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DIPARTIMENTO DI SCIENZE ECONOMICHE E SOCIALI

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the Failure of SMEs in the Italian
Manufacturing Industry to Grow**

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Quaderno n. 132/marzo 2018

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Abstract

We use a panel of Italian manufacturing firms for the period 2001-2014 to analyse the distribution of firm size, and then test for the validity of Gibrat's law using unit root tests. Although Gibrat's Law is rejected and the estimates suggest that small firms grow faster than larger ones, we do not observe a significant change in the average size of companies at the end of the period under investigation. Also, by using a long-run Transition Probability Matrix, we verify that the steady-state distribution of firm size remains stable. The higher propensity to grow shown by smaller firms is confined to the size class in which the firm is established. We further investigate the relationship between the rate of growth in a firm's size conditional on specific firm and industry characteristics. Export intensity plays a significant role in affecting the size growth rate together with industry characteristics related to technological levels. Finally, we estimate the probability that a firm increases in size relative to the mean size prevailing in its own size class over a 14-year interval. This approach enables us to highlight those factors that affect this probability, thereby enabling us to underline how Gibrat's Law tests, although important, require complementary analysis to ascertain whether a firm's propensity to increase in size is a long run effect and thus a significant modification of the distribution of company size or only implies a marginal increase in size within a reference size class.

JEL Classifications: L11, L2, L6

Keywords: Gibrat's Law, Lognormal distribution, firm size distribution.

1 Introduction

The analysis of firm size distribution has long been considered within the debate concerning the ability of small and medium-size enterprises to grow at the international level.

Typically this literature has focused on tests on observance of Gibrat's Law, i.e. that a firm's growth is independent of its initial size. The literature on this topic has increased significantly over the years; we aim to focus on those issues that still need to be investigated in more detail. In particular, we want to emphasise how tests for the validity of Gibrat's Law do not respond to the initial issue, i.e. whether small and medium-size firms grow significantly more than their larger counterparts, and thus cause a change in the long-run distribution of firms. The results of these tests may suggest, for example, that Gibrat's Law does not hold and that small firms grow faster than larger firms. However, this contribution may be negligible and may not affect the long run distribution of firm size. Much of the literature has focused on the most appropriate methodology for testing validity of Gibrat's Law, and less attention has been paid to the long-run effect of the estimated results, which crucially entails considering the ability to grow of small and medium size enterprises in comparison with large companies. The seminal studies by ?? define the methodological framework in which proper analyses and tests have since been developed. In particular, more recent studies have focused on the need to consider tests of Gibrat's Law in a dynamic panel data framework.

Goddard *et al.* (2002); Chen and Lu (2003); Oliveira and Fortunato (2006b) apply dynamic panel data estimation techniques and the panel unit root test to test Gibrat's Law for Japanese, Taiwanese and Portuguese data sets. This literature is closely related to the investigations dealing with panel unit root tests (Im *et al.*, 2003; Choi, 2001; Levin *et al.*, 2002) which have transferred previous results of time series unit root tests to a panel framework. In addition, other studies have highlighted the role of industry-specific effects, age and the birth or death rate of firms (Almus, 2000; Lotti *et al.*, 2009; Fotopoulos and Giotopoulos, 2010). Our research falls within this stream of investigation and our aim is to test whether the growth rate of SMEs does significantly contribute to a modification of size distribution of firms in the long-run. Additionally, we estimate those factors that contribute to such a growth path. We use a large and representative data set of Italian manufacturing firms for the period 2001-2014, which enables us to derive significant and robust results. The size distribution of Italian firms has always been much discussed, and this debate is crucial because the ability of firms to grow ultimately offers more opportunities for a country's long-run growth. Technological and non-technological innovation, together with all kinds of innovation involving managerial and administrative approaches, may be better introduced and exploited if businesses evolve towards more structured organizations with the ability to interact in a globally competitive market. For these reasons it is relevant to investigate whether such a pattern is in place, and what factors may

potentially drive the growth rate of firms. The paper is organised as follows. Section 2 discusses the main findings on firms' growth rate in the light of the empirical evidence prevailing internationally. Section 3 presents the data used for the empirical investigation and discusses the main stylised facts concerning firms' growth rate in the Italian manufacturing industry. Section 4 presents the tests for Gibrat's Law and the analysis of those firm-specific factors that crucially affect firms' growth rate. Given this investigation, we specify in Section 5 a long-run logit model that enables us to ascertain the long-term effect of those factors that have a positive effect on the probability of increasing a firm's size relative to the mean size class. Section 6 concludes the paper.

