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Gibrat's Law: Are the Services Different?

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Summary

Several noted surveys on intra-industry dynamics have reached the conclusion from a large body of evidence that *Gibrat's Law* does not hold. However, almost all of these studies have been based on manufacturing or large scale services such as banking and insurance industries. There are compelling reasons to doubt whether these findings hold for small scale services such as the hospitality industries. In this paper we examine whether the basic tenet underlying *Gibrat's Law* – that growth rates are independent of firm size – can be rejected for the services as it has been for manufacturing. Based on a large sample of Dutch firms in the hospitality industries the evidence suggests that growth rates are independent of firm size. Validation of *Gibrat's Law* in the small scale services suggests that the dynamics of industrial organisation for services may not simply mirror that for manufacturing. The present paper includes a full survey of more than 50 empirical studies on firm growth rates.

1 Introduction

In his exhaustive survey in the *Journal of Economic Literature*, John Sutton (1997, p. 40) observed that publication of *Inégalités Économiques* by Robert Gibrat (1931) triggered, "One of the most important strands in the literature on market structure." Sutton points out that what is commonly referred to as *Gibrat's Law* is something of a misnomer. Rather than constituting a bona fide Law, what Gibrat proposed is actually an assumption – that the probability of the "next opportunity is taken up by any particular active firm is proportional to the current size of the firm" (Sutton, 1997, p. 43). From this simple proposition follows the equally simple prediction of proportional effect, that growth rates should be independent of size, which Mansfield (1962, pp. 1030-1031) characterised as, "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."

As Sutton (1997) summarises, when *Gibrat's Law* was finally subjected to empirical scrutiny in the 1950s and 1960s the results were less than unambiguous.[1] While F.M. Scherer's (1980) reading of the literature was that assuming growth rates to be uncorrelated with initial firm size, "is not a bad first approximation," persuasive empirical work by Mansfield (1962) led him to conclude that, "*Gibrat's Law* does not seem to hold up very well empirically."

The ambiguity with respect to *Gibrat's Law* seemed to be resolved in what Sutton (1997) refers to as the "new literature of the 1980s." A series of studies spanning a broad range of countries, and including both small as well as large enterprises, resulted in a singular result – growth rates (of surviving firms) tend to systematically decrease with increasing firm size. This finding emerged so consistently across different studies that Geroski (1995) in his survey of "What Do We Know About Entry?" classified it as a Stylised Result.[2]

Closer inspection of the three survey articles focusing on firm growth reveals that Geroski (1995), Sutton (1997 and 1998) and Caves (1998) did not acknowledge that virtually all of the knowledge assembled to date about *Gibrat's Law* is based on manufacturing. Perhaps this oversight is not surprising, since *Gibrat's Law* of Proportional Effect is sufficiently general as to not distinguish across specific types of economic activity. The Geroski (1995), Sutton (1997) and Caves (1998) surveys imply that what holds for manufacturing would be expected to hold for services. If this were not the case, the results based on manufacturing would actually represent a special case and application of *Gibrat's Law*; less than one-fifth of employment in the OECD countries is in manufacturing. Whether the dynamics of industrial organisation for the services simply mirrors that in manufacturing is an open-ended question where little is known but has significant policy implications. In fact, as we make clear in the third section of this paper, there are compelling theoretical reasons to expect the relationship between firm size and growth to be different for services than in manufacturing.

[1] See for example the early studies by Hart and Prais (1956), Simon and Bonini (1958), Hymer and Pashigian (1962), Hart (1962), Prais (1976), and Singh and Whittington (1962).

[2] More specifically Geroski's (1995, p. 434) *Stylised Result 8* is "Both firm size and age are correlated with the survival and growth of entrants."

Recently, the three survey articles have been supplemented by a series of studies which also took services into account. We have identified 19 such studies of which four deal exclusively with the services. Three of these four studies are concerned with large scale services such as banking and insurance industries. Only Santarelli (1997) deals with small scale services. See Table G of the Appendix to this paper for details.

The purpose of this paper is to examine whether Sutton's (1997) Statistical Regularities and Geroski's (1995) Stylised Results for the validity of *Gibrat's Law* based on evidence from the manufacturing sector holds for small scale services. Systematic differences in the size-growth relationship between small scale services and manufacturing may reflect underlying structural differences shaping the dynamics of industrial organisation in these services in a way that is fundamentally different from that in manufacturing.

The following section of this paper characterises the main findings and summarises the state of knowledge regarding *Gibrat's Law* based on evidence from manufacturing. In the third section theoretical reasons are presented why *Gibrat's Law* would be expected to hold for the services but not in manufacturing. The comprehensive longitudinal database used to track the growth rates of over 1,000 Dutch service firms is introduced and documented in the fourth section. In the fifth section the empirical results are presented. Finally, conclusions and a summary are presented in the sixth section. In particular, our empirical evidence indicates that, in contrast to manufacturing, *Gibrat's Law* generally holds for small scale services. This is in line with recent studies dealing with both manufacturing and services, which show mixed results in that *Gibrat's Law* is less persistently rejected when compared to what the three surveys report. This suggests that the dynamics of industrial organisation for services may not simply mirror that for manufacturing.

