Survival of the fittest or does size matter: What are the main drivers of Productivity in Brazil?

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State University of Campinas

2016

“Texto para discussão

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Outubro 2016

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Survival of the fittest or does size matter: What are the main drivers of Productivity in Brazil?

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Abstract

This article aims to explore learning and selection effects of productivity change for three classes of firm's sizes in Brazilian manufacturing and service sectors from 1996 to 2011. The methodology is based on the Price Equation. Our results support the international evidence about the weak intensity of the selection effect to explain aggregate productivity change for medium and large size firms. Small firms, however, are much more affected. Besides, size, measured by number of employees, appears to be a good proxy for capital intensity. There are as well signs that the learning effect is highly correlated with the economic cycle.

JEL: L11, D22, L60, L80.

1 Introduction

In the vast landscape of economic analysis, from deriving a market equilibrium and determining international comparative advantages, to describing evolutionary change in neo-schumpeterian models, the central role of productivity is unquestioned. But so little yet is known about the mechanism that promotes aggregate productivity change.

An important turning point on the discipline was the growing availability of micro-level data with a systematic representation of industry at the firm level. By having the appropriate information of profitability, productivity and corporate growth, the data allowed new insights on the understanding of market functioning.

This led to numerous studies evaluating the transformation of productivity using decomposition methodologies and parametric estimations. The great heterogeneity found regardless

*The authors would like to thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP - process number 15/17059-3) for their funding of this research.

of the level of disaggregation, and especially, its persistence through time, created unpleasantness with the concept of aggregate production functions. It also exposed the weakness of averages taken from sectoral level analysis as they largely simplify the underlying phenomena.

Further, the great turmoil of entry and exit of firms seemed to fit well with a Schumpeterian view of *creative destruction*. Differently from the neo-classical perspective, where firms enter and exit the market only to reestablish the equilibrium of market's price, the idea of creative destruction assumes a constant process of renovation, with lots of churning and where new firms consistently replaces the fallen ones.

In this sense, the relation between growth and productivity is given by different families of theoretical models, and usually involves more productive firms gaining market-share either by lowing mark-up or through larger investments driving more innovation and better products. A first approach is given by what was called an "evolving equilibrium" or "dynamic equilibrium", and it is exposed in works that embed heterogeneity as a fundamental force, like Jovanovic (1982), Hopenhayn (1992), Ericson and Pakes (1995), Olley and Pakes (1996), Luttmer (2007) and Acemoglu et al. (2013). Another approach is given by the neo-schumpeterian literature, with the classic from Nelson and Winter (1982) and others like Winter (1984), Silverberg et al. (1988), Dosi et al. (1995), Silverberg and Verspagen (1995), Metcalfe (1998), Bottazzi et al. (2001), Winter et al. (2000, 2003).

The necessity of measuring this dynamics led to a rich route of decomposition methodologies. This article contributes to this literature in three important ways: 1) it covers both industry and services, giving a broader context of Brazilian Economy; 2) it uses the Price Equation as the decomposition method, a still underexplored tool to describe evolutionary change of any type; 3) it performs a decomposition analysis considering three categories of firm's size, allowing better clarity in the characterization of these results for both segments.

Our main outcomes suggest that, confirming what was found in the international literature, the selection forces acting upon market are indeed less relevant than what was thought at first. The idiosyncratic learning process inside the firms seems to play a much larger role in aggregate productivity change. But this doesn't tell the whole history. There are significant changes accordingly with firm size, as measured by number of employees. Smaller firms productivity appears to be much more affected through selection than the larger ones. Also, although the absolute values are greater for the learning effect, it is hard to point a defined trend in the results, and their signal seem highly correlated to the economic cycle.

2 Background Literature

Besides the topic of productivity being extensively explored throughout the twentieth century[1], the first studies using modern micro-level data appeared only in the early nineties. Baily et al. (1992) was one of the pioneers to describe the relationship between productivity and market composition for the US Manufacturing. Other studies for US were conducted by Baily et al. (1996), which find great heterogeneity among firms regardless of the disaggregation level, and Bartelsman and Dhrymes (1998), which demonstrates its high persistence through time. Similar studies were also conducted for other countries, like Israel (Griliches and Regev, 1995), United Kingdom (Disney et al., 2003a,b), Germany (Cantner and Kruger, 2008), Chile (Petrin and Levinsohn, 2012) and Canada (Baldwin and Gu, 2006).[2]

Among several stylized facts that these studies analyze, we find a minor role for the selection effect - the reallocation of shares between continuing firms[3] - with most of productivity change being caused by the movement of entry and exit of firms and due to internal variation. Parametric estimations of this process also corroborated these results. Dosi et al. (2015), improving on Bottazzi et al. (2010), found a small contribution of selection for France, Germany, UK and US, with most of the impact coming from the first difference of relative productivity - that is, the variation of the distance of each firm's productivity from the average productivity - rather than in relative productivity by itself, or the distance of each firm's productivity from the average. Analogous results are found in Chinese Manufacturing by Yu et al. (2015a).

Another fact that usually appears in the empirical studies is the heterogeneity among firms and the most diverse variables analyzed. Apart from the previous literature, heterogeneity was extensively investigated. Such analysis produced as a stylized fact a characteristic Laplacian format in the distribution of firms' productivity, which resembles a "tent shape", which was robust to all degrees of disaggregation available in different countries (Bottazzi et al., 2007; Bottazzi and Secchi, 2003, 2005; Yu et al., 2015b).

Other important fact related to our study is the relation with size. In general, even if the evidence is more dubious for smaller firms (Lotti et al., 2001), growth does not seem to be correlated either with productivity or profitability (Bottazzi et al., 2010; Yu et al., 2015a). On the other hand, size and productivity are important metrics for survival, where smaller and less productive firms die faster (Baily et al., 1992; Griliches and Regev, 1995) and entry and exit are highly correlated, with sectors with a high number of entrants usually having a

[1] Salter (1966) is an earlier example of the kind of analysis conducted here.

[2] For two reviews of the literature see Bartelsman and Doms (2000) and Foster et al. (2001).

[3] Some studies, like Disney et al. (2003a), even find a negative value for this component, suggesting a reallocation to less productive firms.

high number of exiters. That is, markets are relatively stable in size (Disney et al., 2003a).

One main issue that all these studies consider is the methodological one, on how to measure those variables as well as the choice of the proxies to use for that purpose: how to measure productivity, growth, size, capital, etc? The diversity of methodological possibilities in this venue is not trivial. For example, if we consider productivity as an efficiency index, in its basic conception it is given by the output-input relation. Then, several caveats appear: how to measure output and input? which inputs and outputs do we consider? Do we use gross output revenue or value added? And so on.