2 Firms' growth: the analytical framework

The literature on firms' growth has typically focused on the more appropriate methodology to test for the so called Gibrat's Law, according to which a firm's growth rate is independent on its past size. Thus, testing for Gibrat's Law implicitly entails that firm's growth rate is defined as a random walk, i.e, we can write:

$$y_{it} = \gamma_0 + \gamma_1 y_{it-1} + u_{it} \tag{1}$$

where y_{it} is the log size of firm i at time t and u_{it} is an i.i.d. error term. If γ_1 is equal to unity, Gibrat's law is verified, whereas if $\gamma_1 < 0$ small firms grow faster than the larger ones and we observe convergence

toward the mean. If $\gamma_1 > 1$ large firms grow faster and the growth path is unstable.

The empirical literature presents results that are controversial as they crucially depend on the characteristics of the data sets used for the empirical investigation. In addition, the methodological development of the literature on panel unit root tests has contributed, on the one hand, to include such methods within the more general framework of the test for stationarity which were originally developed within the time series literature. On the other hand, this relatively new literature has increased the uncertainty about the outcome of the test, given the assumptions on which such tests are based and the controversy that this brings about.

One of the most significant limitations of the literature on testing for Gibrat's Law is that results crucially depends on the characteristics of the data set used for their implementation. Early studies have typically focused on cross-section data, thus lacking to take into consideration the real dynamics and evolution of firm size across time and industries. The application of these tests to different industries, although relevant for understanding dynamics related to specific conditions and technological opportunities, does not provide a general validity of the hypothesis being tested for. Also, the consideration of firms' birth and death rate is crucial to obtain estimates that otherwise would suffer of significant selection bias. Goddard *et al.* (2002) provide a detailed analysis of panel unit root tests for a set of Japanese manufacturing firms,

concluding that firm size is mean reverting towards heterogeneous values, and thus Gibrat's Law should be rejected. Oliveira and Fortunato (2006b) extend the testing procedure by including firm and industry specific factors affecting size growth, suggesting that age, and financial constraints play a significant role. In particular firm age and leverage negatively affect size growth, while a liquidity index exerts a positive impact. Almus (2000) apply tests for Gibrat's Law to a set of young German manufacturing firms, rejecting the underlying hypothesis of proportionate growth rate.

Lotti *et al.* (2009) test the hypothesis for a set of Italian firms belonging to the radio, TV and communication equipment industries, by taking also account for possible selection bias related to firms' death and birth rate. They do not find support to the hypothesis being tested for. However, they suggest that convergence towards Gibrat's Law is verified, in that a separate test including only the final years of the period taken into consideration, allows for not rejecting the hypothesis. This fact is interpreted as an indication that market selection, at least in these industries, produces a final condition in which the dynamics of industrial business is coherent with Gibrat's pattern. Such a pattern is also verified by Fotopoulos and Giotopoulos (2010) within medium and large Greek manufacturing firms; however, Gibrat's Law is rejected for micro, small and young firms.

3 The data set and the stylised facts

3.1 General overview

Our data set is represented by the *Panel data on the balance sheets of corporations with employees* (ISTAT), an integrated data source providing demographic and economic information on the population of Italian limited companies during the period 2001-2014. Firms' demographic information is based on the ASIA archive (Statistical Register of Active Businesses), which was set-up in 1996 and is regularly updated according to the European Council Regulations. The ASIA register covers all enterprises carrying on economic activities contributing to the formation of Italian gross domestic product and, thus, it is used by ISTAT for sample and census investigations. Our dataset also provides annual information about imports and exports and, thus, allows one to widening the analysis to firms' internationalization patterns. From the original dataset we select an unbalanced panel of almost 193 thousand manufacturing firms (more than one million three hundred thousand observations) during 14 years, which include the financial crisis of 2008 and its aftermath. Descriptive statistics are reported in Table 1.

This data set enables us to analyse transitions between size classes along the whole period. We thus consider long-run transitions, i.e. , upsizing and downsizing for those firms which were active in 2001 and 2014, in order to gather information on firm size dynamics and persistence patterns.