2 Results from Manufacturing

Virtually all knowledge about the validity of *Gibrat's Law* is from manufacturing (see Appendix A for a compilation of the most important studies). Geroski (1995), Sutton (1997) and - although only indirectly since his article deals mostly with the mobility and turnover of firms - Caves (1998) conclude from their surveys of the literature linking firm size to growth that "Both firm size and age are correlated with the survival and growth of entrants" (Geroski, 1995, p. 434), thus leaving little support for the validity of *Gibrat's Law*. While Geroski (1995) considers the empirical evidence compelling enough to constitute a bona fide Stylised Result, Sutton (1997, p. 46) only concludes that the proportional rate of growth of a firm , conditional upon survival, decreases with size. This ambiguity seems to arise from the types of firms included in the sample. *Gibrat's Law* tends to hold when only large firms or firms that have exhausted scale economies are included in the sample (cf., for example, the results by Geroski *et al.*, 2000; and those by Bottazzi *et al.*, 2001). According to Geroski (1995, p. 435), "The results are interesting because they suggest that the growth patterns of large and small firms differ. As is well known, the growth rates of well-established corporations are, roughly speaking, random, and do not seem to vary in any stable or systematic way with firm size." However, as Caves (1998, p. 1948) aptly observes "Although the importance of these facts for economic behaviour is manifest, their development has not been theory-driven", and *Gibrat's Law* is still an empirical regularity in search of sound theoretical justification (in this connection see McCloughan, 1995; Sutton, 1998; Brock, 1999; Cooley and Quadrini, 2001; Cabral and Mata, 2001; Ghosal, 2001)

Just as the earlier studies based solely on large manufacturing industries typically found support for *Gibrat's Law* (Hart and Prais, 1956), so have some of the most recent studies (Geroski and Machin, 1993; Geroski *et al.*, 2000; Pfaffermayr and Bellak, 2000). By contrast, those studies, both pioneering (Samuels, 1965; and Prais, 1976) and more recent (Evans, 1987a and 1987b, Hall, 1987; Dunne, Roberts and Samuelson, 1988 and 1989; Reid, 1995; Audretsch, Santarelli and Vivarelli, 1999, Almus and Nerlinger, 2000), including small firms in the sample typically concluded that growth rates tend to be negatively related to the size of (surviving) firms. Conversely, Lotti, Santarelli and Vivarelli (1999 and 2001) show that Gibrat's Law fails to hold for Italian manufacturing firms only in the year immediately after start-up, whereas it is confirmed in subsequent years. This implies that a post-entry size adjustment process takes place among the smaller ones of the new entrants which, having entered with a marked sub-optimal scale, adjust their size towards the mean size exhibited by larger entrants, but once they reach (in subsequent years) a size large enough to enhance their likelihood of survival, their pattern of behaviour matches that of larger entrants.[1] This and other significant exceptions (Del Monte and Papagni, 2001; Heshmati, 2001) notwithstanding, the more general and broader samples of firms including a full spectrum across size classes have led to results inconsistent with *Gibrat's Law*.

Sutton (1997) has attempted to resolve any remaining ambiguities by recollecting Mansfield's (1962) interpretation of *Gibrat's Law*. Mansfield (1962) pointed out that there are three main renditions of *Gibrat's Law* . The first version postulates that the Law

[1] This finding is consistent with the hypothesis put forward by Cabral (1995) that entering the market implies capacity and technology costs that involve some degree of sunkness.

holds for firms that exited the industry as well as for those remaining in existence. The second interpretation is that the Law holds only for firms that survive over the relevant time period (Hart and Prais, 1956). The third main version is that the Law applies only to firms that are large enough to exceed the minimum efficient scale (MES) level of output (Simon and Bonini, 1958).

Sutton (1997) makes clear that the ambiguity created by different results for different samples becomes resolved when the empirical evidence is weighed through these three different lenses. In his view *Gibrat's Law* holds under the third version but not under the first two. Our survey, also containing more recent studies, shows that in the static analysis of version three for manufacturing industries *Gibrat's Law* is accepted in just three out of eight studies while three show mixed results[1]. See Table G of the Appendix.

[1] Table G of the Appendix also shows that in the temporal analysis of version three for manufacturing industries Gibrat's Law is accepted in only one of six cases.

3 Why the Services Should Differ

In contrast to Geroski's (1995) Stylised Result based on evidence from manufacturing, there are compelling theoretical reasons to expect that *Gibrat's Law* would hold for the services. These theoretical reasons are based on interpreting why *Gibrat's Law* fails to hold generally in manufacturing, but, in fact, does hold in a number of sub-samples. As Geroski (1995) and Sutton (1997) point out, the literature has been more focused on testing for the validity of the Law than on explaining and interpreting the empirical results.