In general, it is possible to measure productivity by Total Factor Productivity (TFP) or labour productivity. TFP evaluates cases the endowment of two specific inputs, capital and labor, thus controlling for changes in productivity related to the quantity of each factor rather as much as technological change. Unfortunately, this forces the adoption of very restrictive hypothesis about the relationship between labour and capital as well as the use of an aggregate production function for a macro analysis of sectoral or global productivity, which also implies the adoption of a set of hypothesis that are inconsistent with the evolutionary theory used as theoretical reference in this paper. Nevertheless, since other studies find a high level of correlation between both measures (Foster et al., 2001), we opted to use Labour Productivity as our proxy.

Labour productivity is usually measured as a relation between value added or gross revenue per employees or hours worked. For our purposes, we opted by using value added per employee as a proxy for labour productivity given that we want to analyze the internal factors of the firms that affect productivity and despite of the several critiques it may suffer as well as the bias it presents mainly due to the the exclusion of other inputs.

The information about value added was available only for a couple of years, so to extend our analysis to the longest period possible, we used the Value of Industrial Transformation (VTI) for the manufacture sector and value added (VA) for the service segment[4]. Other issue relays on how to correctly address the importance of each firm in the aggregate index. This weight, usually related to the size of the firm, is measured by output or employment share, the last being the chosen measure for this work.

Other important decision is about the decomposition methodology used to evaluate productivity change. In this work, the method of shift-share decomposition adopted is the Price

[4]The difference of the two criteria given by the Brazilian Statistical Office (IBGE) occurs both in the revenues and costs considered. The value of industrial transformation (known as VTI) takes the costs directly involved in production, such as raw materials, energy and maintenance, while the added value criterion also deducts rent, advertising, freight, among others. The same occurs in the revenues, where financial operations are removed and only income from products manufactured or inventory changes are included. Both are used indistinctly by IBGE.

Equation. It was developed by George R. Price to study inheritance of genetic traits in Biology, but as he posed, it is easily generalized to deal with any characteristic that evolves with time, in any field (Frank, 1995; Price, 1970, 1972, 1995). The Equation[5], very cleverly, clarified the relationship expressed in the Fisher's Fundamental Theorem of Natural Selection (Fisher, 1930), and enabled a merge between Darwin's evolution and John Nash's work in Game Theory. It is important to notice that the structure and formulation of the Price equation is not attached to any theoretical - and particularly biological - content. Its structure, when compared to other decomposition approaches, has as main advantage the possibility of performing a multilevel analysis, which has already been used in Holm (2010) and lately in Luna et al. (2015), for the analysis of the Danish and Brazilian industry, respectively, and which allows, when applied recursively, the characterization of the selection effect in all the current and subordinate structures - as, for example, selection occurring between different sectors and selection occurring between firms in the same sector.

Furthermore, as Holm (2010) describes, there are other theoretical works in which it plays a central role: in determining evolution of routines' frequencies, such as in a Generalized Darwinism perspective (Andersen, 2004; Hodgson and Knudsen, 2004); in neo-schumpeterian models, where it appears as a mathematical expression for the construction of evolutionary explanations in line with the replicator's dynamics (Metcalfe, 1994, 1998; Metcalfe and Ramlogan, 2006), and in the general principle of selection of all evolving systems (Knudsen, 2004).

Other decomposition methods frequently used in the literature are the modified version of Baily et al. (1992), proposed by Foster et al. (2001), and Griliches and Regev (1995). The Price Equation resembles the first, with the difference being that it doesn't separate the within effect between a cross-variance effect and a constant-share learning effect. The method of Griliches and Regev is similar in this respect, but uses an average of the shares between periods to prevent against measurement error. The entry and exit terms are related in all, with minor differences in the variables regarding the use of initial or final period values.

Notwithstanding this, it is difficult to compare results amidst them or to use different methodologies to test for robustness, as it may be the case that all are valid *per se* and ultimately are measuring distinct things (Holm, 2010).

It is important to note that this work is far in analytical and methodological terms of other similar studies for Brazil, especially those departing from traditional production aggregate functions, such as the one presented in Ferreira et al. (2008) and in Bonelli and Bacha (2013), among others. Despite of the several works on the productivity of the Brazilian manufacture, the service sector is less explored and as in the previous papers cited,

[5]The Price Equation is explained in details on page 09.

in general, the explanations behind the industrial dynamic is not under an evolutionary framework. Recently and in that evolutionary context, Catela et al. (2015) presents a non parametric approach for the analysis of the evolution of sectoral labour productivity and its determinants, for the period of 2000-2008 and for the manufacture of the Brazilian industry. The results put in evidence the market asymmetries, showing that the less productive sectors are more heterogeneous and that there is just a small amount of sectors with a high labour productivity, which is also verified through a quantile econometric analysis. Hence, the comprehension of the Brazilian industry dynamic under an evolutionary point of view still demands research.

This work aims to fulfill this gap with a preliminar descriptive analysis of the evolution of labour productivity change, considering the impact of size on the performance of firms and with the evolutionary theory to lighten and explain our findings.

3 Data

This study is based on two databases from IBGE, the Brazilian Institute of Geography and Statistics, responsible for collecting and publishing most of statistical data of the country: PIA[6],which is the annual survey of the manufacturing sector (ISIC Codes 10-36) and PAS[7],which is its mirror for the service sector (ISIC Codes 55-93 plus services related with agriculture and livestock).

Both databases have census information for firms over 20 (PAS) and 30 (PIA) employees for the period 1996-2011 in the case of the manufacturing sector and 1998-2011 for the service sector. The access to the data is restricted and due to privacy reasons we are obliged to exclude any 3-digit sectors with less than 03 firms. It is important to highlight that both databases only include information for the formal economy. This is more significant for the services since Brazil, historically, has a great share of informal economic activity in this sector. Moreover, despite of the importance that small firms have on the Brazilian economy - specially in the service sector - it is important to remark that our sample is responsible for at least 65% and 80% of the whole added value of the service and manufacture sector, respectively (SEBRAE, 2014).

The nominal values were deflated for the manufacturing sector with 2-digit sectoral prices indexes (IPA-OG). For the service sector, these indexes were not available, so we used a general aggregate index for all subsectors (IPCA-Geral).

For a better presentation of the economical and political context of the Brazilian economy

[6]PIA - Annual Industrial Survey.
[7]PAS - Annual Services Survey.

from the late nineties to the early 2000's we opt to split the data in two periods. The first period, 1996-2003, represents the efforts of stabilization of the currency through a pegged system linked to the US dollar. It covers most of the period of the overvalued exchange rate and two international crisis, the first with the Balance of Payments Crisis of the Emergent Countries in 1997-1999, and the second with the burst of the Dot-com Bubble in 2001. In the whole period, these resulted in a low raise in value of transformation (11%) and employment (16%). Productivity in this context is mostly decreasing for manufacturing and, with the exception of a short recovery in 2001-2002, stagnant for services.

