by prevailing high interest rates. This feature sparkled an intense debate about the sustainability of the economic growth considering the negative impact on industrial and manufacturing competitiveness and the rapid deterioration of the current account balance (Serrano and Summa, 2011).

Permeating this macroeconomic situation, a topic that was present in the debate was the performance of the manufacturing sector. Although the sector was presenting consistent positive growth rate gross and net output, with increasing employment rates, a decline in labour productivity indexes (when measured through the concept of value added) of -0.3% p.a. between 2000 and 2008 and a decline in the share of manufacturing output in GDP, when measured in current prices, produced concerns with hypotheses that a deindustrialization process was occurring in the Brazilian economy.

This short outlook of the Brazilian economy in the 2000's provides the backdrop and starting point for our paper. In a scenario of appreciation of the exchange rate, with real wages increases and apparently negative grow rates of labour productivity, how was the manufacturing sector able to maintain growth both in output and in employment?

In order for these discussions to generate an adequate understanding of what happened in the period, it is important to have indicators, and specifically with an indicator of labour productivity that correctly reflects the facts that have occurred. Contrary to what one might initially think, this is not a trivial task. As discussed in De Juan and Febrero (2000), a good indicator of labour productivity depends fundamentally on the purposes (of the objective) to which the study intends to fit. In general, productivity studies are interested in the competitiveness of a firm, industry or economy, while some of them are also interested in the

[1] Average GDP per capita growth rate in the 1980s was of -0.4% p.a. and 0.9%p.a. in the 1990s. For a detail analysis of Brazil's long-run economic performance see Freitas and Dweck (2013) which provides a growth accounting decomposition from a demand perspective.

relationship between productivity and social welfare or economic growth. In addition another requirement of a good productivity index, put forward by the authors, would be that movements of this variable should be exclusively related to technical progress and, thus, the analyst, while studying competitiveness, should disregard indexes that capture changes in the distribution or composition of production as productivity changes.

As Dietzenbacher et. al. (2000) argues, this is the case of conventional measures of labour productivity. These may capture changes in the organization of underlying production process (when using gross product) or in the relative price structure between the different stages of the production chain (when value added is used) as changes in the labour productivity of a firm or sector. A clear example of these possible biases is the reorganization of the productive process through the outsourcing of activities such as accounting, engineering and architecture services, cleaning and security, among other activities by manufactures to specialized firms. Although, in the aggregate, the production might be carried out by exactly the same number of workers, the measured labour productivity of the outsourcing sector would be enhanced. Though the motivation of outsourcing is to transfer activities to specialized firms that, in theory, would be more efficient in providing these services (otherwise they would lose their *raison d'être*), the consequences in terms of growth, economic development and inflation would be different from gains accruing from *stricto sensu* technological progress or from increasing returns to scale. In short, measured sectoral labour productivity gains accruing from outsourcing would have much lower effects on the "real" labour productivity of the economy or of the production chain, and would reflect incorrectly changes in production costs, thus not being good indicators of the evolution of prices and the competitiveness of a sector in the production of commodities.

Therefore, this paper aims is two folded. In the one hand, the paper has a methodological aim. It uses Brazil experience in the 2000's to highlight the methodological shortcomings of the traditional measures of labour productivity and provides an alternative measure, which uses of the concept of Vertically Integrated Sectors (VIS) as the disaggregated unit of analysis, which reflects only changes in production efficiency. Secondly, it uses the measure of Labour productivity of the VIS, dubbed as Total Labour Productivity (TLP), to analyse the performance of the Brazilian economy in terms of VIS. The results provide an interesting insight as the TLP of manufacturing products, in general, increase at a faster pace than labour productivity in manufacturing sectors measured by conventional measures of labour productivity, which evidence increased gains of efficiency in supporting activities which provides inputs and intermediary service to manufacturing production.

The paper is, thus, divided in five sections including this introduction. The following section provides an overview of the different measures of labour productivity highlighting the problems regarding each one. The third section discusses the data used in this study and the procedures necessary to operationalize the calculations. The forth section presents the results, dividing them into two subsections. The first part concentrates in the comparison in the results of the Direct Labour Productivity (DLP) and TLP. While the second part focuses on the

performance of the VIS in the period under analysis. The fifth section presents some concluding remarks.

Methodological Discussion

At the most intuitive level, the concept of physical productivity is generally understood as the quantity of product obtained per unit of input, and this idea underlies any productivity index. However, as argued by De Juan and Febrero (2000), problems and disagreements appear from the moment it is necessary to define what to include in the numerator and in the denominator.

The most elementary index of sectoral productivity is obtained from the ratio between total production (q_i) of any sector for the labour directly employed in it (L_i). This relationship coincides with the inverse of the direct labour requirement coefficients (l), and will be referred to in the rest of the paper as direct labour productivity (DLP):

$$DLP = \frac{q_i}{L_i} = \frac{1}{l}$$

Changes in the productivity of a particular sector's may stem from a number of real processes, such as technical progress and increasing returns to scale. However, they can also be caused by changes in the underlying productive structure. As stated by Juan and Febrero (p.12, 2000):

> During a time European politicians were proud of the great advances in agricultural productivity: half the peasants were able to produce twice as many goods. Yet, at the crucial moment it was shown that the difference in costs with American products had increased. Politicians had been too naive; they forgot to compute the increase in intermediate goods and fixed capital used by agriculture.

The direct labour productivity measure, thus, will overestimate the productivity increase of the firm in a case where activities of the productive process are outsourced. With an increase in the use of intermediate goods (services) or fixed capital the resulting drop in the production cost would be much lower as the actual efficiency gains in the production process will be much lower than the one measured by the direct labour productivity measure. In addition, differences in the level of direct labour productivity between the different sectors will depend on the stage of the productive chain in which each sector is acting, i.e. sectors that are inserted in the final stages of the chain would have higher levels of productivity than the initial stages. Nevertheless, this will be merely a consequence of the high share of intermediate consumption in the gross value output of sectors inserted in the final stages of the production chain.

Aware of this issue, the use of added value per worker, which we will refer as Apparent Labour Productivity (LP_a), is widely adopted in the literature:

$$\mathrm{LP}_a = \frac{VA_i}{L_i}$$

By this metric, the overestimation of productivity may disappear. However, the roots of the problem are not removed. Instead of including both the direct and indirect labour required for physical production in the denominator, the choice is to reduce the numerator in an improper way, in our view. This measure can only be obtained from data expressed in value and, thus, to obtain a measure expressed in real terms it is necessary to use the double deflation method. The result is that the real value added is obtained from the difference between the gross value of production and the intermediate consumption, both deflated by their respective deflators. As a consequence, the associated labour productivity metrics can vary without any effective efficiency gain in the production process actually taking place, resulting only from a change in the relative prices between the gross output and the intermediate consumption (Dietzenbacher and Hoen, 1999).

Alternatively, the proposed research aims to analyse the evolution of labour productivity from a vertically integrated sectors perspective, which enables the research to avoid the accounting problems described above. The concept of vertically integrated sectors was developed in the works of Pasinetti (1973, 1981), based on the contribution of Sraffa (1960), in which the productive system is analysed based on the concept of subsectors (vertically integrated sectors) in which all stages of production are integrated within a well-defined independent and complete production system, without any other exchange with the other sectors of activity taking place.