The reasons why *Gibrat's Law* does not hold for manufacturing in general, but is, in fact, valid for particular sub-samples, such as for large established firms, is due to a discrepancy between the two assumptions underlying the Law. The first, as stated by Sutton (1997, p. 43), that the "next opportunity is taken up by any particular active firm is proportional to the current size of the firm" does not necessarily lead to the second, that firm growth should be independent of size. An important qualification is that the second proposition will follow from the first if and only if there is no relationship between size and survival.

If opportunities are stochastically distributed but proportional to firm size, the expected growth rate for each firm is the same. As long as the likelihood of survival is also independent of firm size, *Gibrat's Law* would be expected to hold for a reasonably large sample. Each firm has an equal probability of "drawing" any given growth rate. The observed growth rates would then be normally distrbuted for any given firm size or firm-size class, which would conform to *Gibrat's Law*.

However, when the likelihood of survival is positively related to firm size, the observed growth rates are no longer normally distributed for each firm size or firm-size class. If size is a requirement for survival, or at least positively influences the likelihood of survival, the consequences of not obtaining a growth opportunity, or even experiencing negative growth become asymmetrical across firm size classes. Negative growth for a large firm means that the firm will be smaller in period t-1 than in period t but it will still survive; negative growth for a small firm will mean that the firm has a lower probability of survival. Even the lack of growth or insufficient growth for a small firm will reduce the likelihood of survival if the relationship between survival and size is strong enough. The higher propensity for small firms experiencing low (or negative) growth to exit than for low-growth large firms serves to bias samples of surviving small firms towards higher growth enterprises. By contrast, a sample of surviving large firms consists of a greater spectrum including both low - and high-growth enterprises. Thus, when the consequences of not obtaining a high growth opportunity differ systematically between large and small firms in terms of the likelihood of survival, the resulting distributions of actual observed growth patterns across different firm size classes will also vary systematically between large and small firms in two ways. First, *Gibrat's Law* will tend to hold for larger firms but not for smaller enterprises. Second, growth rates will be negatively related to firm size for samples including a full spectrum of large and small firms.

The degree to which smaller firms are confronted with a lower likelihood of survival than their larger counterparts is not constant from industry to industry but rather varies systematically across industries. In some industries the difference between the large- and small-firm survival rates is relatively large; in others it is non-existent. A number of

different studies spanning different countries and time periods have identified a common set of industry-specific characteristics shaping the degree to which a small-firm survival disadvantage exists, including the relative importance of sunk costs, industry growth, scale economies, and capital intensity (Baldwin, 1995; Baldwin and Rafiquzzaman, 1995; Doms, Dunne and Roberts, 1995; Mata and Portugal, 1995; Mata, Portugal and Guimaraes, 1995; Audretsch, 1995, 1991; Audretsch and Mahmood, 1995; Mahmood, 1992). The gap between large-firm and small-firm survival diverges the most in industries with substantial sunk costs and which are capital intensive and characterised by high scale economies. The consequences of low or negative growth for small firms in such industries are elevated costs, leading to a lower probability of survival. As a result of this survival bias, (surviving) small firms in such industries have systematically higher rates of growth than their larger counterparts.

By contrast, the small-firm survival bias tends to disappear in industries with minimal sunk costs and where capital intensity and scale economies do not play an important role. In such industries the consequences of low or even negative growth are symmetric between large and small enterprises. Consequently, observed growth rates also are found to be independent of firm size.

The types of Dutch services we examine in this paper are in the hospitality sector, including restaurants, cafeterias, cafes, hotels and camping sites. By definition these firms operate in very small sub-markets (neighbourhoods rather than municipal areas), which in most cases are characterised by the presence of a few firms or even a single one. Thus, even very small firms in this industry are likely to operate at the minimum efficient scale level of output of their sub-market and do not need to rush for enhancing their likelihood of survival. While large chains and franchising may be more characteristic of the United States and the United Kingdom, the Dutch hospitality sector consists largely of family-owned and independent businesses, therefore displaying similarities with other EU countries such as Greece, Italy, Portugal and Spain. In a sector of family-owned and independent local businesses, sunk costs are minimal, as are scale economies and capital requirements. Thus, those factors leading to a small-firm survival bias and ultimately to a negative relationship between firm size and growth rates in certain manufacturing industries are noticeably absent in the Dutch hospitality sector. Rather, the absence of scale economies, capital intensity and sunk costs leads to the prediction that the consequences of not growing should be symmetric across all firm sizes. In contrast to manufacturing, Gibrat's Law would be expected to hold for Dutch hospitality industries. In fact, this expectation is supported by the results found by Hart and Oulton (1999) - who identified a negative relation between size and growth in their estimates for the "Distribution and hotel" aggregate in the UK where large chains and franchising are quite characteristic for the business - and by Santarelli (1997) - who found that, in the entire Italian hospitality sector which consists largely of family-owned and independent businesses, Gibrat's Law holds for the majority of Italian regions.

