DOES GIBRAT'S LAW HOLD IN THE CASE OF YOUNG, SMALL FIRMS?*

by

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Abstract

According to Gibrat's Law of Proportionate Effect, the growth rate of a given firm is independent of its size at the beginning of the examined period. This paper investigates whether Gibrat's Law holds for new entrants in a given industry: that is for new small firms in the early stage of their life cycle. The main finding is that in some (but not in all) selected industries in Italian manufacturing Gibrat's Law fails to hold in the years immediately following start-up, when smaller firms have to rush in order to achieve a size large enough to enhance their likelihood of survival. Conversely, in subsequent years the patterns of growth of smaller firms do not differ significantly from those of larger ones, and the Law is therefore confirmed.

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1. Introduction

A commonly accepted interpretation of the Law of Proportionate Effect identified by Robert Gibrat (1931) is that the growth rate of a given firm is independent of its size at the beginning of the period examined. In other words, “the probability of a given proportionate change in size during a specified period is the same for all firms in a given industry - regardless of their size at the beginning of the period” (Mansfield, 1962, p. 1031).

Gibrat’s Law can be empirically tested in at least three different ways. Firstly, one can assume that it holds for all firms in a given industry, including those which have exited the industry during the period examined (setting the proportional growth rate of disappearing firms equal to minus one). Secondly, one can postulate that it holds only for firms that survive over the entire time period. If survival is not independent of firm’s initial size - that is, if smaller firms are more likely to exit than their larger counterparts - this empirical test can be affected by a sample selection bias and estimates must take account of this possibility (see Section 3 below). This observation applies in particular to new and small firms, for which the hazard rate is generally high (about 10% per year in the first five years of firm’s life cycle; see Audretsch, Santarelli and Vivarelli, 1999). Thirdly, one can state that Gibrat’s Law only applies to firms large enough to have overcome the minimum efficient scale (MES) of a given industry (for instance, Simon and Bonini (1958) found that the Law was confirmed for the 500 largest U.S. industrial corporations).

The purpose of this paper is to investigate whether Gibrat’s Law hold for new entrants in a given industry, or in other words, new small firms in the early stage of their life cycle. While the empirical test of the hypothesis that smaller firms have higher growth rates than larger firms has been used by most previous research (see Section 2), only few studies have conducted longitudinal investigation of new small firms’ growth during their infancy (to our knowledge, Dunne, Roberts and Samuelson, 1989; Mata, 1994; Solinas, 1995; and Almus and Nerlinger,1999, see below). If new small entrants displayed a particular pattern of behavior, previous results based on incumbent firms (including both mature and young firms) would have to be reconsidered since they may be affected by composition effects. While the third version of the Law is obviously not suitable for new firms, the first version treats exit and growth as homogeneous pattern. This has been questioned by the recent literature, which has focused on giving correct econometric specification to the second version of the Law of Proportionate Effect.

The paper is organized as follows. Section 2 briefly surveys the rich empirical literature which focuses specifically on Gibrat's Law[1]; section 3 presents the dataset and discusses some methodological issues related to estimation of Gibrat's Law; while section 4 conducts a within-industry longitudinal investigation of the second version of Gibrat's Law. Finally, section draws some concluding remarks.

2. Previous empirical studies

While early studies tended to confirm Gibrat's Law (Hart and Prais, 1956; Simon and Bonini, 1958; Hymer and Pashigian, 1962), subsequent research began to question its overall validity. In this respect, the contribution by Edwin Mansfiled (1962) is a point of departure for empirical analyses of industry dynamics.

Mansfield (1962) investigated three industries (steel, petroleum, tires) in different time periods between 1916 and 1957. The specification used by Mansfield relates the logarithm of final size (measured in terms of capacity in steel and petroleum and in terms of employment in tires) to the logarithm of initial size and investigates whether the coefficient is equal to one (in which case Gibrat's Law is confirmed, while an estimated coefficient less than one implies that smaller firms grow more than their larger counterparts; this is the specification used in our study, see Section 3). As far as the first version of the Law of Proportionate Effect is concerned, Mansfield found that it failed to hold in seven cases out of ten, while the second version was rejected in four of his ten samples. As correctly pointed out by Sutton (1997, p.44), Mansfield was aware that the rejection of the Law may be a consequence of the fact that smaller firms are more likely to die; if this is the case, both the versions of the Law may be incorrectly specified. In particular, the second version of the Law may not have taken account of the distribution of growth rates that would result if all firms survived.

Table 1 summarizes a selection of previous empirical studies which have dealt specifically with Gibrat's Law and found that small firms grow faster than their larger counterparts.

Brusco, Giovannetti and Malagoli (1979), tested Gibrat's Law over the 1966 – 1977 period for about 1,250 small firms operating in the province of Modena (in the Emilia region of Italy) and belonging to three manufacturing industries: ceramic tiles, metal working & mechanical, textiles. Using quarterly data on firms' employees, they adopted the same method as Mansfield (1962) by regressing the logarithm of final size on that of initial size, and they by-passed the problem of the

[1] For recent theoretical speculations on the implications of the Law, see Cabral (1995), and McCloughan (1995).

allegedly lower likelihood of survival of smaller firms by carrying out separate regressions for all firms (surviving and exiting alike) and firms surviving until the end of the period. They found the Law held in most cases when all firms were included, but they obtained the opposite results when only surviving firms were included (a coefficient less than one, revealing that smaller surviving firms tended to grow faster than their larger counterparts).

insert table 1

The results obtained by Brusco, Giovannetti and Malagoli (1979) prompt the following important qualification: if one assumes the reasonable hypothesis that small firms with lower growth rates are more likely to die, estimates based on surviving firms are affected by a sample censoring which tends to magnify the impact of rapidly growing small firms. Thus, the rejection of the Law, and the conclusion that smaller firms tend to have growth rates higher than their larger counterparts, may be partly due to a sample selection bias. Most of the recent literature has been devoted to finding an econometric specification able to deal with this kind of problem. In this connection, the main question is: "do small firms grow faster than larger ones because they are selected in empirical available samples or because they need to rush in order to achieve an acceptable market size?" (the latter being the contention of Audretsch, 1995).