Table 1: Variable definition and descriptive statistics - Selected years

variable name	type	variable description	Year 2001 - N=85,633 mean	std. Dev	Year 2008 - N=102,536 mean	std. Dev	Year 2014 - N=97,047 mean	std. Dev
size	c	Firm's size (number of employees)	33.42	192.88	30.00	158.57	27.47	160.19
dsize	c	Firm's growth (annual rate of increase in employees)*	0.02	0.29	0.02	0.26	0.01	0.24
age	c	Firm's age in years	14.41	12.43	16.05	13.51	18.76	15.06
lev	c	The ratio of total debt to total assets. A measure of a firm's exposure to external financing sources (%)	71.79	23.06	69.43	27.23	66.56	29.41
pavint1	0/1	1 if in the low technology sectors	0.40	0.49	0.38	0.49	0.38	0.49
pavint2	0/1	1 if in the medium-low technology sectors	0.31	0.46	0.32	0.47	0.30	0.46
pavint3	0/1	1 if in the medium-high technology sectors	0.25	0.43	0.26	0.44	0.28	0.45
pavint4	0/1	1 if in the high technology sectors	0.05	0.22	0.04	0.20	0.04	0.19
area1	0/1	1 if the firm is localized in the North-West	0.36	0.48	0.34	0.47	0.34	0.48
area2	0/1	1 if the firm is localized in the North-East	0.28	0.45	0.28	0.45	0.29	0.45
area3	0/1	1 if the firm is localized in the Centre	0.19	0.40	0.20	0.40	0.19	0.40
area4	0/1	1 if the firm is localized in the South	0.16	0.37	0.18	0.38	0.17	0.38
clsize <10	0/1	1 if in the relative class size in terms of employees	0.40	0.49	0.43	0.50	0.48	0.50
clsize 10-19	0/1	1 if in the relative class size in terms of employees	0.26	0.44	0.27	0.45	0.26	0.44
clsize 20-49	0/1	1 if in the relative class size in terms of employees	0.21	0.41	0.19	0.39	0.17	0.37
clsize 50-249	0/1	1 if in the relative class size in terms of employees	0.11	0.31	0.09	0.29	0.08	0.27
clsize 250-499	0/1	1 if in the relative class size in terms of employees	0.01	0.10	0.01	0.09	0.01	0.09
clsize >=500	0/1	1 if in the relative class size in terms of employees	0.006	0.07	0.005	0.07	0.004	0.07
intern1	c	export to total sales ratio	0.14	0.24	0.13	0.24	0.15	0.25
intern2	c	import to total sales ratio	0.05	0.12	0.05	0.12	0.05	0.12
rd_sstrate	c	Sectoral death rate (%)	1.12	0.51	1.45	0.55	1.04	0.39
rb_sstrate	c	Sectoral birth rate (%)	3.88	0.99	3.44	1.25	2.46	0.88

In particular, if one considers the 2001-2014 transition probability matrix (TPM), persistence is the dominant characteristics as the persistence rate varies between almost 95% for larger firms and 84% for firms with 10 to 20 employees (Table 2).

We have also calculated at the bottom of the matrix the so-called steady-state distribution of firms by their size. The implied steady-state firm size distribution may be derived by imposing the steady-state condition, i.e., the outflows and inflows from one state counterbalance each other. In other words, this implies that:

$$xA = x \tag{2}$$

where x is the row vector, which reflects the distribution of firms according to their size, and A is the associated TPM. Equation (2) implies that the steady-state distribution may be found by calculating the eigenvector associated with the unit eigenvalue ¹. The implied long-run distribution indicates that almost 66% of firms belong to the bottom class and slightly more than 27% to the second, i.e., 94% of firms have fewer than 20 employees. Medium to large-sized enterprises represent the smallest minority of the population of Italian manufacturing firms.

This evidence is coherent with previous findings based on the results of the Industry Census (ISTAT, 2013), which shows that the bulk of Italian firms (80%) belong to a conservative or traditional cluster and typically operate with a defensive strategy targeted to the maintenance

¹For a more detailed description of the steady state definition, see Basu (2003).

of the acquired market share.

On the other hand, it is suggested that a small minority of firms, representing approximately 5% of companies, have adopted more aggressive strategies devoted to increasing market share, which enables them to compete in international markets. Among this tiny group, even fewer firms show a large size, a complex organisation structure and a global strategy.

Table 2: Transition probabilities between size classes during the period 2001-2014 (yearly averages)

	less than 10	10-19	20-49	50-249	250-499	500 and more	Total
less than 10	91.8	7.6	0.6	0.1	0.0	0.0	100.0
10-19	10.1	84.1	5.7	0.1	0.0	0.0	100.0
20-49	1.0	7.7	88.2	3.1	0.0	0.0	100.0
50-249	0.3	0.3	6.0	92.6	0.7	0.0	100.0
250-499	0.0	0.0	0.1	8.7	88.6	2.5	100.0
500 and more	0.0	0.0	0.1	0.2	4.9	94.9	100.0
Steady-state distribution	65.6	27.2	3.2	2.9	0.7	0.8	

Notes. Variable *size* and age in log terms. m2 is asymptotically N(0,1) test for second order serial correlation of the residuals. P-values in parentheses.

3.2 Firm size distribution

In this section, we further analyse the characteristics of the data set, by testing whether firms size (as described by the number of employees) may be represented by a lognormal distribution. We describe the fit of the size distribution of firms to the data set previously described, i.e. the panel of manufacturing firms with balance sheet information, and we also apply the same procedure to a second data set, which represents the population of firms drawn from the ASIA archive. This second fit enables us to verify whether the selected panel presents distribu-

tions that are consistent with those of the population of manufacturing firms².