4 Measurement

As Dunne, Roberts and Samuelson (1988 and 1989) emphasise, one of the greatest impediments to examining the relationship between firm size and growth has been the lack of access to longitudinal data sets. This paucity of data has been even more exacerbated for services. In this paper we rely on Statistics Netherlands (CBS) to track the growth performance of firms in the Dutch hospitality sector between 1987 and 1991. Annual observations for firm size are available from CBS data files. While a firm can consist of more than one establishment, 94 percent of all firms in Dutch hospitality are single-establishment enterprises, reflecting a sector of independent and family-owned businesses.[1]

In compiling the data files, CBS follows three rules in their selection process. First, firms are classified according to their main activity (e.g., lodging guests or serving meals) and their size, which is measured by the number of employees. Second, for firms with at least twenty employees a census of the entire population is taken; for smaller firms a sample is taken where the sample proportion increases according to size class. Third, firms that are selected in the survey in one year remain in the sample for subsequent years, creating longitudinal observations.

As first Mansfield (1962) and later Sutton (1997) point out, the discrepancy in conclusions about the validity of *Gibrat's Law* emanates from using three different types of samples of firms – all firms, only surviving firms, and only large firms (that exceed the MES level of output). To ensure that the results in this paper are not slanted towards any one of these, we create three different samples. The first sample consists of all firms. We follow the precedent in previous studies by assigning a growth rate of –100 to any firm that exited between 1987 and 1991.

The second sample consists only of firms that survived the entire period between 1987 and 1991. About 40 percent of the firms in existence in 1987 are not in existence by 1991. The third sample consists only of large surviving firms. We adapt Mansfield's (1962) approach and define those enterprises accounting for one-half of the industry value-of-shipments as being large.

The mean growth rates, measured as the percentage change in firm sales between 1987 and 1991 are shown for each of these three samples in Table 1. The mean growth rate for the 1,170 firms in the sample consisting of all firms is 12.20 percent and ranged from 1.09 percent in cafes to 25.72 percent for camping sites. For the sample consisting of only the 944 surviving firms the mean growth rate is considerably higher, 27.22 percent. When only the 291 (surviving) large firms are included, the mean growth rate is somewhat less, 20.83 percent.

[1] It is not possible to identify the separate establishments of the remaining six percent multi-establishment enterprises.

Table 1 Firm size and growth rates in the Dutch hospitality sector for the period 1987-1991

Business Group	*Growth*[d]	*Size*[e]	*N*[f]	*Growth*[d]	*Size*[e]	*N*[f]	*Growth*[d]	*Size*[e]	*N*[f]
Restaurants	4.10	2,219.70	213	17.48	2,392.09	172	18.89	3,440.93	116
Cafeterias	8.56	616.41	124	37.95	695.34	102	26.34	1,653.58	34
Cafes	1.09	296.24	305	21.30	309.98	223	11.88	996.15	34
Hotels	10.19	4,221.89	241	21.44	4,351.79	206	9.70	11,718.92	52
Camping Sites	25.72	805.31	103	36.05	810.22	91	34.18	1,874.09	23
Entire Hospitality Sector	12.20	1,848.93	1,170	27.22	2,013.08	944	20.83	4,544.76	291

a. *In the first version all firms are included. If a firm exits between 1987 and 1991 the growth rate (over the four year period) is equated to - 100.*

b. *In the second version all firms that survived during the period 1987-1991 are included.*

c. *In the third version only surviving firms that operate above the minimum efficient scale (MES) are included. We define the MES as the minimum size of the largest firms in a business group that accounts for one half of the value of sales in that business group.*

d. *Firm growth rate measured by the average percentage of change in sales per firm for the period 1987-1991.*

e. *Firm size measured by the average sales per firm in 1987 (in 1,000 Dutch guilders).*

f. *N stands for the number of observations. The entire hospitality sector consists of 13 four digit business groups. Only five business groups are analyzed separately. The remaining business groups contain less than 100 firms.*

5 Empirical Results

In the preceding section we refer to the three versions of *Gibrat's Law* that are tested in the literature: a first version where all firms are included, a second version where only surviving firms are analysed, and a third version including only large survivors, i.e. firms operating at or above the minimum efficient scale (MES). Another way of characterising the studies testing *Gibrat's Law* is: static studies versus studies analysing the persistence of growth. Mansfield (1962) is an example of a static approach, while Chesher's study (1979) is an example of a temporal analysis.