The second period, 2004-2011, represents the growth of the economy following the commodities boom. A lot of infra-structure projects were initiated in this time, and government investment was more fiercely achieved than in the previous period. Also, there was a strong growth in internal demand, based on consumption and on the increase of credit and wages. The aggregate value of transformation for manufacturing expands 41% and the employment in 29%. Productivity for both sectors grows steadily.

Despite the fact that the Price equation can consider the effect of entry and exit, this work considers only the analysis of the selection and the learning effect. The focus on those two effects of the decomposition is due to the lack of access to another database (RAIS[8]), which would make possible the inclusion of age and other variables of interest that would allow the analysis of the churning due to birth and death of firms. In future works we pretend to include these in order to perform a demographic study of the firms.

Therefore, our investigation is based on the observation of incumbents, considering as that the firm that is present in the base-year and the end-year of the panel. This means that our sample is not random, as numerous studies (Disney et al., 2003a; Baldwin and Gu, 2006) highlight that size is negatively correlated with probability of exit. Nevertheless, the impact on medium and large size firms is very reduced, and the number of incumbents declines slowly.

Figures 1 and 2 show some selected variables related to incumbents according to their size, for both periods and sectors. Figures 1-(a) and 2-(a) show the number of incumbents. As mentioned before, the size is defined by the number of employees and three categories are established. Small firms, with a number of employees between 30 (20 for services) and 99; medium firms, between 100 and 499 and large enterprises as the ones that have 500 or more employees. The panel for all sizes has around 20 thousand firms per year for each period. Average productivity and market-shares for manufacturing and services are also depicted on both figures, items (b) and (c), respectively.

[8]The RAIS database covers information about the formal employment of all firms in Brazil and is organized by the Brazilian Ministry of Labour.

It is interesting to see the relevance of size in the market-share[9]. Large firms represents around half of the total employment for each sector among incumbents. Also, there is a huge discrepancy in productivity associated with size for manufacturing, with large firms with the double and quadruple output per worker of medium and small firms, respectively. This contrasts with services, where productivity is about the same for all sizes, thus indicating huge scale gains in the former. The magnitude of the gap when one control for size seems to be a particularity of Latin America, and our finding is strongly corroborated by other studies (CEPAL, 2010; Santoleri and Stumpo, 2016).

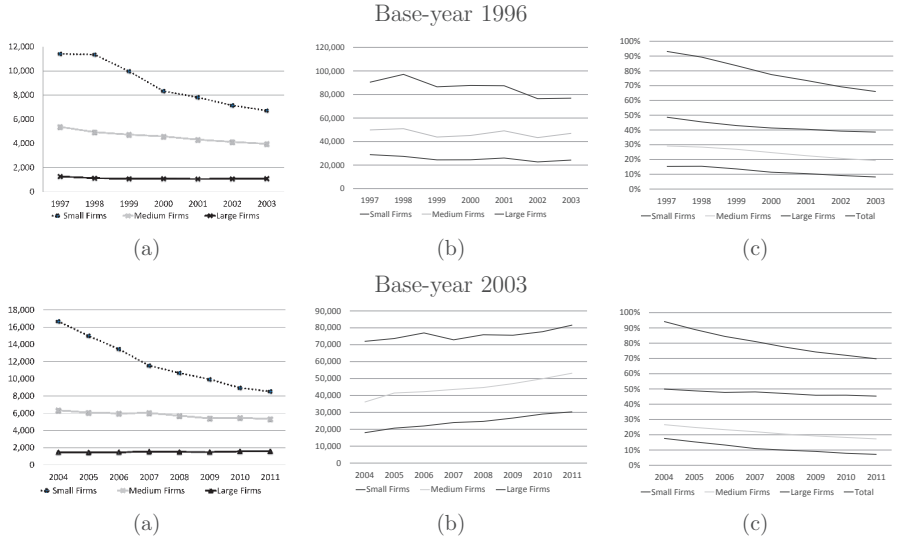


Figure 1: Manufacturing - Incumbents by size. (a) number of firms, (b) average productivity, (c) market-share, measured by total employment.

4 Methodology

Aggregate productivity growth is measured through a weighted average of the productivity of each firm. This growth is the result of the reallocation of shares of the market between incumbent, entering and exiting firms and changes in their productivity levels. Thus, the effects of incumbent firms can be separated in two outcomes. The within effect

[9]The gap between the total market share and 100% for each year is due to sectoral turbulence: entrants and exiters that are not considered in our sample, changes on the size of a firm below the census level (lower than 30 - or 20 for services), change on the firm activity or any other reason not specified in the database.

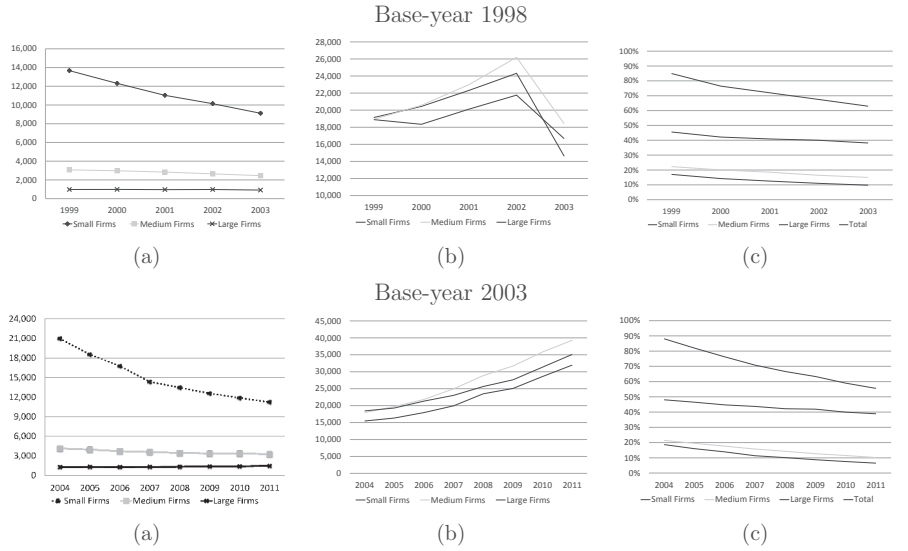


Figure 2: Services - Incumbents by size. (a) number of firms, (b) average productivity, (c) market-share, measured by total employment.

corresponds to firm-specific variations in productivity levels and it is usually associated to the activity of idiosyncratic learning and innovation that occurs inside the boundaries of the firm. The between effect, on the other side, represents changes in the landscape of the market. It accounts for the gains and losses of market-share, weighted by the productivity of the firms, and represents a measurement of selection forces acting to promote the fitness of the environment. Both are also referred as learning and selection effect, respectively, and this terminology will be used indistinctly along this article. The other two effects portray the entry and exit, whereas firms with higher than average productivity levels contribute positively to the overall index when entering, and negatively when exiting.