We then consider the firm size distributions, to test whether, according to the empirical literature, the LN model presents the best fit. The competing models are: gamma (G), unimodal inverse Gaussian (IG), Weibull (W), and logistic (L)³.

To compare models with the same number of parameters, in terms of goodness-of-fit, we use the log-likelihood (in addition to the criteria described below). Comparison of models with differing number of parameters is accomplished, as usual, via the Akaike information criterion (AIC; Akaike, 1974) and the Bayesian information criterion (BIC; Schwarz, 1978) that, in our formulation, need to be maximized.

In Table 6 reported in the Appendix some descriptive statistics related to different years are displayed. Data results (for all the years) right-skewed and leptokurtic, with a long right-tail. To give a graphical idea about the distribution, we report in Figure 1 the histogram of the data for the year 2014.

Figure 2 presents a model comparison in terms of goodness-of-fit. In particular, that figure reports, for each year and estimated model, the AIC value. It is easy to note as the ranking in terms of that index

²It is worth recalling that the selected panel results from merging balance sheet data and statistical information on employees derive from the ASIA archive.

³Parameters are estimated via the maximum likelihood (ML) procedure and the whole analysis is made in the R statistical software (R Core Team, 2016). For the models LN, G, W, and L the estimated parameters are obtained by the `fitdist()` function of the `fitdistrplus` package (Delignette-Muller *et al.*, 2017), while for the model IG the estimates are obtained using the function provided in Punzo *et al.* (2017)

is the same for all the years. The same result holds if the BIC index is considered (for brevity's sake the results are not reported here). In particular, the best model results to be the LN. The second best model is the IG which produce AIC values always lower than the LN model (even if from the Figure 2 it seems that LN and IG provide the same AIC).

Moving to our data base of manufacturing firms with balance sheets, Table 7 reports some descriptive statistics⁴. The histogram of the observed data for year 2014 is reported in Figure 3. Similarly to the first dataset also here we observe right-skewness and leptokurtosis.

The comparison among fitted models is presented in Figure 4 where the AIC for each fitted model is reported along with the corresponding year. As can be easily noted, the ranking induced by the AIC is equal for all years, and results are similar for the BIC criteria. Also, one should note that the ranking corresponds to that obtained in the first data set. Moreover, as in the previous application, the first and the second best models are the LN and IG, respectively.

4 Firms' growth: tests and further evidence

According to the analysis previously described, it is confirmed that firm size is better described by a lognormal distribution. This result is

⁴Differences in terms of mean size are justified on the ground that the ASIA archive, compared to our data set, also includes small individual firms for which balance sheet information is not available from the Italian public register, thus our analysis excludes these firms.

coherent with the stylised facts of firms size distribution detected in the international literature. Given this preliminary inspection of the data, we formally test for the validity of Gibrat's Law. This latter implies, according to equation (1) that firm size dynamics may be described by a random walk. Thus, a first step is represented by testing for unit root the time path of firm size (equation 1). We are aware of the limitations that these tests bring about, particularly when they are applied to a panel framework. However, keeping this consideration into account, we consider such tests as preliminary and complementary to the more general specification of firms growth rate. We thus present panel unit root tests in Table 3.

According to the results of these tests we reject the unit root hypothesis and, therefore, the validity of Gibrat's Law⁵.

Given this preliminary analysis, we decided to model a firms' growth rate also taking into account specific characteristics which may crucially affect a firm's growth rate. In particular, we consider:

- the degree of internationalisation expressed regarding the relative value of import and exports with respect to sales,
- financial efficiency, i.e. leverage, the debt-equity ratio,
- age.

In addition, we control for sectoral birth and death rate, thus en-

⁵We are aware of the fact that these tests are subject to limitations because of the underlying assumptions. However, they provide a first step in the analysis of the validity of Gibrat's Law.

abling our estimates to take into consideration that some firms exit and other enter the market during the sample period. However, one has to consider that exit rates are relatively low even during the great recession of 2008-09, due to institutional and legislative factors that have been introduced over the years and in particular in the aftermath of the financial crisis.

We, therefore, estimate the following equation:

$$\begin{aligned} \Delta size_{it} = & \beta_0 + \beta_1 \Delta size_{it-1} + \beta_2 \Delta size_{it-2} + \beta_3 size_{it-1} \\ & + \beta_4 intern1_{it} + \beta_5 intern2_{it} + \beta_6 age_{it} + \beta_7 lev_pc_{it} \quad (3) \\ & + \beta_8 rd_setrate_t + \beta_9 rb_setrate_t + \epsilon_{it} \end{aligned}$$

where ϵ_{it} is a normal distributed i.i.d. error component and i and t identify respectively firms and time.