In parallel to the crucial problem of sample selection, two more traditional econometric issues arise when one tries to test Gibrat's Law. The first concerns the heteroskedasticity which may occur when the Law is not confirmed (if small firms grow faster than their larger counterparts, the variance of growth should tend to decrease with size). The second one was first discussed in a seminal paper by Chesher (1979) and concerns the fact that, when there is serial correlation in growth rates, ordinary least squares (OLS) estimators are inconsistent "even though estimation proceeds using cross-sectional data" (ibidem, p. 404). The studies now discussed have dealt jointly with one or more of these econometric problems.

For instance, Kumar (1985) used data on 1,747 UK quoted firms in manufacturing and services over the period 1960-76 to measure size in terms of net assets, physical assets, equity assets, employment and sales. Following Chesher (1979), Kumar controlled for persistence in growth and found weak evidence of serial correlation; he then tested a logarithmic specification of Gibrat's Law and found coefficients significantly less than unity, regardless of the measure adopted.

Bronwyn Hall (1987) studied 1,778 US manufacturing firms belonging to two samples spanning the periods 1972-1979 and 1976-1983. All the firms were incumbent firms which had already reached a certain minimum size (measured in terms of employment) and were large enough to involve outside capitalization. Unlike Mansfield (1962), Hall directly regressed growth rates on the logarithm of the initial size and found that the observed negative relationship between size and growth was robust to corrections for both sample attrition and heteroskedasticity. The control for sample bias was carried by means of a maximum likelihood estimation of the sample selection model, using a probit selection equation which related survival and initial size. In the present paper we use the same procedure (see Section 3)

Evans (1988a) analyzed 100 4-digit manufacturing industries using firm level data drawn from the US Small Business Data Base (42,339 firms). The novel feature of this study was its introduction of age as a possible factor - in addition to size measured in terms of employment - in explaining departure from Gibrat's Law. Accordingly, Evans carried out separate estimates for firms six years old or younger and for firms seven years or older and he included age as an additional regressor in the econometric specification (similar to the one used by Hall, 1987). A negative relationship between growth and size was found in 89 per cent of the industries examined, while a negative relationship between growth and age was verified in the 76 per cent of the industries. Like the previous study, the estimation procedure controlled for sample selection bias and heteroskedasticity (both in Hall, 1987 and in this study heteroskedasticity was dealt with using White (1980)'s correction). Similar results were obtained in the companion study by Evans (1987b).

Evans's two studies suggested that the proportional rate of growth of a firm conditional on survival is decreasing both in size and age. Interestingly for the purposes of the present study study, his results were confirmed by Contini and Revelli (1989) using data from a panel of manufacturing firms located in the Northern Italian region of Piedmont (although the departures from Gibrat's Law were considered "modest" by Contini and Revelli). Another study based on Italian data has been conducted by Solinas (1995) and in this case, too, smaller firms turned out to grow faster than larger ones (once the original sample had been limited to companies with at least one employee).

The joint influence of size and age on firms' growth patterns suggests that small and young firms must "rush" in order to survive in the market, whereas more established and larger firms tend to converge towards a Gibrat-like pattern of growth. In economic terms, young firms entering the market at a sub-optimal scale may experience decreasing average costs and enjoy rapid growth, while well-established mature firms can relax along a flattening average cost curve (see Acs and Audretsch, 1990 and Audretsch, 1995). In contrast to Evans (1987a and b), our study focuses only on young firms (less than 6 years old) and age will not be an additional regressor but rather a longitudinal dimension: Gibrat's Law will be repeatedly verified along the early stages of firm's life cycle (see Section 3).

Dunne, Roberts and Samuelson (1989) confirmed the empirical patterns found in the studies discussed above: within each age category, growth rates decline along employment size classes, while within each size class, growth rates decline with increases in plant age. Dunne, Roberts and Samuelson obtained these results from data on 219,754 individual plants - rather than firms as in the previous studies - collected in five US censuses of manufactures (1963-67-72-77-82). Unlike Evans (1987a and 1987b) and Hall (1987), the authors did not use a standard sample selection model but preferred a grouping procedure which enabled them to represent 15 combinations of age and size classes by means of 15 dummy variables.

In contrast to the previous American studies, Wagner (1992) did not control for sample selection and heteroskedasticity but for autocorrelation in growth rates. Using data on around 7,000 manufacturing establishments in Lower Saxony over the period 1978-89, he found that the validity of Gibrat's Law was rejected in most cases, but he did not come up with systematic evidence that small firms grow faster than larger ones. In contrast with Kumar (1985) and Dunne and Hughes (1994, see below), Wagner found a "persistence of change" (ibidem, p.129) whereby growth appeared to be an autocorrelated process (the presence of contrasting results on the possible persistence in firms' growth has been pointed out by Caves, 1998, p. 1949-50).

Another important contribution to investigation of Gibrat's Law has been made by Dunne and Hughes (1994), who used the original Mansfield-Chesher specification (see Section 3) and tested the Law of Proportionate Effect over the periods 1975-80 and 1980-85 using 2,149 quoted and unquoted UK companies belonging to 19 different manufacturing industries. To verify the existence of threshold effects, within industries estimations were carried out using both the industrial sample as a whole and three broad size classes (small, medium and large firms with their sizes measured in terms of net assets). After controlling for sample attrition and heteroskedasticity by means of standard procedures similar to those used by Hall (1987) and Evans (1987a and 1987b), Dunne and Hughes found further confirmation that smaller companies tend to grow faster than larger ones; they also found that younger companies, for a given size, tended to grow faster than old ones. Some evidence that a threshold effect was in operation (the departure from Gibrat's Law being more significant within the small firms size class) was also provided by Dunne and Hughes' study. These results proved robust after controlling for autocorrelation in growth rates (very weak in this particular sample, see Dunne and Hughes, 1994, p.129-130)[2].