Let start with an aggregate index of productivity, Z, the productivity of individual firms, z_i, measured as the logarithmic of the value of transformation per worker (for manufacturing) or value added (for services)[10], and s_i the market share of the firm, measured as its participation in total employment:

$$Z = \sum z_i s_i \tag{1}$$

[10]The advantage to use a logarithmic expression in this case is that it makes sense that relative values of productivity would be more important than absolute ones. On the other hand, this forces us to exclude all firms with a negative value.

This aggregate index can then be decomposed using the Price Equation and considering in its more general configuration the entry and exit effects, the index variation is expressed as[11]:

$$\Delta Z = \sum_{i \in C} \Delta s_i (z_i - Z) + \sum_{i \in C} s'_i \Delta z_i + \sum_{i \in N} s'_i (z'_i - Z) - \sum_{i \in X} s_i (z_i - Z) \tag{2}$$

where C, N and X represent firms that are incumbents, entrants and exiters, ΔZ is the change in log(productivity), variables with a prime represent values at the final period and upper case letters represent the average of the whole sector, regardless of size. The right-hand side terms denote the between, within, entry and exit effects, respectively.

Each of these effects can be further decomposed to represent three classes of firm's size, corresponding to the categories defined before:

$$\begin{aligned}
\Delta Z = & \sum_{i \in C,Small} \Delta s_i (z_i - Z) + \sum_{i \in C,Small} s'_i \Delta z_i + \sum_{i \in N,Small} s'_i (z'_i - Z) - \sum_{i \in X,Small} s_i (z_i - Z) + \\
& \sum_{i \in C,Medium} \Delta s_i (z_i - Z) + \sum_{i \in C,Medium} s'_i \Delta z_i + \sum_{i \in N,Medium} s'_i (z'_i - Z) - \sum_{i \in X,Medium} s_i (z_i - Z) + \\
& \sum_{i \in C,Large} \Delta s_i (z_i - Z) + \sum_{i \in C,Large} s'_i \Delta z_i + \sum_{i \in N,Large} s'_i (z'_i - Z) - \sum_{i \in X,Large} s_i (z_i - Z)
\end{aligned} \tag{3}$$

This division helps to elucidate the characteristics that these effects share with firm's size. By making this kind of evaluation, traces that could inevitably be lost by a more sectoral analysis are kept. And it helps to see whether the relevance to productivity comes more from the type of product or by the scale of the business. Of course, any analysis of this kind is not definitive, but it is interesting to see if this promotes another kind of paradigm shift regarding the relevance of intra-industry and intra-services sectoral investigation.

It is important to highlight that it was not possible to control for *true* entry and exit in this study, where "true entry and exit" means firms that are created and run out of operation for any reason. Also, firms could move from the census sample and the random sample when their number of employees decrease below the inferior limit. This could pose a significant noise in our conclusions, as firms could arise and disappear in the panel due to measurement errors and omissions in the data; so it was decided not include these effects in our analysis.

[11] For the derivation in its modern form, please refer to Luna et al. (2015), Holm (2010) and Frank (1995).

5 Results

The results of the decomposition are presented in Figures 3 and 4, for manufacturing and service sectors, respectively. There is a noticeable difference in the trends of each time period, especially in the within effect of smaller firms of manufacturing. This change in the pattern coincides with the beginning of the commodities cycle.

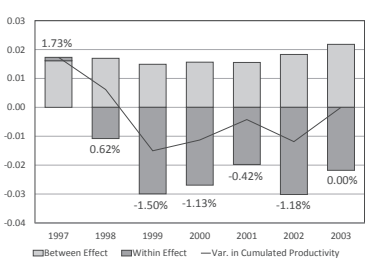
Also, it is interesting to observe that, for both periods and sectors, the between effect is not meaningful to explain changes in productivity for medium and large sized firms. This contrasts with the common argument of the efficiency of the market to promote the survival of the fittest, and add to the international evidence about the small overall contribution of this effect to promote changes in aggregate productivity. As these firms amount to the major part of the market, it is not surprising that this effect, which is very relevant for small firms, doesn't appear so relevant at the aggregate level.

A small caveat is necessary. Besides the low contribution, one has to be very careful about the type of competition addressed here. This type of selection has an implicit hypothesis that there is a mechanism that forces the motion of market-shares toward more productive firms without a clear deductive frame. Therefore, how does it happen? Are their scale so much more efficient than the others so that it allows them to charge less for the product and still have a more productive plant? Or is the quality of their product so superior that they can charge more per unit, thus making their workers more "productive"? There is no easy answer for these questions, and even when using sectoral deflators, there is still a lot of dispersion on prices. Therefore, from what the decomposition allows us to infer, we can observe that, the weak intensity of the selection effect observed in our data can be a consequence of 1) a low deviation on relative productivities, which as we will show, it is not verified in the data, since despite of its small value when compared to other metrics, it is yet significant or 2) the result of a low correlation between the change in market-share and the differentials between firm-specific productivity from the average, which is to be expected if this kind of competition is not so important to define the winners of the market.

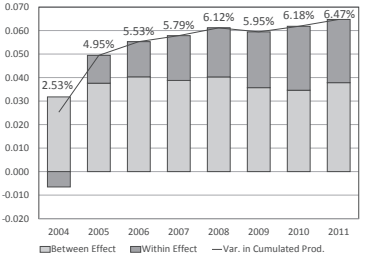
Maybe other types of mechanisms, like cultural selection[12], are more relevant to explain how competition works. And, as the between effect is derived from the covariance of market-share and productivity, it only captures linear relations between the two variables, with higher order's correlations being excluded.

[12]Cultural selection is based on the same idea that drives evolutionary selection, but change the focus from the price mechanism to other sociological traits, like changes in tastes, fashion and mass culture. It is a form of group selection.