Table 3: Unit Root Tests

Choi tests	statistic	p-value
Inverse chi-squared	87,600	0.0000
Inverse normal	-7.0131	0.0000
Inverse logit t	-27.0264	0.0000
Modified inverse chi-squared	86.8466	0.0000
Levin-Lin-Chu test	statistic	p-value
Adjusted t*	-1300	0.0000
Number of panels	29,020	
Number of periods	14	

Notes. Unit root tests according to Choi (2001) and Levin, Lin, Chu (2002). We consider a panel data model with the following autoregressive component: $\Delta y_{it} = \gamma_1 y_{it-1} + k' \delta_i + \gamma_2 \Delta y_{it-2} + u_{it}$, where $k' \delta_i$ are panel specific means. H0: all panels contain unit roots H1: At least one panel is stationary.

As concerns the explanatory variables, *size* is the log of firm size,

intern1 and *intern2* are respectively the value of a firm's exports and imports to total sales, *age* is the log value of a firm's age, *lev_pc* is a leverage index, i.e. the total debt to equity ratio, and *rd_setrate* and *rb_setrate* represent sectoral death and birth rates respectively.

Thus, we estimate an augmented firm size growth equation, in that together with the traditional specification which includes a lagged term and difference terms of the size variable, we control for other factors which are typically recognised as crucial factors affecting a firm's ability to grow according to the international empirical literature (Oliveira and Fortunato, 2006b,a).

Table 4: Firms' growth: dynamic panel data estimation (Arellano-Bond). Period 2001-2014

Variable	full sample	by size class					
		less than 10	10-19	20-49	50-249	250-499	500 and more
L.dsize	-0.0272*** [0.00338]	0.0135** [0.00542]	0.0263*** [0.00502]	-0.0193*** [0.00673]	-0.0745*** [0.0126]	-0.0563* [0.0336]	-0.0245* [0.0126]
L2.dsize	-0.0249*** [0.00217]	-0.00204 [0.00359]	0.00356 [0.00306]	-0.0137*** [0.00418]	-0.0498*** [0.00601]	-0.0191 [0.0146]	-0.00327 [0.0174]
L.size	-0.898*** [0.00487]	-0.913*** [0.00726]	-1.014*** [0.00838]	-0.941*** [0.0105]	-0.874*** [0.0179]	-0.904*** [0.0373]	-0.944*** [0.0928]
intern1	0.104*** [0.00494]	0.144*** [0.0106]	0.0800*** [0.00706]	0.0663*** [0.00690]	0.0805*** [0.0126]	0.0941 [0.0628]	0.0607 [0.0783]
intern2	0.0250*** [0.00924]	0.0415** [0.0205]	0.0218 [0.0145]	0.0141 [0.0122]	0.0253 [0.0185]	-0.0153 [0.0436]	-0.0794 [0.147]
age	-0.116*** [0.00337]	-0.321*** [0.00477]	0.0830*** [0.00538]	0.158*** [0.00825]	0.161*** [0.0166]	0.121** [0.0527]	0.046 [0.0546]
lev_pc	-0.00141*** [3.65e-05]	-0.00199*** [6.20e-05]	-0.00107*** [5.56e-05]	-0.000653*** [6.08e-05]	-0.000428*** [8.83e-05]	-0.0000129 [0.000463]	0.000790* [0.000417]
rd_setrate	0.00812*** [0.000714]	0.00760*** [0.00141]	0.00744*** [0.00102]	0.0113*** [0.00110]	0.0122*** [0.00158]	0.0101 [0.00652]	-0.0024 [0.00826]
rb_setrate	0.00805*** [0.000497]	0.00772*** [0.000941]	0.00787*** [0.000699]	0.00867*** [0.000787]	0.00692*** [0.00133]	0.00593 [0.00659]	-0.00752 [0.00468]
Constant	2.858*** [0.0144]	2.561*** [0.0182]	2.518*** [0.0196]	2.753*** [0.0298]	3.391*** [0.0651]	4.816*** [0.196]	6.313*** [0.611]
Obs.	634,196	224,522	186,194	141,338	72,055	6,276	3,811
n. of firms	110,333	57,165	44,160	28,767	12,793	1,297	632
m2	-0.05 (0.96)	1.44 (0.15)	-1.01 (0.31)	2.08 (0.03)	0.93 (0.34)	-1.42 (0.15)	-0.51 (0.60)

Notes. Variable *size* and age in log terms. m2 is asymptotically N(0,1) test for second order serial correlation of the residuals. P-values in parentheses.

The proposed specification confirm the previous results which reject

Gibrat's Law and suggest that it is crucial to consider other determinants of firm's growth rate which enables us to evaluate more precisely the role of small and medium-sized companies⁶. Indeed, the impact of size on the growth rate is not linear, in that it tends to increase as the size class increases until the "less than 50 employees" size. Such an impact decreases for companies in the 50-249 class, and then it increases for the remaining upper classes.