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[2] In our paper the important suggestion of the possibility of an age effect is developed in a framework different to that of Dunne and Hughes, since we treat new entries (instead of incumbent firms) and track them along six years, therefore taking age as a longitudinal dimension instead of an additional regressor (see Section 3 below).

José Mata (1994) studied the relationship between size - measured in terms of employment - and growth for 3,308 entrants into Portuguese manufacturing in 1983. Mata did not use the Mansfield-Chesher specification, but instead made direct estimates of growth depending on size. After controlling for sample attrition and heteroskedasticity in the usual ways (sample selection model and White's correction), he found an overall negative relationship between initial size and post-entry rate of growth. This result concerning newborn firms was consistent with previous studies on incumbent firms. Interestingly enough, over the post-entry period 1984-1987, the negative relationship between size and growth proved to be rather stable, with no indication of convergence towards a Gibrat-like pattern of growth. Similarly, after controlling for firm fixed effects, and after eliminating firms smaller than 9 employees, Mata found that the negative relationship between size and growth seemed to hold along size classes, without exhibiting a convergence towards Gibrat's Law at least until the 17th size class (84-89 employees).

More recently, Hart and Oulton (1996) have used data on 87,109 UK incumbent companies over the period 1989-93 and tested the Chesher-Mansfield specification measuring size in terms of employment, sales and net assets. In all cases, they found both an overall estimated coefficient of less than one (on average, small firms grow more quickly than larger ones) and a monotonic increase in the relevant coefficient along nine size classes (the departure from Gibrat's Law being more dramatic among small firms than large ones). Unlike most previous studies, this paper by Hart and Oulton (1996) did not control for sample selection.

Tschoegl (1996) - in a study on managerial (dis)economies of scale in 66 Japanese regional banks – made use of thirty-nine annual observations (1954-1993) to estimate a logarithmic model and a percentage growth model, each of which incorporated the possibility of serial correlation of growth rates in the equation (measured in terms of employment). In general, larger Japanese regional banks tended to grow more slowly than smaller ones. Nevertheless, the magnitude of the deviation from one in the logarithmic specification was not large: the minimum estimate was 0.940 and the maximum was 1.016. Controlling for sample selection was not necessary in this particular study because no Japanese regional bank has failed since World War II.

Weiss (1998) is another example of a test of Gibrat's Law using data limited to a particular industry. In this article, the author used data on 43,685 Austrian farms measuring size in terms of livestock; after controlling for sample selection, heteroskedasticity and persistence, he concluded that there is a negative relationship between farm size and growth, particularly among small and the very largest farms.

An important recent contribution has been the paper by Harhoff, Stahl and Woywode (1998). Although the purpose of this study is not direct verification of Gibrat's Law, but rather examination of the relationship between firm's legal form and survival and growth, it introduces initial size (in terms of employment) and age in the growth equation as controlling variables. The estimates are based on data concerning 10,902 West German firms over the period 1989-1994. After controlling for sample attrition (Heckman's model, see Section 3) and heteroskedasticity (White's correction) the authors confirm previous results on the negative correlation between employment growth and firm's size and age.

Finally, Almus and Nerlinger (1999) focused their attention - as does this paper - on firms younger than six years, using Western German manufacturing data on start-ups in the period 1989-1996 (subdivided into five periods with the following number of observations: 1990-92: 784 firms; 1991-93: 1,420; 1992-94: 2,831; 1993-95: 3,495; 1994-96: 4,278). The chosen logarithmic specification of Gibrat's Law is taken from Chesher (1979) and hence controls for autocorrelation, but not for heteroskedasticity and sample selection. Almus and Nerlinger find that the Law is rejected in all cases with the estimated parameters smaller than one, and except for two cases always significantly different from one; in addition, the deviation from Gibrat's Law decreased with increasing firm size. In similar fashion to the study by Almus and Nerlinger, the analysis that follows will focus on manufacturing firms younger than six years, but the data set will be longitudinal, based on a single cohort, and organized by industrial sectors.

3. Data and methodology

The main hindrance to empirical analysis of the post-entry performance of newborn firms has been the lack of longitudinal data sets tracking the evolution of firms subsequent to their birth. In this paper we use a unique data set from the Italian National Institute for Social Security (INPS). This data set identifies new manufacturing firms (with at least one paid employee) born in January 1987 and tracks their post-entry employment performance at monthly intervals until January 1993. No information on firms with zero paid employees is obtainable from the INPS file; however, these firms usually identify self-employment and only occasionally become true entrants with positive post-entry employment growth rates.

All private Italian firms are obliged to pay national security contributions for their employees to INPS. Consequently, the registration of a new firm as "active" signals an entry into the market, while the cancellation of a firm denotes an exit from in (this happens when a firm finally stops paying national security contributions). For administrative reasons - delays in payment, for instance, or uncertainty about the actual status of the firm - cancellation may sometimes be preceded by a period during which the firm is “suspended”. The present paper considers suspended firms as exiting from the market at the moment (month) of their transition from the status of “active” to that of “suspended”, while firms which have halted operations only temporarily (for one or a few months) during the follow-up period, and which were “active” in January 1993, have been treated as survivors.

In addition to the procedure described above, the original INPS file was subjected to a further control, in order to identify entry and failure times correctly and to detect inconsistencies in individual tracks due to administrative factors, problems related to file truncation in January 1993, cancellations due to firm transfers, mergers and take-overs. This cleaning procedure reduced the total number of firms in the database from 1,889 to 1,570.