The logic behind this is to classify each industry based on its final good, identifying the contribution of each industry to the production process of each final good. As such, a VIS can be defined as the total activities used directly and indirectly throughout the productive process of a good or final service, which leads some authors to refer to the VIS as "final product concept" (Schettkat and Russo,1999).

The rationale for analysing labour productivity in a vertical perspective is based on the concept that firms, sectors and countries are interdependent. This interaction means that changes in one part of the economy spread to all other parts along the productive chains. Thus, if productivity improves in one part of the economy, part of these efficiency gains will spill over to other parts of the economy due to the interdependence between different firms and productive sectors. The idea of sectoral interdependence for correct measurement of productivity and unit cost is well defined by Garbellini and Wikierman (2009, p7):

> Essentially, though changes in productivity originate at the industry level, it is quite unlikely that the effects of these changes are all kept to itself. General interdependence makes labour-saving improvement in one industry to induce technical change in all those industries by purchasing the input produced by the technically improving branch. A consistent way of taking into account the cumulative effect of all these interdependencies is to work with sub-systems as the disaggregated unit of analysis.

Intuitively, the VIS (subsystems) measure of labour productivity incorporates the labour embodied in the production of the inputs consumed in the denominator, instead of subtracting the intermediate consumption of the numerator. In this way, all the labour incorporated, directly and indirectly, in the production of a final commodity *j* is taken into account. To

calculate this measure the inverse matrix of Leontief is multiplied by the line vector of the direct labour coefficients, dl, defined as the labour coefficients required directly in the sector per unit of gross output, to obtain the total labour coefficients, tlc:

$$tlc = dl\ (\mathrm{I} - \mathrm{A})^{-1}$$

Where the line vector tlc expresses exatly the total amount of labour required to produce a final demand unit. Finally, the labour productivity of the VIS is given by the inverse of the total labour coefficients (tlc^{-1}):

$$TLP = tlc^{-1}$$

Considering that this measure takes into account all the direct and indirect labour required in the production process of a subsystem, Wikierman (2010) calls this measure Total Labour Productivity (TLP), a denomination that will be used in the rest of the paper.

It is important to highlight that TLP unit of analysis is neither the sector nor the economy as a whole, but each subsystem. The analysis at this level allows us to overcome the weaknesses highlighted by traditional measures previously discussed. First, when a low productivity activity is outsourced, this is positive for the productivity of the outsourced sector, but it does not automatically change the TLP of the subsystem, as it also considers the requirement for indirect labour. Second, the problematic change in the relative prices between intermediate consumption and value added in the sector is avoided, since both are considered as part of the same subsystem.

Data

The measurement of total labour productivity has, however, as a drawback the need to incorporate data which exists only in input-output matrices. Due to their complexity and the high cost involved in collecting the necessary information for their elaboration, the national statistics offices usually make them available only for a few chosen base years and, in general, publish them with a few years of lag. However, in view of the multiple uses for economic analysis, in addition to other areas of knowledge, some methods have been developed to estimate input-output matrices for other years based on data in the supply and use tables. In the case of Brazil, the national statistics office (IBGE) has released input-output matrices for the base years of 2000 and 2005, which have been updated for the period 2000-2009 by Neves (2013), with assistance of data from the supply and use tables using the RAS method to update the input-output matrices.

The input-output model published by Brazil's national statistics office is derived from rectangular supply and uses tables that have a higher number of product than activities. In these cases, as the technical coefficient matrix A have to assume a squared form (equal number of lines and columns) in order to be invertible, it is necessary to adopt an specific technology assumption of how the production process takes place (Miller and Blair, 2009). Since the basic information disclosed in supply and uses tables have a greater number of products than activities, the system of linear equations will have more unknowns than equations. Therefore, it is necessary to adopt the sectoral technology hypothesis, which means

that a sector produces their different products using the same technology. The application of this assumption transform the data the information contained in the supply and use tables, which are in an sector x commodity dimension, into a structure compatible with the input-output model in terms of sector x sector. This is procedure is operationalize through the use of a market-share matrix (D_{ij}), which represents the participation of each sector in the gross output, constructed from the supply table. The result indicates in what proportion the total output of a given product originates in each of the sectors (Miller and Blair, 2009).

$$D_{ij} = \frac{v_{ij}}{\sum_{j=1}^{n} v_j} \quad (4)$$

onde:

D_{ij}= Market-share of sector i in the production of commodity j

v_{ij}= Gross output of commodity j produced in sector i

$\sum_{j=1}^{n} v_j$= Total gross output of commodity j

The matrix D_{ij} is then multiplied by the technical coefficients (rectangular) matrix of national inputs (B_n) to arrive at the square matrix of national input technical coefficients (A_n)

$$A_n = D.B_n \quad (5)$$

With the possession A_n the calculations of the total labour coefficients (*tlc*) and, thus, of total labour productivity (TLP) where made possible. These where first calculated in nominal terms, which were afterwards deflated by the implicit sectoral deflators obtained from the estimated input-output matrices.

However, if output of each sector is deflated by its own deflator, while gross output of the whole economy is deflated by its own deflator, output cease to be additive. That is, the sum of sectorial output of any given year is no longer equal to total output of the economy when expressed in the base year prices. Thus, the labour productivity growth rate of the economy will differ from the weighted sum of sectorial labour productivity and, thus, sectors results might seem misbalanced in relation to the economy labour productivity growth[2]. The other possibility is to deflate all sectors' output by the same price deflator. However, although the additivity property is retained, problems regarding changes in relative prices are re-introduce into the data and, thus, this option in unadvisable for the purposes of this study.

Results

The results here discussed are organized around two parts. The first part focuses on the comparison of TLP and DLP results, whose comparison of average yearly growth rates are presented in figure 1. The second part gives a more detailed analysis of the performance of the VIS in the period analysed, 2000-2008, which results are summarized in figure 2. At the end

[2] The other possibility is to deflate all sectors' output by the same price deflator. However, although the additivity property is retained, problems regarding changes in relative prices are re-introduce into the data.

of the section we present the complete results in table 1, which brings, in addition to the average growth rates of TLP and DLP, the growth rate of employment (L) in each VIS and information on the share of direct labour in the total labour in each VIS, in order to access the change of outsourcing patterns in the production process. An increase (reduction) in this latter index indicates that a larger (smaller) portion of the labour embodied in the final product is being performed by workers employed by the final good producing sector, which tends to affect the growth rate of the DLP, but not of TLP. Further, it is good to stress out that the higher the magnitude of participation of direct labour in the total labour in each VIS the more similar the results of the TLP and DLP, presented in figure 1, tend to be.

a) Comparing the results of DLP and TLP

The average growth rate of TLP between 2000 and 2008 was 1.08% per year, while DLP registered average growth of 0.84% per year. In all, 38 subsystems had a growth in TLP, whose participation in the total number of workers accounted for 73.4% of all employees in 2000 and 72.4% of the total in 2008. While only 22 sectors of activity had DLP growth.