Both static and temporal analyses of the three versions of *Gibrat's Law* would lead to six specifications of modelling empirical growth. However, the first version of the Law cannot be estimated in the case of persistence of growth. It is not possible to analyse the persistence of growth for firms that leave the industry during the observation period. The Appendix to this paper gives a review of empirical studies testing *Gibrat's Law*.[1] Parts A, B, and C deal with the static analyses, while parts D and E cover the studies focusing on the persistence of growth.[2] Results for the static analysis for Dutch services are presented in section 5.1 and the persistence of growth is analysed in section 5.2.

5.1 Distribution of Firm Growth Rates

The first method used to test for the validity of *Gibrat's Law* in the literature divides the observed firm sizes into several size classes and then examines whether firm growth rates are equally distributed across these classes.[3] To construct these size classes firms were ranked in order of size and divided into quartiles in each business group in the hospitality sector. Similarly, firm growth rates were also divided into quartiles. If the observed frequencies of the resulting sixteen cells in the cross tables of firm size and growth rates are equal, *Gibrat's Law* would be supported. Whether or not growth rates and firm size are independent is tested using the χ^2 statistic.[4]

The results for the three different versions of *Gibrat's Law* are presented in Table 2. *Gibrat's Law* is rejected in four of the five business groups for the sample including all firms (version 1 in Table 2). Only for the camping sites are size and growth found to be statistically independent.

[1] See also Lotti, Santarelli and Vivarelli (1999), and Hart (2000) for reviews of a selection of empirical work on *Gibrat's Law*.

[2] A sixth group of studies on firm growth is added to the Appendix as part F. They deal with the so-called post-entry performance of new firms, which is a relatively recent strand of studies in the literature.

[3] See for examples Hymer and Pashigian (1962), Singh and Whittington (1975) and Acs and Audretsch (1990).

[4] To test for independence in the cross tables, the expected value of each cell in the table is at least five. To obtain these expected values we use only two or three classes of size and growth when the number of observations in a table is fewer than 80.

Table 2 Empirical results per business group for Gibrat's Law, which states that firm growth rates are distributed independently of firm size

Chi-Square Value *Degrees of Freedom* *Level of Significance*	*Version 1*[a]	*Version 2*[b]	*Version 3*[c]
Restaurants	34.43	27.27	16.74
	9	9	9
	0.000	0.001	0.053
Cafeterias	21.67	24.09	1.20
	9	9	1
	0.010	0.004	0.274
Cafes	42.02	11.53	0.01
	9	9	1
	0.000	0.241	0.920
Hotels	18.41	15.62	3.56
	9	9	4
	0.31	0.075	0.469
Camping Sites	12.05	3.64	1.86
	9	9	1
	0.211	0.934	0.173
Entire Hospitality Sector	50.83	14.19	12.58
	9	9	9
	0.000	0.116	0.183

a. In the first version all firms are included. If a firm exits between 1987 and 1991 the growth rate (over the four year period) is equated to - 100.

b. In the second version all firms that survived during the period 1987-1991 are included.

c. In the third version only surviving firms that operate above the minimum efficient scale (MES) are included. We define the MES as the minimum size of the largest firms in a business group, that accounts for one half of the value of sales in that business group.

For the sample containing only surviving firms the Law is accepted for the cafes, hotels and camping sites, but is rejected for the restaurants and cafeterias (version 2). For the sample of large firms *Gibrat's Law* is accepted for all five business groups (version 3).

5.2 Persistence of Growth

In this section the other main methodology used to estimate *Gibrat's Law* is used to test the hypothesis that firm growth is independent of size.[1] As developed by Chesher (1979),

$$z_{t,i} = \beta\, z_{t-1,i} + \varepsilon_{t,} \qquad (1)$$

where t is an index for time, i is an index for the firms, and $z_{t,i}$ is the deviation of the logarithm of the size of company i at time t from the mean of the logarithms of the sizes of companies at time t ($z_{t-1,i}$ is analogously defined).

[1] Singh and Whittington (1975) show that the absence of persistence of firm growth rates is an implication of *Gibrat's Law*.

If *Gibrat's Law* is valid and firm growth rates are distributed independently of firm size, the parameter β should be equal to unity.[1] If $\beta < 1$ large firms are expected to grow more slowly than their smaller counterparts; if $\beta > 1$ small firms are expected to grow more slowly than larger enterprises.