The main relationship tested in this study is the original logarithmic specification of Gibrat’s Law:

$$(1) \quad \log S_{i,t} = \beta_0 + \beta_1 \log S_{i,t-1} + \varepsilon$$

Where $S_{i,t}$ is the size of the ith firm at time t, $S_{i,t-1}$ is the size of the same firm at the previous period and ε is a random variable distributed independently of $S_{i,t-1}$. Following Chesher (1979, p.404), if both sides of equation (1) are exponentiated, it becomes clear that if β is equal to unity, then growth rate and initial size are independently distributed and Gibrat’s Law is in operation. By contrast, if $\beta<1$ smaller firms grow at a systematically higher rate than do their larger counterparts, while the opposite is the case if $\beta>1$.

If - as in the majority of previous studies (see Section 2) - growth and exit are not treated as homogeneous phenomena (that is assuming the disputable hypothesis that exit is equal to a minus one rate of growth), empirical estimates need deal only with surviving firms. However, here the sample selection problem arises. Since growth can only be measured for firms which have survived over the entire examined period, and since slow growing firms are more likely to exit, small fast growing firms may be over-represented in the surviving sample and this may bias the results of the empirical research.

As discussed in Hall (1987), Evans (1987a), Mata (1994), Dunne and Hughes (1994), Sutton (1997) and Weiss (1998), the appropriate econometric method to deal with this problem is the two-step procedure suggested by Heckman (1979) (see also Maddala, 1983; Amemiya, 1984; Greene, 1993, pp. 706 and ff.). This specification introduces an additional explanatory variable (the inverse

Mill's ratio) obtained by a probit model (selection equation) in the main equation, estimating the relationship between firm's survival and firm's size at the beginning of the examined period:

$$(2) \qquad P(f_i = 1) = F(\delta + \gamma \log S_{i,t-1} + \varphi \log S^2_{i,t-1} + \mu)$$

with: $f_i = 1$ survivor; $f_i = 0$ exit; μ = disturbance

Since the relationship between size and survival can assume a non-linear feature (as in Evans, 1987a; Dunne and Hughes, 1994 and Harhoff, Stahl and Woywode, 1998), a squared term was introduced in the selection equation. While equation (1) in isolation was preliminary estimated by means of OLS, the sample selection model including equation (2) was estimated using a maximum likelihood two stages method.

As in most previous empirical studies (see Section 2), tests for heteroskedasticity were carried out using the OLS estimations of (1) and White's (1980) correction was introduced when necessary, both in the OLS and in the sample selection model (SSM) estimations.

Finally, the possible occurrence of persistence in firms' patterns of growth was tested using annual growth rates (as in Kumar, 1985 and Dunne and Hughes, 1994): in the vast majority of cases no significant AR(1) process emerged, so that specification (1) was not extended (results available from the authors upon request).

The use of the dataset described above in the empirical test of equation (1) should shed some light on the following two questions:

a) Is the overall inverse relationship between size and growth - found by most of the studies discussed in the previous section - confirmed during the infancy of newborn firms?

b) Is there a convergence towards a Gibrat-like pattern of growth with the passage of time?

If the two hypotheses above were jointly supported by the data, Gibrat's Law would exhibit a behavior dependent on firm's life cycle: the Law would fail to hold during the first years after entry and would become acceptable once a given threshold in terms of size and age had been reached.

Given the characteristics of our data base, which includes all firms born in January 1987 with at least one paid employee, and the specific features of the Italian industrial system (dominated by small firms), most of the firms showed a small start-up size and micro-firms with fewer than 5 employees represented more than 50 per cent of the initial sample (see the average start-up sizes reported in the first column of the upper panel of table 2)[3]. Taking into account the cleaning procedures described in the first part of this section, and owing to problems of numerosity over time (until January 1993), only seven industries were examined (for a total of 970 firms born in January 1987, out of 1,570).

The descriptive statistics in table 2 provide an overview of new firms' patterns of growth across the seven industrial sectors selected. The upper panel of the table reports the average size at the beginning of each of the six years examined and the corresponding standard deviations, whereas the lower panel documents average growth rates. Firstly, both the variation in the mean value and in the standard deviation of start-up size across industries sre sufficiently large, with the average size ranging from 7 employees (rubber & plastics) to 14 (footwear & clothing). Secondly, at the end of the period (six years after start-up) the average size increases fourfold in the food industry, and doubles or nearly doubles in electrical & electronic machinery, footwear & clothing, and rubber & plastics, whereas it grows less markedly in the three remaining industries: 57 per cent in instruments, 43 per cent in wood & furniture, 33 per cent in paper & printing. As regards growth rates, one notes that, in all sectors, they are very high in the first years, but lower in the last ones. This result suggests the presence of a discontinuity in new firms' patterns of growth along the early stages of their life cycle.

insert table 2

4. Results

Tables 3(i), 3(ii), and 3(iii) report the OLS and SSM results from the estimations of equation (1). The results from the corresponding selection equations are not given but are available from the authors upon request. The first two columns of each panel in the tables set out the results from the estimations carried out for the entire six-year period (88-93), along with the usual statistical diagnoses (including the correlation between the selection and growth equation, ρ) and a specific *t* test for the validity of Gibrat's Law (β_1=1; question (a)); final rows report White's test for heteroskedasticity (when significant a consistent covariance matrix has been used) and sample sizes with and without exits. In the following columns the same estimations are repeated for each year, in order to characterize the possible convergence path with the passing of time (question (b) above). Thus, 14 estimates are presented for all firms within each industry.