The two measures point out to different patterns for productivity gains in manufacturing. While TLP recorded an increase in 24 of the 34 manufacturing VIS and in 15 of them this increase was above the average productivity growth of the economy. DLP, in its turn, increased in only 11 manufacturing sectors, and in only 5 sectors of activity the increase was higher than the average of the economy. Further, the TLP growth rate was higher than that of DLP in 28 of the 33 subsystems.

A total of 13 VIS had a growth of TLP, while the corresponding sectors had decrease of DLP. Of these, 10 registered an increase in the proportion between direct work and total work. This fact may help to explain the decline in the DLP of these sectors, since this change may result in an increase in the denominator (labour) without a counterpart in the numerator (output). An indication that there might have occurred an incorporation of productive stages that were prior being carried out by firms classified in other sectors of activity in national accounts.

In Services, the results between the two measures were more similar. TLP increased in 9 of the 14 subsystems, but only "Financial Intermediation" and “Accommodation and food services” subsystem had above-average TLP growth (2.1% p.a. and 2.3%p.a., respectively). On the other hand, the DLP increased in 7 sectors, and in 4 the growth was above the average of the economy: "Wholesale and retail trade" (0.9% p.a.), "Financial intermediation" (4.7% p.a.), “Real estate activities" (1.6% p.a.) and "Accommodation and food services" (1.8% p.a.).

The VIS that compose the Mining and Quarrying industries had an excellent performance in the period, "Mining of Iron Ores", "Extraction of Crude Petroleum and Natural Gas", "Others mining and quarrying" had average TLP growth of 2.1%, 0.6% and 2,1% p.a., respectively. This result is even more remarkable considering that they also presented high average growth rates in employment (6.9%, 124% and 19.1% p.a., respectively). Finally, it should be noted that in the "Extraction of Crude Petroleum and Natural Gas" subsystem the total labour employed increased by 10 times in the period - in

2000 the VIS employed around 21 thousand people, a figure that in 2002 reached 110 thousand people and in 2008 reached 234 thousand people.

As aforementioned, it is argued that part of the differences in growth rates between the two measures can be explained by the ratio between direct labour and total labour and the variation of this ratio over the analysed period (see table 1). It is worth highlighting the results of some sectors that support this argument:

1. "Food products and beverages": The usual DLP measure of the sector shows a continuous decrease throughout the entire period analysed. Between 2000 and 2004 it had an average decrease of -1.9% p.a., while 2004-2008 it was of -1.5% p.a.. In its turn the TLP of the subsystem had an opposite result. It had an average growth of 0.3% p.a. between 2000 and 2004 and of 5.5% p.a. between 2004 and 2008.
   The difference in these results can be explained by two factors. First, there was an increase in direct labour participation over the total labour employed in the VIS. From 13% in 2000, this figure increased to 15% in 2004 and reaching 18% of the total in 2008. This dynamics indicates that there might have been an incorporation of productive activities previously performed by firms classified in other sectors in the national accounts, a pattern which might explain the decline in DLP. Second, it should be remembered that the unit of analysis of TLP is the VIS and that in the case of the subsystem "Food products and beverages" incorporates a significant part of activities performed in agricultural sectors. These sectors, in turn, experienced high increases in productive efficiency, which are incorporated into the measurement of subsystem TLP.

2. "Manufacture of passenger cars and vans", "Manufacture of Truck and Buses" presented the same pattern discussed in the previous case. However, the pattern was in the opposite direction, i.e. both VIS presented a reduction in the ratio between direct labour and total labour and high DLP increases in the respective sectors of activity, an increase which was not reflected in the analysis in terms of TLP, where the observed growth rates were considerably lower.

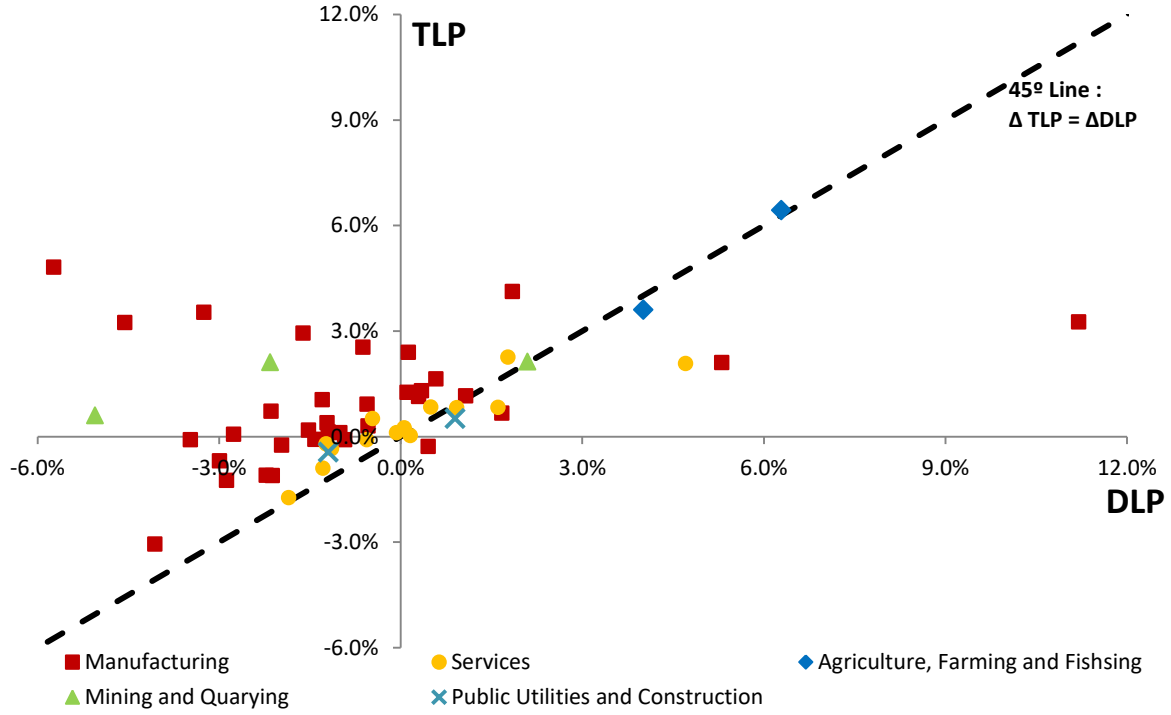
3. The "Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations" sector is one more case that clearly exemplifies the bias present in the DLP measure. Between 2000 and 2004, the ratio between direct labour and total labour in the VIS increased from 21.1% to 25.5%, DLP fell -2.7% per year, while TLP increased to 2.0% p.a. on average. Between 2004 and 2008, the ratio is reversed, the ratio between direct labour and total labour of the VIS fell to 22.4% in 2008, DLP shows an average growth of 1.8% p.a., but TLP fell 0.1% p.a..

4. The "Agriculture, hunting and forestry" exemplifies how the ratio of direct labour to total labour of the VIS can explain the difference (or, in this case, similarity) in the growth rates of DLP and TLP. In this VIS, more than 90% of the occupations are generated in the same sector, although in a falling proportion (see table 1), which

explains the small difference between the average growth rates of the two measures of only 0.1 p.p..