The impact of *age* is differentiated as well, in that although a negative effect is observed for the whole sample, it is however positive for all size classes but the first, i.e. firms with less than 10 employees. It is also worth noting that the impact is increasing until the penultimate class, while it is not significant for large businesses (500 employees and more).

This is coherent with the fact that, on the one hand, small firms do experience higher birth and death rates, and on the other largest companies have encountered non negligible restructuring over the whole period of analysis. This phenomenon involved all companies independently on their age.

This finding complements previous results that underline how the distribution of firms size becomes thicker on the right tail; Cabral and Mata (2003) and Cirillo (2010) analyse the statistical properties of the size distribution of Portuguese and Italian firms respectively, by focusing on the impact of age.

⁶Recall that, in order to reject Gibrat's Law, the coefficient on the lagged size variable should not be significantly different from zero.

Firms' financial condition, as described by the leverage variable, has a negative effect on firm's growth. The impact is however mild and becomes negligible as firm size increases.

The ability to sell product on international markets is captured by the variable that represents the ratio of exports to total sales (*intern1*). Its impact is positive and driven by the effect that it exerts within the group of small firms. This result is important as it highlights that exports and, therefore, the ability to enter international markets may be a driver of a firm's growth.

This is particularly true for small business, although entering international markets also entails possible increases in costs not always compensated by a corresponding increase in revenues ⁷.

We have also considered the ratio of the value of imports to total sales (*intern2*), to indicate another source of openness. The impact is less relevant, as expected, compared with that of exports and is confined only to very small companies.

We control for sectoral birth and death rates. It is worth recalling that these variables are relatively steady, particularly the death rate variable which reflects the negative impact of new legislation introduced in the aftermath of the financial crisis.

The adopted specification of the firms' growth equation includes two lagged values of the growth rate, to tackle possible autocorrelation

⁷In a previous study on Italian manufacturing businesses Bartoloni and Baussola (2017) find that the impact of exporting in international markets on firms' operating profits is either negligible or slightly negative, thus suggesting that their could be external diseconomies in accessing foreign markets, particularly for small firms.

that may, therefore, affect the estimates. On the whole, this dynamic specification provides results that avoid this problem as suggested by the autocorrelation tests.

In general, we observe that firms' size dynamics does not show a persistence pattern. However, this fact does not rule out the inability of firms to pass over another size class, thus providing persistency within a given reference size class. In other words, we observe that size dynamics is confined within the border of the reference size, thus causing the aggregate effect that we have previously underlined, i.e., the inability to significantly increase the number of medium-large sized companies.

For this reason, we decided to specify a logit model, which express the probability that a firm increases its size relatively to the average size of its class⁸. This issue is presented and discussed in the next section.

5 Long-run transitions

Given the previous discussion, we specify a logit model in which the probability of increasing size depends on a set of sectoral, geographical and firm-specific variables, as we used in the previous specifications of firms' growth rate. Equation (4) summarised the model:

⁸We have also experimented a different long-run specification in which the up-sizing probability has been defined with respect to a change in the reference size class. However, given the few changes that occur the model cannot be estimated significantly.

$$z_i = \theta_0 + \sum_{j=1}^N \theta_j x_{ij} + \mu_i \quad (4)$$

where z_i is a dummy variable taking the value of one if firm i has increased its size, and zero otherwise, θ_0 is a constant, θ_j is the coefficient of explanatory variable x_{ij} and μ_i is the error term whose cumulative distribution is assumed to be logistic.

We show in Table 4 results for the logistic model. The export propensity is positive and significant and implies that a unit increase (percentage point) in the export to sales ratio brings about an 8.1% increase in the upsizing probability.

The impact of age is significant, and its impact implies that a unit increase in age (expressed in log) increases the upsizing probability by more than 5%. This result may appear contradictory, given the previous findings of Table 4 where the impact of age is negative.

It is worth noting that the logistic regression presents long-run estimate of the probability of increasing a firm's size compared to the average size of the corresponding class. Thus, it could be the case that in a year by year regression and considering just the marginal impact of age on size, the effect could result negative. Also, one should note that interacting the first size class (< 10 employees) with the age variable, determine a negative effect, thus confirming the result derived in the growth regressions of Table 4.