Small firms

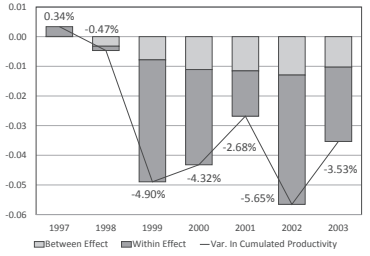


(a)

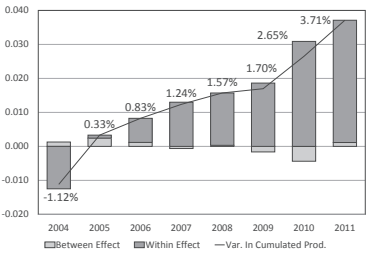


(b)

Medium firms

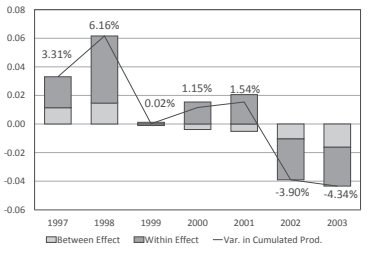


(c)

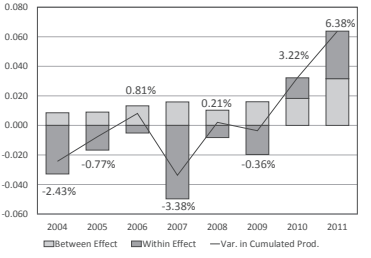


(d)

Large firms



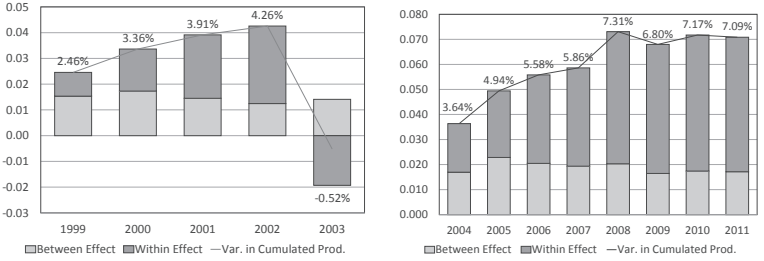
(e)



(f)

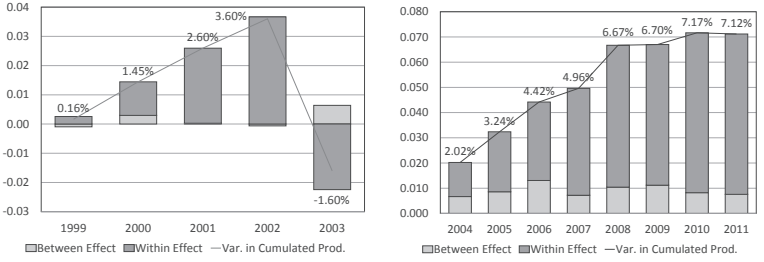
Figure 3: Manufacturing - Decomposition. Cumulated Results for small medium and large firms. Left column with base-year 1996. Right column with base-year 2003.

Small firms



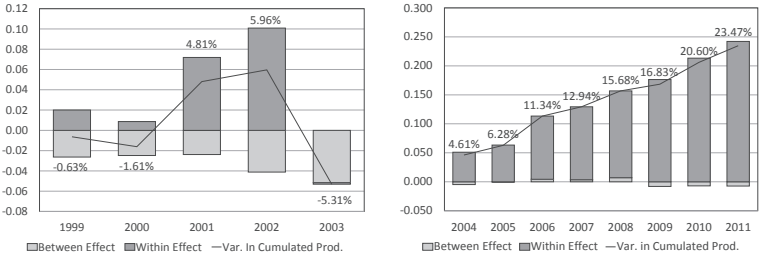
(a) (b)

Medium firms



(c) (d)

Large firms



(e) (f)

Figure 4: Services - Decomposition. Cumulated Results for small medium and large firms. Left column with base-year 1998. Right column with base-year 2003.

In order to enrich the discussion, some complementary descriptive statistics for our main variables are presented in Tables 1 and 2 for manufacturing and for every period analyzed.

Tables 3 and 4 show descriptive statistics for the service sector.

These evidences drive us to question the significant differences in productivity for different firm's sizes. Why selection by fitness seems to be significant only for the small ones, regardless of the sector? This may be a consequence of their restricted access to credit and finance, but certainly more studies are necessary to address that. Nonetheless, it is already shown that Brazilian policies driving towards innovation, as the "Lei do Bem", acted mostly on firms that innovate before its implementation, and from these, more than 80% had more than 500 employees (Calzolaio, 2011). This little external support probably creates an environment that is much more harsh and less creative for these enterprises.

On the other hand, the low standard deviation of productivity for all sizes of firms is astonishing, especially when compared with the variance of net revenue and value of industrial transformation. When controlled by size, this distribution does not seem so heterogeneous as the evidence for other countries (Yu et al., 2015a; Dosi et al., 2015). This could mean that either 1) size measured by number of employees is more relevant to ascertain productivity deviation than intra-sectoral analysis or 2) the capital intensity of each enterprise, at least for those Brazilian sectors, is intimately related to its size as measured here. This brings robustness to our analysis, since, even if we did not control for capital discrepancies, the productive structure appears to be very homogeneous inside each class.

Another interesting fact is that this variance diminishes with size for manufacturing, maybe implying the existence of some technological frontier. The fact that this does not occur to services, and the closeness of values of average productivity for all firms sizes, remember both that scale gains without affecting quality are inherently difficult to be made in this sector, and that measures of productivity are extremely difficult to be validated (Baumol, 1967; Baumol et al., 2012). The last point, however, does not downgrades the results by itself, but claims precaution, as there are "shadow" quality improvements that disappear when looking at prices only.

A more detained vision to market-share is also necessary. The greater share of market is due to large firms, which for manufacturing also happen to be the most productive ones. This is an important insight because the lack of controls for size can mask what happens for smaller enterprises, and leads to a biased view of the process itself. To be able to interpret this in the light of public policies is fundamental, as it helps to evaluate the collateral damage that can happen with governmental intervention. Unfortunately, to our knowledge, few other studies controlled for size when doing decomposition analysis (Dosi et al., 2015).

A significant distinction appears when one analyses the within effect. While it is hard to point a precise trend in the results, certain aspects deserve to be mentioned. First, it is interesting to notice that for the service sector there is much more consistency among the