We first consider the results for the six-year period (88-93). In six out of seven industries - with the sole exception of food - both the OLS and the SSM estimates of β_1 are significantly less than

[3] Of course, the observed patterns of both average sizes and growth rates depend on the combination between employment growth

one. This confirms that, in general, smaller firms grow faster than their larger counterparts over the entire period. In particular, both coefficients (OLS and SSM) are equal to 0.61 for electrical & electronic engineering, and to 0.56 for rubber & plastics. The OLS coefficient is 0.62 and the SSM one 0.59 for instruments, while for footwear & clothing the OLS coefficient is slightly higher than the one obtained in the SSM estimate (0.64 vs. 0.63). Finally, the reverse is true for paper & printing, in which case the OLS coefficient is equal to 0.55 and the SSM to 0.60. Given that over the entire period the inverse relationship between size and growth characterizes the majority, but not the totality, of the industries examined, a first result of the present analysis is that, although Gibrat's Law cannot be regarded as a law in the strict sense, heterogeneous patterns of behavior may emerge across industries.

insert tables 3(i), 3(ii), 3(iii)

Even more interesting results are yielded by the separate estimations carried out for each year and each industry. In four industries out of seven, Gibrat's Law fails to hold in the year(s) immediately following start-up, whereas it holds, or fails less severely, when firms approach maturity. In electrical & electronic engineering, only in the first and second year following start-up does the SSM estimate yield a β_1 significantly less than one, with a value of 0.73 in 1988 and 0.89 in 1989. The convergence towards a Gibrat-like pattern of growth is confirmed by the almost monotonic growth of β_1 in subsequent years, with a value of 0.94 in 1991 and 1.04 in 1992. For instruments, footwear & clothing, and rubber & plastics Gibrat's Law significantly fails to hold only in the first year following start-up. In detail, for the instruments industry the coefficient of β_1 in the SSM estimate is equal to 0.77 in 1988 (with $t(\beta_1=1)$ significant at the 99% level of confidence), whereas for the same year it is 0.80 in footwear & clothing and 0.67 in rubber & plastics, with $t(\beta_1=1)$ significant in both cases at the 99 per cent level of confidence. In the following years, the SSM estimates of β_1 increase towards 1 and the *t* test does not reject the Law. Thus, in these four industries for which Gibrat's Law is initially not confirmed, one finds that smaller firms rush to achieve an acceptable size immediately after they start business, while once they reach (in subsequent years) a size large enough to enhance their likelihood of survival, their pattern of behavior matches that of larger firms. More controversial patterns of growth emerge for the remaining two industries, where Gibrat's Law is rejected over the entire period. Although for both industries β_1 shows an almost monotonic increase over time, in paper & printing the SSM test leads to rejection of the Law in the first and the sixth years after start-up, whereas in wood & furniture in the first and the fifth years.

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in surviving firms and the exit of the slow growing ones.

The most significant exception is the food industry, where for the entire period and for each of the six years following start-up, Gibrat's Law is never significantly rejected in the SSM estimates. This finding suggests that some industry-specific determinants of firm growth are in operation. The regularity over time in the patterns of post-entry growth by small and larger firms in the food industry indicates that, more than strategic interdependence within submarkets, in this case it is independence across submarkets that is involved (cf. Sutton, 1997). In fact, seventeen out of eighty-one entrants (21%) are bakeries, which by definition operate in very small markets (neighborhoods rather than municipal areas) which in most cases are characterized by the presence of a single firm. Thus, even new entrants with a very small start-up size are likely to operate at the MES level of output of their submarket and do not need to rush for enhancing their likelihood of survival.

5. Conclusions

With the focus specifically on young and small firms, the main finding of this paper is that, in some selected industries in Italian manufacturing, Gibrat's Law of Proportionate Effect exhibits a behavior which depends on the life cycle of the firm. In effect, for six of the seven industries examined, the Law fails to hold during the first year(s) following start-up - when smaller entrants grow faster than their larger counterparts - whereas it becomes acceptable once a minimum threshold in terms of size and age has been reached. In sum, the statistical regularities that emerged from six of the seven groups of estimates carried out in section 4 are such that both questions raised in section 3 can be answered in the affirmative: not only is the overall inverse relationship between size and growth confirmed during the infancy of newborn firms, but most industries display convergence towards a Gibrat-like pattern of growth with the passage of time.

However, our results also implicitly corroborate John Sutton's (1997) assumption that any industry, as conventionally defined in official statistics, usually contains several clusters of products, some of which compete closely whereas other do not compete at all. For any industry, two opposite effects therefore obtain:

i) a strategic interdependence effect, which explains why within certain submarkets smaller firms have to rush in order to survive;

ii) an independence effect, corresponding to the presence of many independent submarkets each of which, in Sutton's words, is "large enough to accommodate exactly one entrant". The operation of this effect explains why within certain submarkets very small entrants do not have to grow fast in order to survive.

The combination of the interdependence and the independence effects determines the patterns of post-entry growth observed in each industry. Accordingly, one may conclude that the evolution of market structure is a complex phenomenon which encompasses a series of somewhat contradictory (interdependence vs. independence) statistical effects.