5. At the opposite end, there are sectors of the Extractive Industry such as "Extraction of crude petroleum and natural gas" and "Mining of Iron ores". In these, a small proportion of the total employment generated in the respective VIS are generated within the sector of activity in itself. As a consequence, the difference in the growth rates of the two measures is very high, resulting from the importance that the productivity gains of activities performed by firms classified by the national accounts in other sectors of activity assume in these VIS.

Figure 1: Comparison between the TLP and DLP yearly average growth rate (2000-2008)



Source: Author's own elaboration, based on primary data from Neves (2013) e National Account Systems, reference 2000, IBGE.

b) Analysis of the performance of the TLP in the subsystems:

As a systematic of presentation of the results for the 55 subsystems that is presented in Table 1 we adapt the proposed nomenclature in Garbellini and Wikierman (2014) and classify the VIS according to the following division:

(*i*) Dynamic Subsystems: VIS that had higher than average productivity growth and also had an employment growth rate higher than the growth rate of the population ($TLP_i > \rho^*$ and $\Delta L > \Delta N$).
(*ii*) Labour-expelling Subsystems: VIS that have productivity growth above average but had an employment rate of change smaller than the growth rate of the population ($TLP_i > \rho^*$ and $\Delta L < \Delta N$).

(*iii*) Lagging-behind Subsystems: VIS whose productivity change was below average, but which had growth rate in the total number of persons employed in the subsystem smaller than the growth of the population ($TLP_i < \rho^*$ and $\Delta L > \Delta N$).
(*iv*) Subsystems in recession: VIS that had a productivity change below average and had an employment rate of change smaller than the growth rate of the population ($TLPi < \rho^*$ and $\Delta L < \Delta N$).

Differently from their classification the threshold for the employment performance is the growth rate of the population instead of the subsystem having employment growth or not. This option is adopted in order to take into account the demographic effects, as we are analysing a developing growth with a much higher population growth than the developed country analysed in their work (Italy)[3].

As already mentioned, the economy wide growth rate of labour productivity (ρ^*) between 2000 and 2008 was 1.08% p.a, while population average growth was of 1.31%p.a.. In all, 20 subsystems had TLP growth above the economy. Of those, 15 did so concurrently with an increase in employment higher than the one of the population (Dynamic Subsystems), while only 6 had an employment a smaller growth rate (Labour-expelling Subsystems), wherein four these 6 subsystems had a negative growth rate. This result indicates that a main factor contributing to labour productivity growth was a rapid growth in final demand.

Among the Dynamic Subsystems group 12 belonged to the manufacturing industries, only one to Services ("Accommodation and food services"), while the others are "Mining of Iron Ores" and "Other Extractive Industries". The total share in employment of the Dynamic Subsystems grew from 10.0% in 2000 to 10.8% 2008.

Among the Dynamic Subsystems belonging to Manufacturing are primarily VIS linked to the processing and processing of natural resources such as "Tobacco products", "Paper and paper products", "Coke, refined petroleum products and nuclear fuel ","Ethanol" and "Cement, lime and plaster", which are activities classified by the OECD as low- and medium-low-tech activities, as well as "Publishing, printing and reproduction of recorded media", which is considered a low-tech activity. Within activities which are considered of greater technological intensity, two VIS belonging to the Chemical Complex - "Pharmaceuticals products" and "Pesticides and other agro-chemical products" - , and two VIS belonging to the automotive complex - "Manufacture of passenger cars and vans" and "Manufacture of Trucks and Buses", had a dynamic performance. Besides those, the VIS "Manufacture of machinery and equipment" and "Manufacture of office, accounting and computing machinery" complete the dynamic subsystem group.

In the group of Labour-expelling Subsystems there are 5 subsystems: "Agriculture, hunting and forestry", "Farming of Animals and Fishing", "Food products and Beverages", and "Paints, varnishes and similar coatings, printing ink and mastics", "Financial

[3] Further, we differentiate subsystems with productivity growth below average in two groups, those that employment growth above the population growth rate from those that haven't.

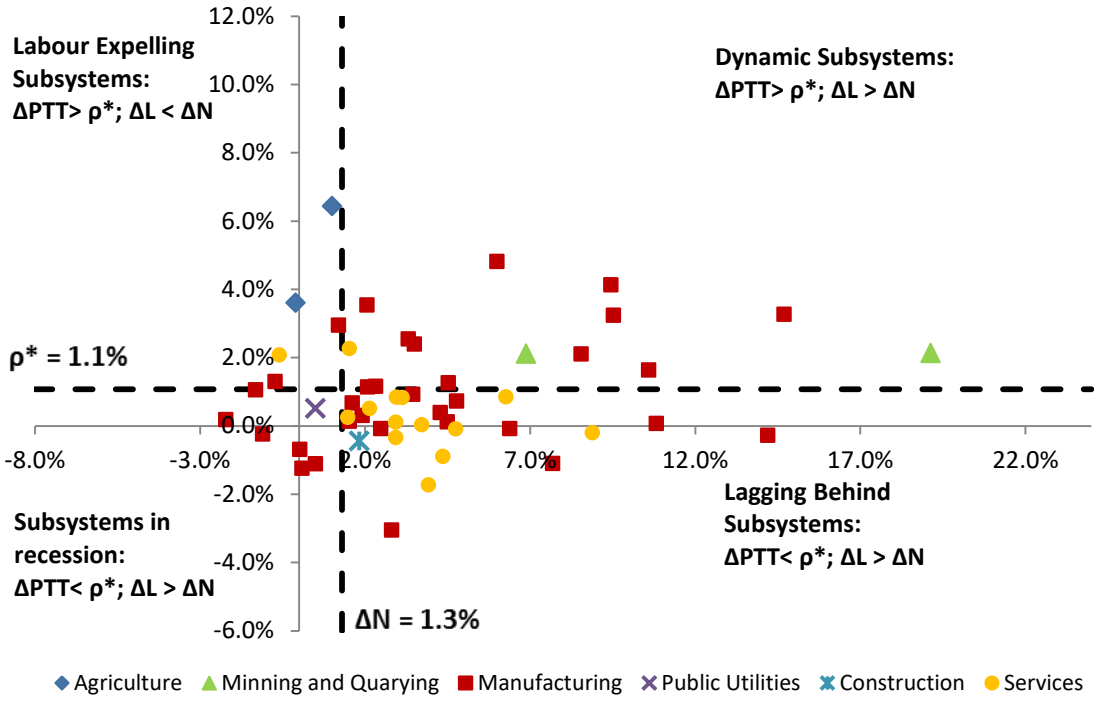
intermediation", whose combined share in total employment dropped from 23.5% in 2000 to 20.5% in 2008.

The group of Lagging-behind Subsystems consists of 28 subsystems, 14 of which are VIS belonging to the Manufacturing Industries. With the exception of the VIS of "Financial Intermediation" and “Accommodation and Food services”, all other subsystems belonging to the Services Subsystems were in this group. Although several subsystems of Services had TLP growth in the period, they were classified as Lagging behind subsystems since their growth rate was lower than the average of the economy. It is also worth noting that the VIS of "Construction" fit this group, one of the largest employers in Brazil whose share was 8.1% in 2008. Lastly, the "Extraction of crude petroleum and natural gas" subsystem stands out: even though the VIS experienced an enormous increase in employment, with total employment growing by 10 fold between 2000 and 2008, TLP growth was still positive (0.6% p.a.). In the period under analysis, the combined share of this group in total employment grew from 63.6% to 66.4%.