Table 1: Manufacturing - Statistical Summary. Base-year 1996

Year	#	% t_0	Z	sdev(z_i)	Emp	sdev(emp_i)	VIT	sdev(VIT_i)	Net Revenue	sdev($netrevenue_i$)
						Small Firms				
1997	11419	100%	28.9	4.8	52.3	21.5	3,200	7,182	7,614	15,218
1998	11357	99%	27.4	6.6	49.3	22.4	3,071	5,959	7,637	15,356
1999	9971	87%	24.4	6.6	50.7	22.5	2,833	6,231	7,226	17,363
2000	8335	73%	24.5	6.2	53.7	21.9	2,958	5,777	7,856	17,479
2001	7815	68%	26.0	5.2	53.8	21.6	3,089	7,288	8,252	21,250
2002	7147	63%	22.7	4.9	54.3	21.7	2,667	5,253	7,202	17,523
2003	6722	59%	24.2	4.2	53.5	21.7	2,803	5,814	7,654	17,905
						Medium Firms				
1997	5375	100%	49.9	4.1	211.0	101.6	22,100	52,589	51,831	103,628
1998	4939	92%	50.9	4.8	208.9	100.2	22,802	55,520	54,972	104,393
1999	4731	88%	43.8	5.6	210.7	101.2	20,624	43,245	50,159	101,135
2000	4582	85%	45.2	5.3	211.4	101.1	20,990	63,518	53,123	122,696
2001	4314	80%	49.1	4.3	210.5	99.5	21,262	42,886	54,235	116,805
2002	4129	77%	43.4	4.4	211.9	100.4	18,994	45,756	48,943	105,226
2003	3969	74%	46.9	3.2	212.9	100.4	19,737	45,274	52,679	114,665
						Large Firms				
1997	1268	100%	90.4	2.8	1,490.5	2,240.2	278,864	1,450,840	618,507	3,311,142
1998	1128	89%	97.1	2.8	1,462.6	2,139.6	311,860	1,844,200	669,611	3,274,277
1999	1074	85%	86.5	3.8	1,479.9	2,174.9	313,850	2,309,991	644,044	3,448,939
2000	1081	85%	87.7	3.2	1,497.1	2,164.8	341,159	2,940,050	692,014	4,119,253
2001	1063	84%	87.5	3.2	1,531.2	2,235.9	347,813	2,787,123	728,610	4,297,843
2002	1074	85%	76.5	2.8	1,537.3	2,197.3	299,175	2,246,858	642,433	3,446,237
2003	1089	86%	76.9	3.4	1,554.6	2,233.7	329,728	3,014,912	714,254	4,395,854

Source: Our elaboration. All monetary values are in BRL 1k. Z is productivity measured as annual VIT per employee, weighted by firms. Emp represents the average number of employees. % t_0 shows the percentual of incumbents as compared against the first subsequent year of the base-year. Values above 100% represent firms that moved to a higher size category in the period. As we opted for a dynamic categorization, firms that hire more employees between two years can move to a higher class of size.

different sizes than in manufacturing, with the within effect being positive in a significant part of both periods for all sizes. This shows how much of the average values of productivity are correlated with this term.

In the industrial sector, there seems to be more of an inverse movement in the learning effect observed among small and medium firms versus the large ones, with most of the years showing that the internal movements act distinctively for these two groups. But why? It is hard to find a convincing explanation for this without more data. It does not seem to be related to the investment cycle or downsizing, as the large firms class expanded the average number of employees consistently in both periods, even if more fiercely in the second one. Also, it appears to be greatly influenced by the stage of the economic cycle, contributing negatively in the first period and positively in the second for small and medium firms.

This poses the important question of how much of real, physical productivity is measured when making decomposition studies. Are these differences consequence of investments in capital and technology or only changes in mark-up and idle capacity due to a higher or lower demand? Well, the evidence in this regard is more dubious, especially because of the

Table 2: Manufacturing - Statistical Summary. Base-year 2003

Year	#	% t_0	Z	sdev(z_i)	Emp	sdev(emp$_i$)	VIT	sdev(VIT$_i$)	Net Revenue	sdev(netrevenue$_i$)
					Small Firms					
2004	16680	100%	18.0	4.5	51.2	21.5	2,190	6,573	6,119	27,430
2005	14983	90%	20.7	3.7	51.8	21.7	2,387	9,874	6,732	36,094
2006	13453	81%	22.0	3.8	52.4	21.8	2,474	6,894	6,816	29,343
2007	11527	69%	24.0	3.7	54.1	21.7	2,653	6,397	7,361	31,648
2008	10683	64%	24.7	3.6	54.2	22.1	2,610	6,451	7,084	19,355
2009	9931	60%	26.6	3.5	53.9	22.1	2,697	4,436	7,050	16,437
2010	8947	54%	29.0	3.5	55.5	21.9	2,994	5,971	7,602	22,050
2011	8531	51%	30.3	3.5	55.0	22.0	3,026	5,037	7,728	18,422
					Medium Firms					
2004	6343	100%	36.1	4.0	203.3	98.9	16,198	38,496	44,867	96,855
2005	6072	96%	41.5	3.1	207.0	100.6	17,256	44,538	48,494	101,497
2006	5988	94%	42.2	3.4	207.3	100.8	17,405	44,432	47,833	101,214
2007	6029	95%	43.6	3.1	207.7	101.0	17,111	50,210	47,881	103,513
2008	5705	90%	44.7	3.3	208.9	100.6	17,483	50,333	48,890	95,987
2009	5406	85%	47.0	3.0	209.0	100.2	17,740	54,962	47,927	94,359
2010	5475	86%	49.9	3.0	210.1	100.8	18,593	55,887	48,321	93,192
2011	5328	84%	53.2	2.8	212.7	101.6	18,715	33,001	50,219	90,289
					Large Firms					
2004	1461	100%	72.0	2.9	1,656.4	2,624.7	294,743	2,513,027	670,465	3,669,323
2005	1446	99%	73.7	2.8	1,707.7	2,763.3	309,954	2,790,484	711,218	4,068,698
2006	1472	101%	77.0	2.7	1,724.0	2,893.8	306,047	2,950,973	697,108	4,328,239
2007	1538	105%	72.9	2.9	1,778.8	3,102.9	296,759	2,773,904	706,594	4,341,542
2008	1503	103%	75.9	2.6	1,825.3	3,337.0	321,335	3,226,675	742,392	5,024,031
2009	1488	102%	75.6	2.7	1,811.8	3,234.8	300,703	2,659,687	719,130	4,158,280
2010	1572	108%	77.7	2.5	1,840.1	3,338.6	318,767	2,855,634	730,139	4,438,095
2011	1571	108%	81.6	2.5	1,889.6	3,458.8	341,359	3,084,376	786,841	4,808,847

Source: Our elaboration. All monetary values are in BRL 1k. Z is productivity measured as annual VIT per employee, weighted by firms. Emp represents the average number of employees. % t_0 shows the percentual of incumbents as compared against the first subsequent year of the base-year. Values above 100% represent firms that moved to a higher category in the period. As we opted for a dynamic categorization, firms that hire more employees between two years can move to a higher class of size. That was the case for medium firms that, starting in 2006, became large firms.

lack of data from individual firms' investments. But the high degree of correlation between Net Revenue and VIT, even when only average data is used for its measurement, points to a considerable effect of sales in promoting the within effect, and thus, in the aggregate productivity change.