A firms' financial condition negatively affects the upsizing probability, although the impact is very mild. Industry characteristics, sum-

Table 5: Upsizing probability 2001-2014 - Logistic estimation (Odds Ratios)

Variable	Model (1)	Model (2)	Model (3)
intern1	1.081*	1.089**	1.738***
	[0.0459]	[0.0461]	[0.0808]
age	1.054*	1.054*	1.378***
	[0.0313]	[0.0313]	[0.0505]
lev_pc	0.999***	0.999***	0.999***
	[0.000429]	[0.000429]	[0.000435]
area1	1.069	1.074	1.027
	[0.0487]	[0.0489]	[0.0475]
area2	1.093*	1.095**	1.104**
	[0.0505]	[0.0506]	[0.0518]
area3	1.146***	1.152***	1.092*
	[0.0572]	[0.0577]	[0.0554]
clsize <10			12.64***
			[3.519]
clsize 10-19			6.372***
			[1.039]
clsize 20-49			4.453***
			[0.723]
clsize 50-249			2.404***
			[0.392]
clsize 250-499			3.233***
			[0.618]
clsize <10*age			0.846**
			[0.0575]
pavitt2	1.061**		1.097***
	[0.0308]		[0.0323]
pavitt3	1.033		1.045
	[0.0309]		[0.0318]
pavitt4	1.075		1.186***
	[0.0679]		[0.0766]
mrbs_setrate		1.022	
		[0.0175]	
mrds_setrate		0.896***	
		[0.0363]	
Constant	0.841	0.904	0.0612***
	[0.0930]	[0.107]	[0.0132]
LR chi2	32.84 (8)	35.44 (8)	974.37(15)
Observations	29,409	29,409	29,409

Notes. Variable *age* in log. Firms which are present at the beginning and at the end of the period. Probability of increasing firms' size above their respective class size averaged over the entire period.

marised by the Pavitt technological dummy variables, suggest that as technological level increases the upsizing probability increases accordingly with an impact that varies between 3.3% and 7.7% with respect to the lowest technological level.

Death and birth rates are also included in a separate logistic regression which shows that only the former is significant and reduces the probability of increasing a firm's size by more than 10%.

This analysis is therefore complementary to the previous panel investigation on firms' growth rate. It focuses on evaluating the extent to which firm and industry characteristics affect upsizing in the long run. The ability to sell on international market and industry technological opportunities play a crucial role in this context. However, this positive impact, although significant and not negligible, is still insufficient to determine a right shift of the size distribution of firms implying that the weight of medium size enterprises is increased.

6 Conclusions

It is a well established fact that the ability of firms to compete internationally crucially depends on their ability to innovate and to introduce new products or processes into the market. This ability requires a more structured and complex business organisation, and ultimately a firm size that is suited to the size of the market.

We have carried out an empirical investigation concentrating on a

large sample of Italian manufacturing firms over the last 14 years.

We first analysed the statistical properties of firm size distribution and then calculated a Transition Probability Matrix that enabled us to quantify movements between size classes and thus determine transition probabilities over the long run.

Results suggest that downsizing, i.e. a significant reduction in employees in large companies, is a prevailing tendency. There are, however, weak signs suggesting that a small number of medium-sized firms have marginally increased in size and so also in their ability to compete in the global market.

We therefore further investigated the relationship between the rate of growth in a firm's size and its past size level, conditional on specific firm and industry characteristics. This investigation followed a preliminary test, including panel unit root tests, for the validity of Gibrat's Law, which was rejected.

The panel growth regressions implicitly confirm previous unit root tests and suggest that small firms tend to grow faster than larger firms. This evidence is also confirmed by regressions for the sample of firms belonging to the reference class size.

Export intensity plays a significant role in affecting the size growth rate; the latter is also positively affected by industry characteristics related to technological levels.

We have also taken into account possible bias related to business demography by controlling for industry death and birth rates.

Although we estimated significant negative effects between growth and size, the impact observed in the long run does not lead to significant modification of the size distribution of firms. In other words, small- and medium-sized firms fail to climb the ladder, i.e. they fail to pass into higher size classes.

This evidence is further confirmed using a logit model which enabled us to specify a firm's upsizing probability between the initial and final dates of the sample period.

Thus significant questions arise, given that the inability of small and medium sized firms to effectively increase in size may negatively affect their ability to compete in international markets which are often characterised by new technological paradigms.

Appendix

Table 6: ASIA: descriptive statistics for years 2000-2014

Year	No. Of Obs.	Mean	St. Dev	Skewness	Kurtosis	Maximum
2000	308402	13.899	75.205	53.370	4227.044	8782
2001	295910	14.082	75.524	54.209	4463.026	9496
2002	276854	14.275	74.886	54.362	4643.302	9778
2003	260153	14.601	71.168	47.443	3615.791	9202
2004	243234	14.823	70.831	45.268	3307.297	9000
2005	229776	15.045	71.978	44.088	3102.821	8938
2006	215478	15.437	73.879	43.944	3055.735	8872
2007	203225	16.067	80.363	48.040	3703.838	9941
2008	193112	16.445	83.000	45.883	3204.826	8929
2009	181637	16.453	83.080	44.725	3049.702	8741
2010	172987	16.469	83.795	43.785	2922.995	8490
2011	167292	16.460	83.139	43.826	2964.425	8518
2012	159558	16.632	82.770	42.741	2862.302	8682
2013	152694	16.712	83.531	41.832	2749.886	8820
2014	144123	17.050	85.023	42.411	2904.879	9414