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Table 1 – Selected empirical studies on Gibrat's Law

STUDY	METHODOLOGY	CONTROLS	DATA	RESULTS
Mansfield, 1962	Logarithmic specification	None	About 1,000 US firms in steel, petroleum and tires over 1916-57.	Gibrat's law fails to hold in about 50% of cases: smaller firms grow faster.
Brusco - Giovannetti - Malagoli, 1979	Logarithmic specification	None	1,250 Italian firms in ceramics, mechanical and textiles over 1966-77.	Gibrat's law fails to hold in most cases when only survived firms are included: smaller firms grow faster.
Kumar, 1985	Logarithmic specification	Persistence	1,747 UK quoted firms in manufact. and services over 1960-76.	Smaller firms grow faster.
Hall, 1987	Growth rate regression	Sample selection, heteroskedasticity	1,778 US manufact. firms over 1972-79 and 1976-83 (only incumbents)	Smaller firms grow faster.
Evans, 1987a and 1987b	Growth rate regression	Sample selection, heteroskedasticity	42,339 US manufacturing firms, subdivided in 100 sectors.	Smaller firms grow faster in 89 industries out of 100.
Contini - Revelli, 1989	Growth rate regression	Persistence	1,170 Italian firms over 1980-86 (only incumbents).	Moderate evidence that smaller firms grow faster.
Dunne – Roberts - Samuelson, 1989	Growth rate regression with grouping procedure	None	219,754 US manufacturing plants over 1967-82 (only entrants).	Smaller firms grow faster.
Wagner, 1992	Logarithmic specification	Persistence	About 7,000 West German manufact. plants over 1978-89; (only incumbents).	Gibrat's law fails to hold, but no evidence that smaller firms grow faster.
Dunne - Hughes, 1994	Logarithmic specification	Sample selection, heteroskedasticity, persistence	2,149 UK companies over 1980-85 (only incumbents).	Smaller firms grow faster.
Mata, 1994	Growth rate regression	Sample selection, heteroskedasticity	3,308 Portuguese manufacturing firms over 1983-87 (only entrants).	Smaller firms grow faster.
Solinas, 1995	Logarithmic specification	None	5,128 Italian firms over 1983-88 (only entrants).	Once the sample is limited to companies with at least one employee, smaller firms grow faster.
Hart - Oulton, 1996	Logarithmic specification	Heteroskedasticity, persistence	87,109 UK companies over 1989-93 (only incumbents).	Smaller firms grow faster.
Tschoegl, 1996	Logarithmic specification, growth rate regression	Heteroskedasticity, persistence	66 Japanese regional banks over 1954-93 (only incumbents).	Moderate evidence that smaller firms grow faster.
Weiss, 1998	Logarithmic specification	Sample selection, heteroskedasticity, persistence	43,685 Austrian farms over 1986-90 (only incumbents).	Smaller firms grow faster.
Harhoff – Stahl - Woywode, 1998,	Growth rate regression	Sample selection, heteroskedasticity	10,902 West German firms over 1989-94 (only incumbents).	Smaller firms grow faster.
Almus - Nerlinger, 1999	Logarithmic specification	Persistence	39,355 West German manufacturing firms over 1989-96 (only entrants).	Smaller firms grow faster.

Table 2 - Average Size (A.S.), Growth Rate (G.R.) and corresponding standard deviations (S.D.) : firms still alive at the end of each period

Industry	**A.S. 87**	**S.D.87**	**A.S. 88**	**S.D.88**	**A.S. 89**	**S.D.89**	**A.S. 90**	**S.D.90**	**A.S. 91**	**S.D.91**	**A.S. 92**	**S.D.92**	**A.S. 93**	**S.D.93**
Electrical & electronic engineering	12.40	38.92	15.41	46.27	20.01	59.57	20.89	63.46	22.23	68.80	23.90	69.22	23.42	65.05
Instruments	12.17	30.18	12.96	27.16	15.84	34.95	18.97	43.36	19.72	42.87	21.01	51.33	19.17	40.46
Food	11.16	25.16	31.19	184.04	33.59	181.55	34.46	163.19	40.78	176.81	41.52	174.52	42.49	160.91
Footwear & clothing	14.61	34.63	19.76	38.51	22.64	41.96	22.86	45.36	24.62	49.19	26.32	50.75	26.62	52.18
Wood & furniture	11.51	24.58	15.71	26.35	16.55	28.36	17.15	29.39	15.04	17.79	15.42	18.15	16.46	19.37
Paper & printing	10.23	24.58	10.95	23.91	10.66	21.17	11.94	20.54	12.84	20.34	13.05	20.45	13.65	20.59
Rubber & plastics	7.24	9.57	10.38	12.38	12.46	12.35	13.72	14.21	14.57	16.19	14.54	16.94	15.17	18.01
Industry			**G.R.88**	**S.D.88**	**G.R.89**	**S.D.89**	**G.R.90**	**S.D.90**	**G.R.91**	**S.D.91**	**G.R.92**	**S.D.92**	**G.R.93**	**S.D.93**
Electrical & electronic engineering			0.97	1.91	0.28	0.59	0.11	0.36	0.08	0.36	0.03	0.32	-0.02	0.25
Instruments			0.81	1.75	0.25	0.57	0.12	0.42	0.10	0.76	0.04	0.43	0.01	0.36
Food			0.88	2.23	0.50	2.26	0.10	0.48	0.22	1.10	0.03	0.42	0.00	0.25
Footwear & clothing			1.36	5.90	0.23	1.13	0.07	0.42	0.09	0.47	0.05	0.60	0.01	0.26
Wood & furniture			0.98	1.91	0.08	0.32	0.12	0.46	0.16	0.97	0.15	0.71	0.06	0.26
Paper & printing			0.48	1.12	0.22	0.74	0.20	0.52	0.10	0.47	0.16	0.83	0.09	0.34
Rubber & plastics			1.20	2.32	0.54	1.74	0.08	0.29	0.08	0.47	0.01	0.35	0.06	0.31

Table 3(i) - OLS and Sample Selection Model (SSM) estimates of Gibrat's Law: Electrical & electronic engineering, instruments, food