Equation (1) assumes that the disturbances, $\varepsilon_{t,i}$, are serially uncorrelated. In the case of serially correlated disturbances the firm growth rate in one period depends on the growth rate in the preceding period.[2] Thus, *Gibrat's Law* can be rejected even when the parameter β is (about) equal to one.[3] Assuming a first order autoregressive process for the disturbances $\varepsilon_{t,i}$

$$\varepsilon_{t,i} = \rho\, \varepsilon_{t,i} + \nu_{t,i} \qquad (2)$$

where $\nu_{t,i}$ is assumed to be non-serially correlated. Expressing the disturbances $\varepsilon_{t,i}$ and $\varepsilon_{t-1,i}$ in terms of $z_{t,}$, $z_{t-1,}$, and $z_{t-1,i}$ and $z_{t-2,i}$ respectively,

$$z_{t,i} = (\beta + \rho)\, z_{t-1,i} + (-\beta\rho)\, z_{t-2,i} + \nu_{t,i}, \qquad (3)$$

We use the non-linear regression procedure by Marquardt (1963) to obtain (asymptotic) standard errors for β and ρ. *Gibrat's Law* is considered to be valid if the joint hypotheses $(\beta\ \rho) = (1\ 0)$ is accepted. Assuming that the estimators of β and ρ are asymptotically normally distributed, the test-statistic for the joint hypothesis is (asymptotically) chi-squared distributed with two degrees of freedom.[4]

The estimation results for equation (3) are shown in Table 3.[5] There are three important results emerging in Table 3. First, in 11 of the 15 cases *Gibrat's Law* is accepted. This is a sharp contrast to the findings for manufacturing by Singh and Whittington (1975), Chesher (1979), Kumar (1985) and Wagner (1992) where the Law is generally rejected. In all of these studies the autoregressive coefficients (ρ) are positive and statistically different from zero, while β is close to unity. For the results in Table 3 only negligible or very modest autocorrelation coefficients are found.[6]

[1] See Chesher (1979) for a more detailed explanation.

[2] See Amirkhalkhali and Mukhopadhyay (1993) for an explanation.

[3] The condition that parameter β is equal to one is a necessary but not a sufficient condition for *Gibrat's Law* to be true.

[4] See Malinvaud (1980).

[5] Equation (3) is not corrected for sample selection bias for three reasons. First, we test for *Gibrat's Law* using a sample of only surviving firms. Second, because of the variety of reasons for an exit the sample selection bias can not be corrected by a straightforward econometric technique (Wagner, 1992). Third, the period under study is short. Results in Hall (1987) show that for short periods the potential bias is unlikely to be serious.

[6] The autocorrelation coefficients in the studies of Singh and Whittington (1975), Chesher (1979), Kumar (1985) and Wagner (1992) vary between 0.1 to 0.3. These coefficients deviate more from zero than those found for Table 3.

Table 3 Empirical results for equation (3): $z_{t,i} = (\beta+\rho)z_{t-1,i} + (-\beta\rho)z_{t-2,i} + v_{t,i}$, t = 1989, 1990 or 1991

		Dependent variable		
Business Group		z_{91}	z_{90}	z_{89}
Restaurants	β	1.0203*	1.0105	0.9838*
		(0.0098)[b]	(0.0067)	(0.0073)
	ρ	–0.0519	–0.0869	0.1419*
		(0.1111)	(0.0864)	(0.0565)
	$(\chi^2)^a$	4.117	3.739	10.334**
Cafeterias	β	1.0135	1.0172	0.9492**
		(0.0169)	(0.0136)	(0.0145)
	ρ	0.0672	0.0454	0.0925
		(0.1303)	(0.0895)	(0.0588)
	χ^2	1.151	1.755	15.108**
Cafes	β	0.9986	1.0035	0.9870
		(0.0134)	(0.0122)	(0.0176)
	ρ	0.0838	-0.1317*	0.1652*
		(0.0617)	(0.0648)	(0.0776)
	χ^2	1.869	4.098	4.791
Hotels	β	0.9653**	0.9986	0.9954
		(0.0104)	(0.0067)	(0.0089)
	ρ	0.1935*	-0.0811	0.1564*
		(0.0782)	(0.0670)	(0.0622)
	χ^2	18.271**	1.552	6.450*
Camping Sites	β	0.9976	1.0150	0.9833
		(0.0146)	(0.0131)	(0.0127)
	ρ	0.0061	-0.2009	-0.1342
		(0.0985)	(0.1116)	(0.1125)
	χ^2	0.020	4.616	3.344
Entire Hospitality	β	0.9954	1.0018	0.9964
Sector		(0.0039)	(0.0032)	(0.0038)
	ρ	0.0697*	-0.1009*	0.0975**
		(0.0337)	(0.0335)	(0.0300)
	χ^2	5.224	9.152*	11.089**

a. In equation (3) Gibrat's Law *holds when the joint hypothesis (β, ρ) = (1, 0) is accepted. The test-statistic for this joint hypothesis is (asymptotically) χ^2-distributed with two degrees of freedom.*

b. Asymptotic standard errors are given between parentheses.