Table 7: Panel Data on balance sheets: descriptive statistics for years 2001-2014

Year	No. Of Obs.	Mean	St. Dev	Skewness	Kurtosis	Maximum
2001	85663	35.424	192.885	76.637	10268.717	32307
2002	87643	34.276	179.653	71.339	9079.383	29147
2003	85881	33.965	173.537	66.070	7360.544	25592
2004	92091	33.093	166.789	62.126	6529.436	23641
2005	94154	33.123	166.199	60.281	6096.152	22716
2006	99006	32.178	162.553	60.663	6194.863	22741
2007	100595	32.051	160.595	62.278	6511.053	22998
2008	102536	31.996	158.571	60.324	6246.616	22641
2009	100722	31.414	158.618	61.914	6622.398	23381
2010	99847	30.467	158.130	67.897	8083.631	25179
2011	100747	30.156	153.195	66.130	7908.020	24428
2012	98941	29.529	137.546	63.362	7549.183	21846
2013	97419	30.033	159.048	88.091	14034.687	30142
2014	97047	29.465	160.186	96.927	16466.928	31654

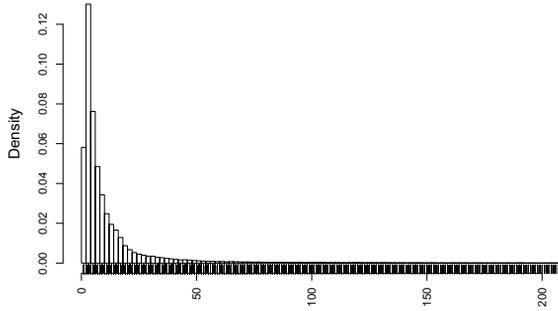


Figure 1: ASIA: histogram, year 2014.

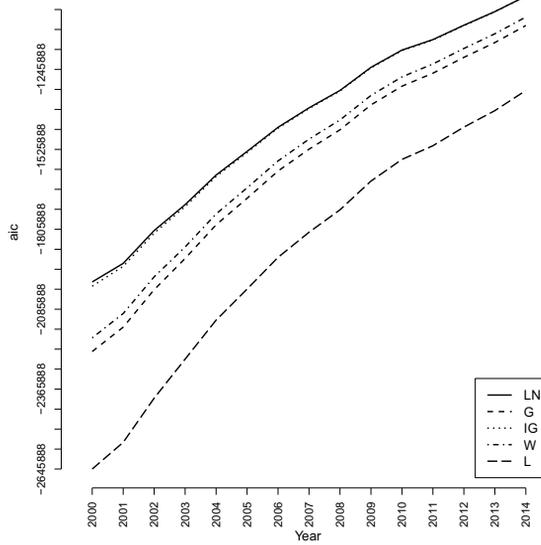


Figure 2: ASIA: AIC of fitted models for years 2000-2014.

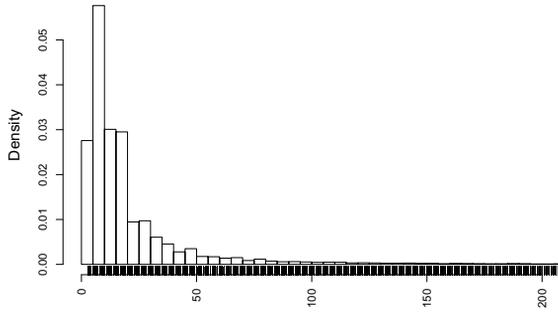


Figure 3: Panel Data on balance sheets: histogram, year 2014.

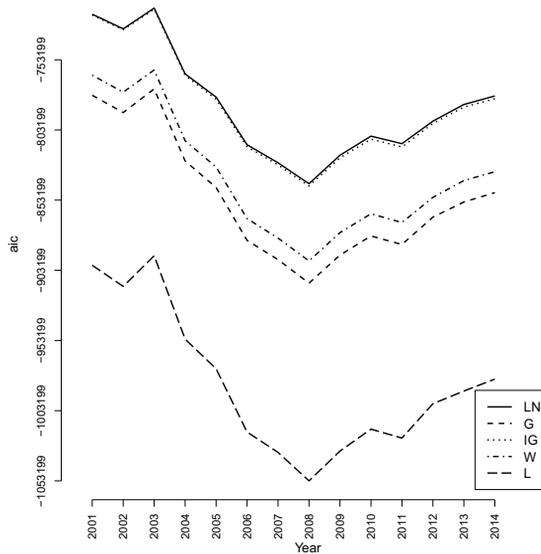


Figure 4: Panel Data on balance sheets: AIC of fitted models for years 2001-2014.

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