In the fourth group, Subsystems in recession, are the VIS that had both a growth of TLP below the average and an employment growth below the population growth. In the period between 2000 and 2008, seven subsystems are included in this group. Being six VIS from Manufacturing while the other was "Electricity, gas and water supply". Their combined share in employment dropped from 2.9% to 2.3%. From these Subsystems, two presented negative employment growth namely: (i) "Manufacture of wood and of products of wood and cork, except furniture", which had a decrease of TLP of -0.2% p.a. and of -1.1% p.a. in employment; (ii) “Manufacture of radio, television and communication equipment and apparatus”, which had TLP growth of 0.2% p.a. and a decrease of -2.2% p.a. in employment. On the one hand, the recessive pattern of the first subsystem does not come as a surprise, since it is a traditional subsystem of low-technology whose final products can be partially replaced by products of other materials. On the other hand, the presence of the electronic material and communication equipment subsystem in this group causes concern, since it is a sector classified as high technology by the OECD, whose final demand *a priori* wouldn’t be close to saturation levels.

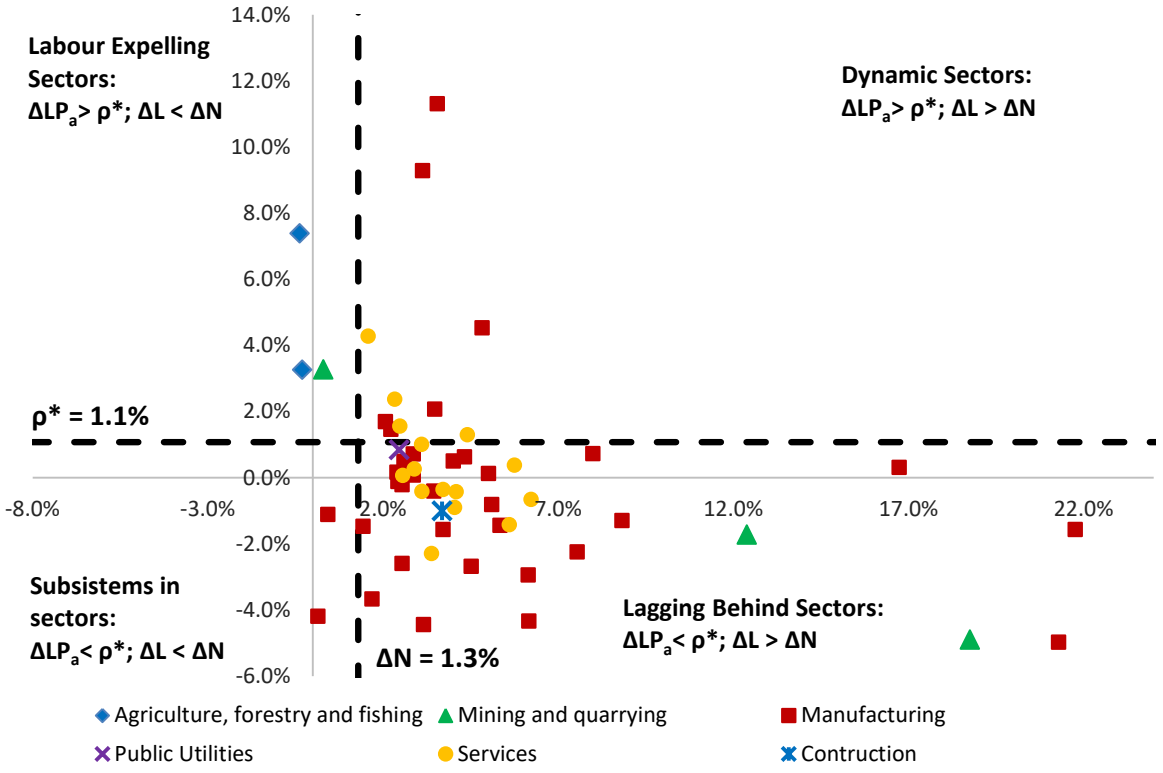
It should be noted that the latter two groups (Subsystems lagging-behind and Subsystems in recession, which have in common a TLP average growth rate below the average of the economy in the period considered) increased their share of total employment by 2.2 p.p., that is from a 66.5% to 68.7% between 2000 and 2008. This fact reinforces in a VIS perspective, therefore, a proposition already present in Baumol (1967) that if the greater growth of labour productivity in dynamic sectors is not accompanied by an income elasticity of demand higher in these sectors than that of technologically stagnant (lagged) sectors, then an increasing share of the labour force will end up engaged in sectors of low productivity growth, which would produce a stagnation trend in the aggregate labour productivity growth.

Figure 2: Comparison between the yearly average growth rates of the TLP and Employment in each VIS, 2000-2008.



Source: Authors own elaboration, based on raw data produced by Neves (2013) and System of National accounts from IBGE

Figure 3: Comparison between the yearly average growth rates of the LP_a and Employment in each Sector of activity, 2000-2008.



Source: Authors own elaboration, based on raw data produced in Neves (2013) and System of National accounts from IBGE.

When the results of TLP growth of the Manufacturing subsystems are contrasted with the results of the manufacturing sectors based on Apparent Labour Productivity (LP_a) measure (see Figure 3), which is based on value added and direct labour, the performance of manufacturing is much better, while Services is a little worse. The non-weighted average rate of growth of TLP of the manufacturing subsystems was 0.94% p.a., while the result of LP_a was negative (-0,24% a.a.). Only six manufacturing sectors can be classified as dynamic, with the vast majority presenting a behaviour of lagging-behind.

There are two factors which account for this difference. One issue is related to the problem of change in relative prices between intermediate consumption and gross output. A higher inflation rate in intermediate consumption than in gross output in manufacturing sectors produce a compression of the value added. Secondly, this result might reflect the fact that the productivity gains occurring in the Service sector are in many cases in activities which provides intermediate services to manufacturing and, thus, these gains are incorporated in the result of TLP of manufacturing subsystems.

Table 1: Total Labour Productivity (TLP), Direct Labour Productivity (DLP), Employment and share of direct labour in total labour employed by each VIS