* *The hypothesis $\beta = 1$ or the hypothesis $\rho = 0$ or* Gibrat's Law *is rejected at the 5 percent level of significance.*

** *The hypothesis $\beta = 1$ or the hypothesis $\rho = 0$ or Gibrat's Law is rejected at the 1 percent level of significance.*

The second important finding from Table 3 is that the results differ across the years and business groups. When the dependent variable refers to the year 1990, *Gibrat's Law* is accepted for all six business groups. By contrast, the Law is rejected for three of the groups for 1989. These differences over time may reflect different stages in the business cycle. The years 1987 and 1988 show modest results in terms of sales and profit levels, while the years 1989 and 1990 show quite good results. Clear differences across the business groups occur when the results for cafes and cafeterias are compared with those for hotels. *Gibrat's Law* is accepted for all three time periods for cafes and cafeterias, but is rejected for two of the time periods for hotels. The third major result is that

for the entire hospitality sector the coefficients β never differ from one, implying that growth is independent of firm size, which is consistent with *Gibrat's Law*.

The data available also enable the estimation of a second and third order autoregressive process. In a second and third order autoregressive process $z_{t,i}$ is related to $z_{t-1,i}$, $z_{t-2,i}$ and $z_{t-3,i}$ and to $z_{t-1,i}$, $z_{t-2,i}$, $z_{t-3,i}$ and $z_{t-4,i}$ respectively. For 1991 neither a second nor a third order autoregressive process improves the estimation results significantly compared to a first order autoregressive process.[1] For 1990 the second order autoregressive coefficient ρ_2 differs significantly from zero for cafeterias, cafes and hotels. In all three business groups the coefficient of ρ_2 is negative. This result suggests that high firm growth rates in 1988 coincide with low growth rates in 1990. There is no indication that higher order autocorrelation processes should be preferred to the first order autoregressive process. Therefore, the results of the second and third order autoregressive process are not presented here in detail.[2]

[1] For the year 1991 the null hypothesis that $\rho_2 = 0$ and that $\rho_2 = \rho_3 = 0$ are accepted for all business groups and for the entire hospitality sector.

[2] Equation (3) was also estimated for the sample including only large firms. Because of a lack of observations it is not possible to estimate the model for cafeterias, cafes and camping sites. However, the estimation results for large firms in restaurants and hotels, as well as the entire hospitality sector are virtually identical to the results for the sample of surviving enterprises. For the entire hospitality sector as well as for both restaurants and hotels, the coefficients of β are still statistically equal to one. This implies that there is no relationship between firm size and growth rates. For restaurants the autocorrelation coefficients (ρ) deviate more from zero than those in Table 3. For the entire hospitality sector as well as for hotels the autocorrelation coefficients are quite similar to those reported in Table 3.

6 Conclusions

In the most influential surveys about the intra-industry dynamics of firms, Geroski (1995), Sutton (1997) and Caves (1998) examine what has by now become a large literature and independently conclude that the empirical evidence does not support Gibrat's Law. Our survey, also containing more recent studies, shows that in the static analysis of version three for manufacturing industries Gibrat's Law is accepted in only three out of eight studies while three show mixed results. In contrast to manufacturing, Gibrat's Law would be expected to hold for Dutch hospitality industries. In fact, this expectation is supported by the results found by Hart and Oulton (1999) - who identified a negative relation between size and growth in their estimates for the "Distribution and hotel" aggregate in the UK characterised by large chains and franchise operations - and by Santarelli (1997) - who found that, in the entire Italian hospitality sector which consists largely of family-owned and independent businesses, Gibrat's Law holds for the majority of Italian regions. In fact, the results of our paper do not indicate that in Dutch hospitality industries small firms tend to have systematically higher growth rates than their larger counterparts. This conclusion is based upon the temporal analysis of the Law for five business groups in Dutch hospitality. It is shown that the Law is accepted in 11 out of 15 cases. This is in sharp contrast to manufacturing. What Geroski (1995) concludes is a Stylised Result for manufacturing does not appear to hold for small scale services. The large majority of previous studies in the literature finding a statistical independence between firm size and growth rates for manufacturing are based on samples consisting of large firms.

This discrepancy in the validity of *Gibrat's Law* between manufacturing and small scale services suggests that the structure of these services may be inherently different from manufacturing. While small firms are at a disadvantage in at least some manufacturing industries, this does not appear to be the case in Dutch services. New entrants are typically under the pressure to grow to avoid being confronted by a greater likelihood of failure in manufacturing, but the absence of growth in the services does not apparently threaten the viability of the firm.

It may be that thinking about *Gibrat's Law* has been somewhat miscast. While *Gibrat's Law* may not hold in those situations where growth will reduce the likelihood of failure, the evidence from this paper suggests that such industry dynamics do not appear to be general enough to include at least some aspects of the services.

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Appendix A Empirical studies testing Gibrat's Law: A review

The comparison of empirical studies testing *Gibrat's Law* is not always possible in a straightforward manner, because they differ widely in the samples used and the methods applied. Therefore, we divide the studies into groups of which the results can be compared. We take two characteristics into account when we distinguish the studies into these groups. Firstly, in several studies, like Mansfield (1962), a static analysis is carried out, while other studies, like Chesher (1979), deal with the persistence of growth. Secondly, we follow Mansfield (1962) who tests three versions of *Gibrat's Law*. In version 1 all firms are included, also those leaving the industry during the observation period. In version 2 only the survivors are analysed. According to version 3 only large surviving firms that operate at or above the minimum efficient scale (MES) are included.