Electrical & electronic engineering

	OLS 88-93	SSM 88-93	OLS 88	SSM 88	OLS 89	SSM 89	OLS 90	SSM 90	OLS 91	SSM 91	OLS 92	SSM 92	OLS 93	SSM 93
β_0	1.36***	1.30*	0.80***	0.72***	0.40***	0.35*	0.11	(a)	0.06	0.19*	-0.10	-0.10	-0.10	(a)
β_1	0.61***	0.61***	0.71***	0.73***	0.88***	0.89***	0.97***		0.98***	0.94***	1.04***	1.04***	1.02***	
ρ	—	0.12	—	1.00***	—	0.31	—		—	-0.93****	—	-0.01	—	
$t(\beta_1 = 1)$	4.11***	4.63***	3.63***	5.06***	3.00***	1.92*	1.00		0.50	1.29	1.00	0.44	0.67	
F	58.80***	29.04***	201.51***	108.55***	759.69***	443.18***	768.45***		577.28***	286.31***	763.13***	377.07***	1157.33***	
R^2 adj.	0.41	—	0.62	—	0.88	—	0.89	—	0.86	—	0.90	—	0.93	
LRI	—	0.19	—	0.34	—	0.80	—		—	0.70	—	0.78	—	
White §	2.67*	—	7.41***	—	7.11***	—	1.00	—	0.32	—	1.48	—	5.87***	
N. tot	129		129		123		104		101		94		86	
N. surv.	83		123		104		101		94		86		83	

Instruments

	OLS 88-93	SSM 88-93	OLS 88	SSM 88	OLS 89	SSM 89	OLS 90	SSM 90	OLS 91	SSM 91	OLS 92	SSM 92	OLS 93	SSM 93
β_0	1.18***	1.44***	0.67***	0.61***	0.23***	0.24	0.01	-0.01	0.13*	0.11	0.05	0.15	0.08	0.03
β_1	0.62***	0.59***	0.77***	0.77***	0.95***	0.95***	1.02***	1.02***	0.94***	0.94***	0.96***	0.94***	0.94***	0.95***
ρ	—	-0.40	—	0.66***	—	-0.15	—	0.08	—	0.12	—	-0.70***	—	0.35
$t(\beta_1 = 1)$	3.53***	6.53***	5.75***	6.73***	2.50**	1.07	1.00	0.42	2.00**	0.98	1.33	1.55	2.00**	1.15
F	108.20***	53.78***	526.44***	266.17***	1408.94***	721.47***	1528.35***	766.45***	1035.51***	518.73***	1013.57***	503.11***	1064.19***	542.72***
R^2 adj.	0.45	—	0.72	—	0.88	—	0.90	—	0.87	—	0.88	—	0.89	—
LRI	—	0.20	—	0.42	—	0.71	—	0.73	—	0.65	—	0.66	—	0.72
White §	1.17	—	6.17***	—	3.86**	—	3.31**	—	2.29	—	1.05	—	0.29	—
N. tot	214		214		200		183		168		155		141	
N. surv.	131		200		183		168		155		141		131	

Food

	OLS 88-93	SSM 88-93	OLS 88	SSM 88	OLS 89	SSM 89	OLS 90	SSM 90	OLS 91	SSM 91	OLS 92	SSM 92	OLS 93	SSM 93
β_0	0.98***	1.72*	0.42***	-0.03	0.34***	0.34*	-0.01	0.06	0.10	0.12	-0.03	-0.05	-0.12	(a)
β_1	0.79***	0.78***	0.93***	1.03***	0.88***	0.88***	1.01***	1.00***	0.97***	0.97***	1.00***	1.00***	1.04***	
ρ	—	-0.62	—	0.98***	—	-0.04	—	-0.79*	—	-0.11	—	0.17	—	
$t(\beta_1 = 1)$	1.29	1.08	0.70	0.35	2.00**	1.27	0.25	0.00	0.50	0.29	0.00	0.00	1.33	
F	23.80***	15.98***	187.07***	98.15***	245.76***	120.68***	580.82***	300.59***	333.82***	163.45***	632.93***	318.19***	1317.64***	
R^2 adj.	0.38	—	0.66	—	0.81	—	0.92	—	0.88	—	0.94	—	0.97	—
LRI	—	0.19	—	0.44	—	0.53	—	0.75	—	0.63	—	0.82	—	
White §	0.87	—	7.89***	—	0.73	—	0.26	—	3.65**	—	2.35	—	0.50	—
N. tot	81		81		63		58		54		45		42	
N. surv.	39		63		58		54		45		42		39	

*** = significant at 99% level of confidence; ** = significant at 95% level of confidence; * = significant at 90% level of confidence.

§ , F- statistic; null hypothesis: homoskedasticity; in case of heteroskedasticity (at least at 90% level of confidence) a consistent covariance matrix was used (White's correction).

(a) the algorithm did not reach convergence.

Table 3(ii) - OLS and Sample Selection Model (SSM) estimates of Gibrat's Law: Footwear & clothing, wood & furniture

Footwear & clothing

	OLS 88-93	SSM 88-93	OLS 88	SSM 88	OLS 89	SSM 89	OLS 90	SSM 90	OLS 91	SSM 91	OLS 92	SSM 92	OLS 93	SSM 93
β_0	1.27***	1.09	0.86***	0.65***	0.25***	0.25	0.16**	0.15	0.20**	0.18	0.06	0.01	-0.02	0.08**
β_1	0.64***	0.63***	0.76***	0.80***	0.94***	0.94***	0.93***	0.93***	0.92***	0.92***	0.95***	0.96***	0.99***	0.97***
ρ	—	0.29	—	0.79***	—	0.00	—	0.05	—	0.08	—	0.18	—	-0.93***
$t(\beta_1 = 1)$	5.49***	3.79***	6.00***	3.80***	2.00**	1.04	2.33**	1.87	2.67**	0.46	1.25	0.33	0.50	0.83
F	96.10***	43.67***	416.09***	208.88***	1693.55***	841.97***	1003.16***	498.45***	697.09***	346.41***	501.06***	249.14***	1665.67***	912.11***
R^2 adj.	0.46	—	0.68	—	0.91	—	0.87	—	0.83	—	0.80	—	0.94	—
LRI	—	0.18	—	0.36	—	0.75	—	0.64	—	0.56	—	0.50	—	0.87
White §	0.52	—	6.07***	—	6.20***	—	0.32	—	0.16	—	0.56	—	1.19	—
N. tot	231		231		204		179		157		144		124	
N. surv.	112		204		179		157		144		124		112	