Level 55 (CNAE 1.0)	Δ % TLP (p.a.)			Δ % DLP (p.a.)			Δ % L in each VIS (p.a.)			Share direct labour / total labour		
	2000-2008	2000-2004	2004-2008	2000-2008	2000-2004	2004-2008	2000-2008	2000-2004	2004-2008	2000	2004	2008
Dynamic Subsystems: ρ>ρ* e ΔL > ΔN												
0202 Mining of Iron Ores	2.1%	2.7%	1.4%	-2.2%	-0.5%	-3.9%	6.9%	3.9%	8.5%	9.9%	9.5%	12.5%
0203 Others mining and quarrying	2.1%	1.1%	3.0%	2.1%	-0.1%	4.4%	19.1%	26.1%	6.0%	57.4%	56.7%	50.8%
0302 Tobacco products	2.5%	-1.0%	6.3%	-0.6%	1.2%	-2.3%	3.3%	14.5%	-5.0%	5.0%	3.9%	4.9%
0307 Paper and Paper Products	1.3%	1.3%	1.1%	0.1%	0.2%	0.0%	4.5%	3.7%	4.7%	23.3%	23.5%	24.0%
0308 Publishing, printing and reproduction of recorded media	1.1%	1.2%	1.0%	0.3%	-0.4%	1.0%	2.1%	2.0%	2.0%	46.1%	51.6%	55.5%
0309 Coke, refined petroleum products and nuclear fuel	3.5%	7.8%	-0.5%	-3.2%	-1.3%	-5.5%	2.1%	-0.2%	4.4%	1.6%	1.7%	2.0%
0310 Ethanol	4.8%	6.1%	2.8%	-5.7%	-5.5%	-7.7%	6.0%	-8.1%	29.6%	5.5%	11.0%	15.8%
0313 Pharmaceuticals Products	1.2%	-0.3%	2.6%	1.1%	-3.1%	6.0%	2.3%	1.5%	2.9%	22.2%	25.0%	24.4%
0314 Pesticides and other agro-chemical products	4.1%	7.2%	0.8%	1.8%	0.2%	3.5%	9.4%	28.4%	-4.5%	8.1%	6.4%	8.4%
0319 Cement, lime and plaster	2.4%	4.7%	0.1%	0.1%	0.1%	0.2%	3.5%	-12.8%	40.3%	10.9%	12.4%	11.7%
0324 Manufacture of machinery and equipment	1.6%	2.3%	0.9%	0.6%	1.4%	-0.3%	10.6%	10.9%	7.2%	39.3%	37.0%	39.5%
0326 Manufacture of Office, accounting and computing machinery	3.2%	3.8%	2.3%	-4.6%	-5.4%	-4.8%	9.5%	-2.7%	24.3%	12.7%	16.9%	19.9%
0330 Manufacture of passenger cars and vans	2.1%	0.3%	3.8%	5.3%	6.7%	3.1%	8.5%	8.8%	6.2%	9.3%	7.0%	7.1%
0331 Manufacture of Truck and Buses	3.3%	2.7%	3.5%	11.2%	6.8%	12.3%	14.7%	18.5%	6.3%	10.4%	8.1%	6.3%
1102 Accommodation and Food Services	2.3%	0.8%	3.6%	1.8%	0.9%	2.6%	1.5%	-0.1%	3.1%	58.0%	63.1%	63.2%
Labour Expelling Subsystems : ρ>ρ* e ΔL < ΔN												
0101 Agriculture, Hunting and Forestry	6.4%	4.5%	7.0%	6.3%	4.4%	6.9%	1.0%	2.9%	-0.8%	95.0%	93.3%	92.4%
0102 Farming animals and fishing	3.6%	1.4%	5.5%	4.0%	1.8%	5.8%	-0.1%	1.6%	-1.7%	82.3%	80.9%	79.5%
0301 Food products and beverages	2.9%	0.3%	5.5%	-1.6%	-1.9%	-1.5%	1.2%	4.6%	-1.9%	13.7%	15.0%	18.3%
0316 Paints, varnishes and similar coatings, printing ink and mastics	1.3%	1.5%	1.0%	0.3%	-0.1%	0.8%	-0.7%	-8.0%	9.6%	18.8%	18.0%	24.5%
0901 Financial intermediation	2.1%	0.4%	3.7%	4.7%	-1.2%	11.1%	-0.6%	-0.8%	-0.4%	35.2%	40.1%	39.3%

Source: Authors own elaboration, based on raw data produced by Neves (2013) and System of National accounts from IBGE

Table 1 (cont.): Total Labour Productivity (TLP), Direct Labour Productivity (DLP), Employment and share of direct labour in total labour employed by each VIS

Level 55 (CNAE 1.0)	Δ % TLP (p.a.)			Δ % DLP (p.a.)			Δ % L in each VIS (p.a.)			Share direct labour / total labour		
	2000-2008	2000-2004	2004-2008	2000-2008	2000-2004	2004-2008	2000-2008	2000-2004	2004-2008	2000	2004	2008
Lagging-behind Subsystems: ρ<ρ* e ΔL > ΔN												
- Subsystems com 0< ρ < ρ* e ΔL > ΔN												
0201 Extraction of Crude Petroleum and Natural Gas	0.6%	1.2%	0.0%	-5.1%	-7.5%	-3.7%	124.0%	145.7%	15.0%	5.7%	5.2%	6.1%
0303 Textiles	0.1%	-2.0%	2.4%	-1.2%	-2.5%	0.2%	1.5%	3.1%	0.0%	63.1%	61.0%	68.7%
0315 Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	0.9%	2.0%	-0.1%	-0.6%	-2.7%	1.8%	3.4%	2.1%	4.4%	21.1%	25.5%	22.4%
0320 Other non-metallic mineral products	0.4%	1.3%	-0.5%	-1.2%	-1.6%	-0.9%	4.3%	3.6%	4.4%	54.9%	58.5%	58.4%
0321 Manufacture of basic iron and steel	0.1%	0.8%	-0.7%	-2.8%	-1.8%	-4.0%	10.8%	14.6%	4.5%	17.6%	14.4%	14.4%
0325 Manufacture of domestic appliances	0.7%	1.0%	0.3%	1.7%	0.0%	3.4%	1.6%	2.6%	0.6%	25.0%	26.9%	28.5%
0329 Medical, precision and optical instruments, watches and clocks	0.1%	2.1%	-1.7%	-1.0%	-0.4%	-1.6%	4.5%	2.9%	5.4%	57.6%	57.3%	64.0%
0332 Parts and accessories for motor vehicles and their engines	0.7%	1.4%	0.1%	-2.1%	-3.0%	-1.4%	4.8%	11.4%	-1.3%	36.8%	33.9%	36.0%
0334 Furniture and and n.e.c manufacturing products	0.3%	0.8%	-0.2%	-0.5%	-0.5%	-0.6%	1.9%	0.7%	3.1%	58.0%	60.0%	62.7%
0601 Wholesale and retail trade	0.8%	-1.7%	3.6%	0.9%	-1.7%	3.8%	3.1%	2.8%	3.1%	88.7%	88.5%	87.4%
0701 Transport, storage and post	0.5%	-0.1%	1.2%	-0.5%	-1.6%	0.8%	2.1%	1.4%	2.8%	66.8%	69.7%	70.3%
0801 Information Services	0.8%	1.8%	-0.1%	0.5%	1.3%	-0.3%	6.3%	6.7%	4.6%	54.6%	59.1%	58.6%
1001 Real estate, renting and business activities	0.8%	3.1%	-1.3%	1.6%	4.9%	-1.4%	3.0%	-0.3%	6.3%	63.7%	62.4%	59.6%
1101 Maintenance and repair services	0.2%	-1.9%	2.6%	0.1%	-2.5%	2.9%	1.5%	1.2%	1.7%	87.6%	92.8%	93.4%
1106 Other Services	0.1%	-1.0%	1.3%	-0.1%	-1.3%	1.3%	2.9%	3.5%	2.1%	87.3%	89.9%	90.1%
1203 Public Administration and social security	0.0%	-0.2%	0.3%	0.2%	-1.3%	1.7%	3.7%	3.9%	3.1%	63.3%	65.2%	63.5%