This supports the idea that firms do have a non-negligible idle capacity and that productivity itself may be highly pro-cyclical and demand-dependant, at least for manufacturing. That is because, if firms need a change on market size to expand or contract their productivity, then the variation in productivity and the within effect is not due to an internal transformation, but to the cyclical economic activity. In other words, the evidence of a fixed mark-up expressed by the high correlation between the two variables supports the idea of unaltered productive structure. This, of course, would not be true if the investments promoted higher sales but not a higher mark-up, or if the better quality products that were made through investments do not acquire a mark-up differential, but are instead passed as

Table 3: Services - Statistical Summary. Base-year 1998

Year	#	% t_0	Z	sdev(z_i)	Emp	sdev(emp$_i$)	VA	sdev(VA$_i$)	Net Revenue	sdev(netrevenue$_i$)
					Small Firms					
1999	13674	100%	19.1	2.9	37.0	20.9	1,736	19,475.4	2,883	7,677
2000	12309	90%	20.4	3.0	37.7	21.0	1,661	7,432	3,091	9,234
2001	11035	81%	22.3	3.0	38.6	21.0	1,975	13,044	3,228	8,037
2002	10142	74%	24.3	3.1	38.6	21.1	2,170	17,081	3,190	9,087
2003	9117	67%	14.6	2.9	38.9	21.0	1,070	2,571	3,069	7,305
					Medium Firms					
1999	3079	100%	18.9	2.8	214.6	102.4	7,259	18,643	15,346	27,578
2000	2978	97%	20.6	2.8	219.0	105.8	8,469	34,392	16,472	31,180
2001	2836	92%	23.0	2.8	221.8	107.6	9,271	35,748	16,383	27,544
2002	2642	86%	26.2	2.8	222.1	107.3	11,511	76,910	16,939	28,274
2003	2451	80%	18.4	2.4	222.1	107.7	6,227	11,306	17,784	30,376
					Large Firms					
1999	972	100%	18.9	2.6	1,391.7	3,017.3	55,172	222,791	122,999	548,429
2000	982	101%	18.3	2.7	1,399.7	2,969.0	54,034	226,954	117,329	588,890
2001	962	99%	20.1	2.6	1,444.4	3,274.4	64,154	362,986	128,172	804,169
2002	975	100%	21.8	2.8	1,463.1	3,478.1	78,531	520,870	131,169	863,820
2003	911	94%	16.7	2.2	1,521.5	3,852.2	51,763	329,269	131,858	850,357

Source: Our elaboration. All monetary values are in BRL 1k. Z is productivity measured as annual VA per employee, weighted by firms. Emp represents the average number of employees. % t_0 shows the percentual of incumbents as compared against the first subsequent year of the base-year. Values above 100% represent firms that moved to a higher category in the period. As we opted for a dynamic categorization, firms that hire more employees between two years can move to a higher class of size.

a consumer benefit. This would show signs of correlation for the within and between effect when using other metrics to measure market-share, as revenues, since firms that would have the higher gains in productivity would also grow more. Another evidence for this is the importance of the within effect for the smaller firms, which are supposedly less prone and capable to make the required investments in innovation and research. If these variations in productivity are not consequence of R&D, what generates them? The fact that they are consistently negative for these firms in the first period also points to an increase in the idle capacity. Yet, the evidence in this respect is far from conclusive and we plan to address this point more profoundly in the future.

Figures 5 and 6 shows the share of each effect by class of size in the aggregate productivity change. As viewed in the previous graphs, the within effect tends to dominate both sectors in most of the years. But they make more clear the importance of the between effect for small firms, as they tend to respond for the major part of it. Moreover, there is a kind of discrepancy between services and manufacturing, where the former seems to be more affected by competition in the first period and the latter in the second one.

Table 4: Services - Statistical Summary. Base-year 2003

Year	#	% t_0	Z	sdev(z_i)	Emp	sdev(emp_i)	VA	sdev(VA_i)	Net Revenue	sdev($netrevenue_i$)
					Small Firms					
2004	20979	100%	15.5	2.9	36.6	20.8	1,065	2,912	2,683	7,360
2005	18540	88%	16.3	2.9	37.6	20.9	1,137	3,444	2,831	8,028
2006	16774	80%	17.9	2.8	38.3	21.2	1,259	3,862	3,019	8,437
2007	14351	68%	19.9	2.8	39.7	21.2	1,422	5,469	3,346	10,382
2008	13459	64%	23.5	2.8	40.4	21.3	1,735	5,297	3,532	10,175
2009	12571	60%	25.1	2.8	40.9	21.2	1,899	6,501	3,598	11,644
2010	11873	57%	28.6	2.8	41.2	21.3	2,069	5,506	3,747	11,627
2011	11229	54%	32.0	2.8	41.5	21.4	2,373	7,475	3,957	14,206
					Medium Firms					
2004	4128	100%	17.9	2.7	213.2	102.7	6,974	16,384	18,106	45,891
2005	3947	96%	19.7	2.7	215.4	104.7	7,855	20,349	19,206	49,379
2006	3710	90%	21.8	2.6	220.0	106.4	8,187	16,381	19,421	36,546
2007	3575	87%	25.0	2.6	221.2	106.9	9,300	19,060	20,989	38,139
2008	3439	83%	28.9	2.5	223.4	107.5	10,536	21,324	22,010	42,684
2009	3364	81%	31.7	2.6	222.0	107.3	11,389	20,502	21,932	36,196
2010	3354	81%	35.8	2.4	223.3	106.8	12,645	22,256	23,407	41,916
2011	3260	79%	39.3	2.5	223.5	107.1	13,804	23,923	23,506	41,395
					Large Firms					
2004	1279	100%	18.4	2.5	1,547.9	3,871.9	61,474	346,469	152,885	828,399
2005	1306	102%	19.3	2.4	1,549.0	2,749.2	57,570	298,037	141,924	757,082
2006	1289	101%	21.3	2.3	1,602.2	2,925.5	61,201	289,620	141,832	727,086
2007	1301	102%	23.0	2.3	1,687.5	3,336.1	71,891	338,127	158,320	834,532
2008	1319	103%	25.6	2.4	1,721.5	3,567.9	76,643	317,800	160,294	815,065
2009	1371	107%	27.6	2.4	1,798.5	4,586.0	89,297	392,712	174,162	883,506
2010	1394	109%	31.4	2.3	1,863.2	4,777.0	102,225	440,655	181,021	877,927
2011	1444	113%	35.1	2.3	1,928.8	5,069.0	114,786	481,259	187,899	884,294

Source: Our elaboration. All monetary values are in BRL 1k. Z is productivity measured as annual VA per employee, weighted by firms. Emp represents the average number of employees. % t_0 shows the percentual of incumbents as compared against the first subsequent year of the base-year. Values above 100% represent firms that moved to a higher category in the period. As we opted for a dynamic categorization, firms that hire more employees between two years can move to a higher class of size.