Wood and furniture

	OLS 88-93	SSM 88-93	OLS 88	SSM 88	OLS 89	SSM 89	OLS 90	SSM 90	OLS 91	SSM 91	OLS 92	SSM 92	OLS 93	SSM 93
β_0	1.42***	1.41	0.86***	0.83***	0.12*	0.13	0.11	0.15	0.24	0.25*	0.38**	0.26**	0.03	0.03
β_1	0.56***	0.56	0.75***	0.76***	0.96***	0.96***	0.97***	0.98***	0.90***	0.90***	0.85***	0.88***	1.00***	1.00***
ρ	—	0.01	—	0.17***	—	-0.04	—	-0.70***	—	-0.53	—	1.00***	—	-0.01
$t(\beta_1 = 1)$	5.67***	…	5.00***	2.29**	1.33	0.80	1.00	0.26	1.43	1.55	2.14**	1.90*	0.00	0.00
F	63.01***	31.05***	299.32***	162.19***	1215.32***	601.11***	636.30***	323.96***	323.35***	160.31***	408.15***	201.29***	1002.02***	493.71***
R^2 adj.	0.47	—	0.75	—	0.93	—	0.89	—	0.81	—	0.85	—	0.94	—
LRI	—	0.26	—	0.51	—	0.93	—	0.77	—	0.60	—	0.76	—	0.95
White §	6.28***	—	22.46***	—	0.50	—	2.47*	—	5.54***	—	14.10***	—	6.64***	—
N. tot	115		115		100		91		81		78		72	
N. surv.	70		100		91		81		78		72		70	

*** = significant at 99% level of confidence; ** = significant at 95% level of confidence; * = significant at 90% level of confidence.

§ , F- statistic; null hypothesis: homoskedasticity; in case of heteroskedasticity (at least at 90% level of confidence) a consistent covariance matrix was used (White's correction).

Table 3(iii) - OLS and Sample Selection Model (SSM) estimates of Gibrat's Law: Paper & printing, rubber & plastics

Paper & printing

	OLS 88-93	SSM 88-93	OLS 88	SSM 88	OLS 89	SSM 89	OLS 90	SSM 90	OLS 91	SSM 91	OLS 92	SSM 92	OLS 93	SSM 93
β_0	1.25***	0.61	0.39***	0.35**	0.20**	0.29***	0.24***	0.22	0.14*	0.20	0.22	-0.75***	0.24***	0.19**
β_1	0.55***	0.60***	0.86***	0.87***	0.91***	0.91***	0.92***	0.92**	0.94***	0.93***	0.90***	1.35***	0.91***	0.92***
ρ	—	0.82***	—	0.29	—	-0.78***	—	0.13	—	-0.67	—	1.00***	—	0.93
$t(\beta_1 = 1)$	6.59***	3.77***	3.50***	2.12**	2.25**	1.01	2.00**	0.19	1.50	1.05	1.67	2.77***	3.00***	1.79*
F	65.04***	32.46***	422.55***	212.67***	413.36***	205.52***	507.20***	251.07***	679.87***	372.17***	350.23***	177.31***	878.12***	432.62***
R^2 adj.	0.52	—	0.81	—	0.83	—	0.87	—	0.91	—	0.85	—	0.94	—
LRI	—	0.28	—	0.53	—	0.56	—	0.67	—	0.82	—	0.65	—	0.98
White §	0.05	—	2.01	—	1.39	—	0.13	—	1.33	—	2.96*	—	0.80	—
N. tot	109		109		99		88		77		68		64	
N. surv.	60		99		88		77		68		64		60	

Rubber & plastics

	OLS 88-93	SSM 88-93	OLS 88	SSM 88	OLS 89	SSM 89	OLS 90	SSM 90	OLS 91	SSM 91	OLS 92	SSM 92	OLS 93	SSM 93
β_0	1.36***	1.33***	0.92***	0.94***	0.48**	0.49***	-0.04	-0.06	0.08	0.08	0.02	0.05	0.05	0.07
β_1	0.56***	0.56***	0.67***	0.67***	0.87***	0.88***	1.04***	1.03***	0.97***	0.97***	0.96***	0.95***	0.97***	0.97***
ρ	—	0.07	—	-0.22	—	-0.25	—	1.00***	—	0.60	—	-0.50	—	-0.50
$t(\beta_1 = 1)$	3.48***	2.98**	4.71***	3.78***	1.63	1.87	1.33	0.83	0.60	0.64	0.80	0.57	0.60	0.41
F	19.70***	9.69***	79.83***	39.48***	215.51***	106.75***	1024.94***	514.28***	663.40***	334.02***	366.12***	180.25***	414.36***	234.67***
R^2 adj.	0.23	—	0.50	—	0.75	—	0.94	—	0.91	—	0.85	—	0.87	—
LRI	—	0.10	—	0.27	—	0.52	—	0.97	—	0.83	—	0.64	—	0.71
White §	0.23	—	2.02	—	4.53**	—	4.26**	—	5.22***	—	0.00	—	0.30	—
N. tot	85		85		79		74		71		69		67	
N. surv.	65		79		74		71		69		67		65	

*** = significant at 99% level of confidence; ** = significant at 95% level of confidence; * = significant at 90% level of confidence.

§ , F- statistic; null hypothesis: homoskedasticity; in case of heteroskedasticity (at least at 90% level of confidence) a consistent covariance matrix was used (White's correction).