Source: Authors own elaboration, based on raw data produced by Neves (2013) and System of National accounts from IBGE

Table 1 (cont.): Total Labour Productivity (TLP), Direct Labour Productivity (DLP), Employment and share of direct labour in total labour employed by each VIS

Level 55 (CNAE 1.0)	Δ % TLP (p.a.)			Δ % DLP (p.a.)			Δ % L in each VIS (p.a.)			Share direct labour / total labour		
	2000-2008	2000-2004	2004-2008	2000-2008	2000-2004	2004-2008	2000-2008	2000-2004	2004-2008	2000-2008	2000-2004	2004-2008
Lagging-behind Subsystems (cont.): ρ<ρ* e ΔL> ΔN												
- Subsystems with ρ < 0 e ΔL > ΔN												
0304 Wearing Apparel; dressing and dyeing of fur	-3.1%	-5.2%	-1.2%	-4.1%	-6.2%	-2.6%	2.8%	1.8%	3.5%	69.5%	72.1%	72.8%
0312 Manufacturing of resins and elastomers	-0.1%	5.3%	-4.5%	-3.5%	0.1%	-7.0%	2.5%	11.4%	-4.4%	7.3%	7.1%	8.7%
0322 Manufacture of basic precious and non-ferrous metals	-0.1%	2.9%	-2.8%	-1.4%	3.7%	-5.7%	6.4%	4.1%	7.4%	31.3%	29.8%	27.5%
0323 Fabricated metal products, except machinery and equipment	-0.1%	1.7%	-1.8%	-0.9%	1.0%	-2.8%	26.2%	2.4%	45.8%	60.9%	62.2%	60.3%
0327 Electrical machinery and apparatus n.e.c.	-1.1%	-0.1%	-2.1%	-2.2%	-1.0%	-3.5%	7.7%	-0.9%	16.9%	35.9%	38.8%	39.3%
0333 Other transport equipment	-0.3%	-4.3%	4.6%	0.5%	-4.0%	5.8%	14.2%	22.9%	2.8%	27.8%	26.4%	31.0%
0501 Construction	-0.4%	-1.0%	0.1%	-1.2%	-2.2%	-0.2%	1.8%	-1.1%	4.9%	69.3%	75.1%	76.2%
1103 Business Services	-0.2%	-1.9%	1.6%	-1.2%	-3.7%	1.4%	8.9%	8.1%	7.3%	74.4%	79.1%	79.8%
1104 Private Education	-0.9%	1.2%	-2.9%	-1.3%	1.7%	-4.0%	4.4%	4.2%	3.9%	71.0%	67.4%	76.8%
1105 Private Health	-0.3%	-1.7%	1.1%	-1.1%	-2.7%	0.5%	2.9%	4.8%	0.9%	60.2%	60.8%	64.5%
1201 Public Education	-1.7%	0.7%	-4.1%	-1.8%	0.7%	-4.3%	3.9%	2.0%	5.4%	85.9%	86.6%	83.2%
1202 Public Health	-0.1%	-0.2%	0.0%	-0.6%	-0.2%	-0.9%	4.7%	5.3%	3.4%	64.7%	60.2%	63.4%
Subsystems in Recession: ρ<ρ* e Δ L < ΔN												
0311 Manufacture of basic chemicals	1.1%	1.8%	0.3%	-1.3%	-3.0%	0.5%	-1.3%	2.4%	-4.6%	14.1%	13.2%	12.8%
0328 Manufacture of radio, television and communication equipment and apparatus	0.2%	-0.2%	0.6%	-1.5%	-5.2%	2.8%	-2.2%	1.3%	-5.4%	14.9%	17.0%	18.9%
0401 Electricity, gas and water supply	0.5%	0.3%	0.8%	0.9%	-0.1%	1.9%	0.5%	-1.3%	2.4%	39.1%	36.5%	36.8%
0305 Leather and Footwear	-1.2%	-1.9%	-0.7%	-2.9%	-3.9%	-2.2%	0.1%	3.2%	-2.7%	55.8%	59.3%	66.6%
0306 Manufacture of wood and of products of wood and cork	-0.2%	0.5%	-1.0%	-2.0%	-0.9%	-3.2%	-1.1%	15.8%	-11.0%	60.0%	56.9%	61.1%
0317 Manufacture of other chemical products	-0.7%	-0.1%	-1.3%	-3.0%	-4.3%	-2.0%	0.0%	8.0%	-6.0%	29.7%	29.5%	34.4%
0318 Rubber and plastics products	-1.1%	0.5%	-2.7%	-2.1%	-2.2%	-2.3%	0.5%	-2.6%	4.0%	35.5%	36.7%	41.4%

Source: Authors own elaboration, based on raw data produced by Neves (2013) and System of National accounts from IBGE.

Concluding Remarks

The main objective of this article was to propose measures of labour productivity in terms of vertically integrated sectors (VIS, also referred as subsystems). The main benefit of adopting such a framework is to obtain a physical productivity accounting measure that is solely affected by technical change, whose results are not dependent on changes organization of the productive process, (such as outsourcing like it happens with the direct labour productivity, DLP, measure) or by changes in the relative prices and, thus, in the income distributions (as it happens in the apparent labour productivity, ALP, measure).

The measurement of labour productivity in terms of VIS, dubbed Total labour Productivity (TLP), makes it possible to avoid the problems faced by the two measures that are commonly used in productivity analysis. On the one hand, TLP is not influenced by the outsourcing of activities, since the indirect labour requirements are also incorporated in the denominator. On the other hand, the change in relative prices between intermediate consumption and value added at the sectoral level is annulled. Since both are incorporated in the same subsector, only a reallocation of the margins between the different firms composing the same subsystem will occur.

The analysis of labour productivity in a VIS framework is not exempt of shortcomings. It is important to bear in mind, as argued by Steedman (2004), that a VIS is a theoretical construction whose relevance and applicability would be restricted to an *ex-post* analysis of the consequences of investment decisions and technological innovations occurring at the sector/firm level and in specific activities. Therefore, they would be of more interest to the analyst in the evaluation of policies than to an entrepreneur:

> Such sectors are hypothetical constructions, built by the theorist, whilst actual investment decisions relate to investment in actual, individual industries and even in specific production processes. (...) Similarly, technical change actually occurs at the level of quite particular production activities and, while the theorist can calculate the consequent changes at the vertically integrated level, the result is just that – a calculated, accounting magnitude. There is no such real thing as a way of acting to reduce some vertically integrated production coefficient. Any such reduction is only an ex-post statistical artefact. (Steedman, 2004, p. 359 e 360)

The option of not aggregating the results and presenting them individually for the 55 VIS was due to the fact that the measure of labour productivity of a VIS would be the best possible approximation of a measure that captures only the variation of the productive efficiency.

The analysis of the results, albeit preliminary, revealed some interesting aspects. An important aspect of the period analysed was the high employment growth in Brazil, where more than 17 million jobs were created in eight years. As a consequence of this

fact, only 6 subsystems had a fall in employment in the period. However, this widespread employment growth didn't prevent most subsystems from obtaining a growth of TLP. A total of 38 VIS out of 55 possible had TLP growth. Nevertheless, the share of these subsystems in total employment felt from 73.4% to 72.4% over the period analysed. The 21 subsystems that had TLP growth above the average of the economy (classified in the groups of dynamic and labour-expelling subsystems) also had a decrease of their share in the total labour, falling from 33.5% in 2000 to 31, 5% in 2008.