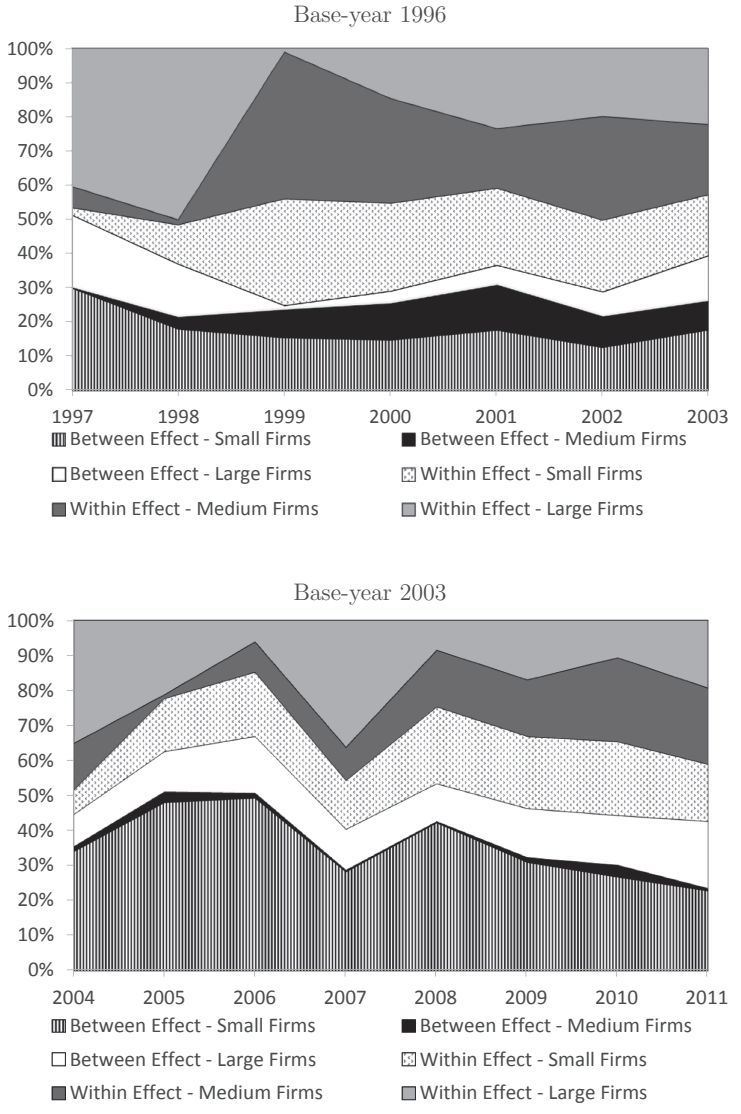


Figure 5: Manufacturing - Decomposition by effect, size and year.

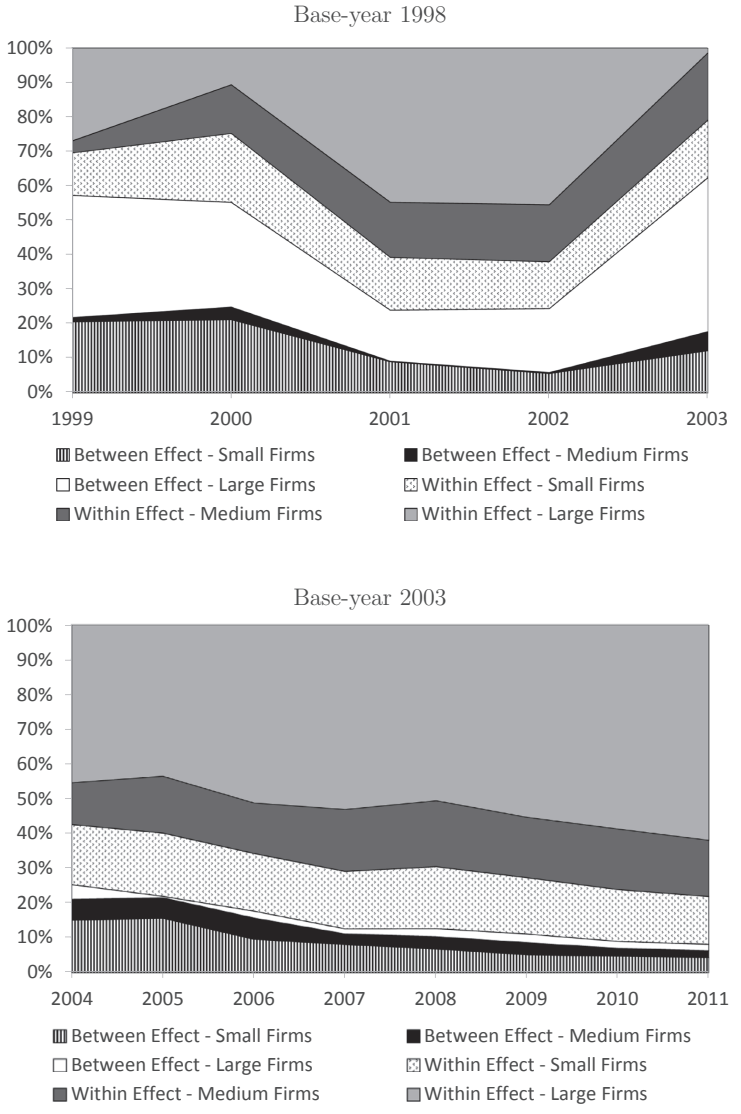


Figure 6: Services - Decomposition by effect, size and year.

6 Conclusion

Our main results support the presence of a low between effect in the industrial dynamics as found in the international literature as well as the relevance of the idiosyncratic internal behaviour to promote aggregate productivity change. They also point to the importance of size as a control for capital intensity, as showed by the little deviation found for productivity in all the classes of firms sizes, especially when compared to other selected metrics. The fact that this deviation diminishes as firms get bigger for manufacturing also gives us some support to the idea of technological frontiers. On the other hand, in the service sector, the lack of scale gains shows that it is very hard to promote efficiency in a sector that depends fundamentally on human hours of work to produce its *goods*, besides the difficulties of measurement already mentioned and the "shadow" improvements in quality as well. The great market-share of larger firms, likewise, shows the vulnerabilities of decomposition studies that do not make distinctions based on number of employees to represent the whole landscape of the market, as smaller firms seem to be much more affected by competition than the larger ones. Lastly, there is some indication that the within effect can be a representation of the economic cycle, and highly idle-capacity dependent, but more studies are necessary to address that.

Further improvements on this research and promising venues are related to the disaggregation of these analysis both by size and sub-sectors of manufacturing and services. It would be expected that the variance of productivity would decrease, and the scale gains diminish, at least for the most technological intensive areas. In this context, size would not be a relevant metric. In services, instead, some scale gains could now occur, with retail being a good candidate. The relationship between the economic cycle and the within effect also needs to be tested by a direct approach using investment data and productivity change. It is also curious to notice that the general productivity of services is so low, close to the productivity of the smaller firms of manufacturing. The supposed great mass of low skilled workers in both may tell a story where the closeness between these two groups of firms in terms of characteristics is higher than the one observed between small and big firms of manufacturing.

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