It should be noted that the results of the period cannot be extrapolated, i.e. there is no guarantee that the subsystems that had TLP growth in the period analysed will displays similar patterns in the future. However, the loss of participation of VIS that had TLP growth reinforces the proposition made by Baumol (1967) that if there is no difference in the income elasticity of demand between products of the dynamic and stagnant subsystems, then an increasing share of the labour force will be employed in activities of low productivity growth, which would compromise future growth of the aggregate labour productivity and, possibly, of real wages.

When analysed in vertically integrated terms, the labour productivity growth of the manufacturing industries has improved considerably. The growth rate of the subsystems TLP being higher than the DLP growth of the respective manufacturing sectors of activities in 28 out of the 33. A result which might reveal a high growth of productive efficiency in the production of intermediate inputs of manufacturing products.

Among the 20 subsystems that had an above-average productivity growth, 15 had, simultaneously, an increase in employment, constituting the group labelled as Dynamic Subsystems. In this group, 12 subsystems belonged to manufacturing. These were mainly low-technology subsystems, related to the processing of natural resources, and subsystems of the automotive complex, such as "Manufacture of passenger cars and vans" and "Manufacture of trucks and buses", as well as subsystems related to the production of capital goods as "Manufacture of machinery and equipment" and "Manufacture of office, accounting and computing machinery".

On the other hand, from the Services subsystems only the "Accommodation and Food Services" comprise in the group of Dynamic Subsystems. In addition to this sector, only "Financial Intermediation" had TLP growth above the average of the economy. All other subsystems of Services had a fall or a growth of TLP below the average of the economy.

These results provides a quite different picture than the results which arises within the conventional horizontal analysis based either on DLP or apparent labour productivity (LP_a). In both metrics labour productivity growth in services is higher and in manufacturing lower. This highlights an important feature, which has important consequences for the deindustrialization debate - the most dynamic activities within the Service sector are linked as suppliers to the manufacturing sector. Thus, an increased efficiency in these activities is capable of enhancing competitiveness of domestic

production of manufacturing final goods even in the event of no increase in production efficiency within the manufacturing sectors stages of production.

Further, it also demonstrates the importance of the Industrial sector for the country economy and the problems arising from a possible deindustrialization, as if the Industrial sector shrinks so does important dynamic activities of the Service sector. Thus, rather than dynamic Services being a substitute to Manufacturing as an engine of growth for a developing economy the analysis in terms of VIS reveals their complementary nature.

The example of the VIS of "Extraction of Crude Petroleum and Natural Gas" is enlightening of this aspect. The discoveries of new oil reserves and the increase in oil prices during the commodity boom triggered a high growth in the sectors output and related activities. Total employment in the VIS grew from 21 thousand people in 2000 to 234 thousand in 2008. However, over 90% of this employment was generated by firms which provide inputs and services to the activity of extracting oil and gas, many of which in sectors that have high productivity levels and wages. These jobs, however, depend on the economic viability of the main activity, that is, the total cost of extracting these natural resources being lower than their price in the international market. Therefore, a gain of efficiency which is transmitted to the cost structure will be also key for the competitiveness of the commodity produced by the main activity. On the other hand, if the country is no longer competitive and it stops/reduces production of this commodity, therefore deindustrializing, a whole variety of jobs in the service sector will also be discontinued.

This reasoning provides context to what was discussed in the methodological section regarding the general interdependence that prevail in the production process. Where something happening in a sector might be determinant to the results of other sectors through their linkages within the production process, either supplying inputs or demanding inputs from other sectors. Thus, in line with Garbellini and Wikierman (2009), a consistent way of taking this into account in the analysis of productivity and competitiveness is to work with VIS as the disaggregated unit of analysis.

References

BAUMOL W.; Macroeconomics of Unbalanced Growth: The Anatomy of an Urban Crisis. American Economic Review, June 1967.

DE JUAN, O.; E. FEBRERO; "Measuring Productivity from Vertically Integrated Sectors, Economic Systems Research", Vol. 12(1), 2000

DIETZENBACHER, E.; A.R. HOEN; B. LOS; "Labour Productivity in Western European Countries 1975-1985: An Intercountry, Interindustry Analysis", Journal of Regional Science, Vol. 40(3), 2000.

DIETZENBACHER, E.; A.R. HOEN; B.; "Double deflation and aggregation", Environment and Planning A, volume 31, pages 1695-1704, 1999.

FREITAS, F., DWECK, E.; “The Pattern of Economic Growth of the Brazilian Economy 1970-2005”. In Levrero, S., Palumbo, A. & Stirati, A. (eds.) Sraffa and the Reconstruction of Economic Theory, volume II: aggregate demand, policy analysis and growth. London: Palgrave Macmillan, 2013

GARBELLINI, N.; WIRKIERMAN A.L., “Changes in the Productivity of Labour and Vertically Integrated Sectors - An Empirical Study for Italy”, MPRA Paper No. 18871, 2009.

GARBELLINI, N.; WIRKIERMAN A.L., “Productivity Accounting in Vertically (Hyper-) Integrated Terms: Bridging The Gap Between Theory And Empirics”, Metroeconomica, Vol. 65(1), 2014.

MILLER, R.; BLAIR, P., *Input-Output Analysis: Foundations and extensions*. United Kingdom: Cambridge University Press, 2009.

NEVES, J. P., Mudança Estrutural na Economia Brasileira entre os anos 2000 e 2008: uma Análise de Decomposição Estrutural. Master’s thesis, Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2013.

PASINETTI, L.L., “The Notion of Vertical Integration in Economic Analysis”, Metroeconomica, Vol. 25(1), 1973.

PASINETTI, L.L., “Structural Change and Economic Growth. A Theoretical Essay on the Dynamics of the Wealth of Nations”, Cambridge University Press, 1981.

SCHETTKAT, R AND RUSSO, G; “Are structural economic dynamics a myth? Changing industrial structure in the final product concept”, Economia & lavoro: revista quadrimestrale di politica economica, sociologia e relazioni industriali.- Roma : Carocci, Vol. 33.1, 3/4, p. 173-188, 1999.

SERRANO, F. AND SUMMA, R.; “Macroeconomic Policy, Growth and Income Distribution in the Brazilian Economy in the 2000s”; Center for Economic and Policy Research, June 2011.

SRAFFA, P. Production of Commodities by Means of Commodities: Prelude to a Critique of Economic Theory, Cambridge University Press. (1960).

STEEDMAN, I., Vertical Integration in the Changing Economy, in Richard Arena and Neri Salvadori (eds.), Money, Credit and the Role of the State: Essays in Honour of Augusto Graziani, Ashgate, 2004.

WIRKIERMAN, A. L., Patrones de Productividad y Cambio Técnico en un Esquema de Relaciones Interindustriales. Un Análisis por Sectores Verticalmente Integrados," Master's thesis, Facultad de Ciencias Económicas Universidad Nacional de la Plata, 2010.