Both static and temporal analysis of three versions would lead to six types of empirical growth studies. However, the first version of *Gibrat's Law* can not be studied in the case of persistence of growth: it is not possible to analyse the persistence of growth for firms that leave the industry during the observation period. Recently, some attention has been paid to the post entry growth of new firms. We add such studies as the sixth group to our review. In each of the tables A through F below of the six groups is reviewed. It should be noted that different versions of *Gibrat's Law* are tested in some studies. Such studies appear more than once in the tables. Finally, a concise version of the contents of all six tables is given in table G.

Table A Static analysis and version 1

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Mansfield (1962)	Almost all firms in three US manufacturing industries (Steel, Petroleum refining and Rubber tire) are observed; in each industry several periods of some 10 years between 1916 and 1957 are considered.	The distributions of growth rates for several size classes are compared.	*Gibrat's Law* is rejected in 7 out of 10 cases; smaller firms are more likely to leave the industry.
Acs and Audretsch (1990)	Acs and Audretsch used the Small Business Data Base like Evans (1987a and 1987b) did; they aggregated the data into 408 four-digit US manufacturing industries; firm growth is considered for the period 1976-1980.	Based on 1976 firm size each four-digit industry is divided in four size classes; mean (employment) firm growth rates are calculated for every size class in every industry; the hypothesis to be tested is that the mean growth rates in the four firm-size classes are equal.	In 60 percent of the 408 industries mean growth rates in the size classes are not significantly different; *Gibrat's Law* holds in 60 percent of the industries; this finding is different from Evans (1978b); incorporating the impact of exits tends to produce more support for *Gibrat's Law* than otherwise would be found.
Fariñas and Moreno (2000)	Fariñas and Moreno used a sample of 1971 manufacturing firms drawn from the Encuesta sobre Estrategieas Empresariales (ESEE) carried by the Ministry of Industry in Spain; Average annual growth rates are considered over the period 1990-1995, for a total number of 7265 observations; Size is measured in terms of employment.	The empirical model examines how the mean growth rate and the exit rate vary across size and age of firms, controlling for industry and year categories; The offsetting effect predicted by the selection model is that the probability of failure diminishes with size and age; Fariñas and Moreno correct for sample selection bias and heteroscedasticity; They follow the method proposed by Dunne, Roberts and Samuelson (1988) to distinguish between potential and observed growth rates in order to account for sample selection due to exit.	Application of Wald statistics using robust variance estimates shows that the size pattern is not uniform at all, and the differences in growth rates across the size of firms are not statistically significant; This pattern of no relationship between expected growth and size appears because the reduction in the failure rate with increased size and the reduction in the growth rate of non-failing firms with increased size compensate each other; Besides, the net effect of age on firm growth is similar to the effects of size.

Table B Static analysis and version 2

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Mansfield (1962)	Almost all firms in three US manufacturing industries (Steel, Petroleum refining and Rubber tire) are observed; in each industry several periods of some 10 years between 1916 and 1957 are considered.	The distributions of growth rates for several size classes are compared; the regression of the logarithm of size at the end of the period on the logarithm of size in the beginning of the period is also carried out.	*Gibrat's Law* is rejected in 4 out of 10 cases when distributions of growth rates for different size classes are compared and in 3 out of 10 cases when the regression estimates are used.
Evans (1987a)	Data for approximately 20,000 US manufacturing firms are used; firm growth is analysed between 1976 and 1982; data are pooled across industries; very small firms are under-represented.	Regression analysis is carried out for (employment) growth rates on firm size, firm age, and quadratic terms and the cross product of size and age; Evans corrects for sample selection bias and heteroscedasticity and reports for young and old firms separately.	Firm growth decreases with size; departures from *Gibrat's Law* tend to decrease with firm size; for young firms growth decreases with age when size is held constant; this result supports Jovanovic's (1982) theory; young firm survival increases with size and age.
Evans (1987b)	A sample of 100 US four-digit manufacturing industries was selected randomly from the population of 450 four-digit industries; data for 42,339 firms operating in 1976 were divided in 13,735 young and 28,604 old firms; firm growth is considered for the period 1976-1980; during this period about 33 percent of the young firms and about 15 percent of the old firms are dissolved.	Regression analysis is carried out for (employment) growth rates on size, age, the number of plants, quadratic terms and cross products of these variables; Evans controls for sample selection bias and heteroscedasticity and reports for young and old firms separately.	Firm growth decreases at a diminishing rate with firm size even after controlling for sample selection bias; *Gibrat's Law* fails and the departures from the Law are more severe for small firms; for young as well as for old firms growth decreases with age; firm growth decreases with size in 89 percent of the industries and with age in 76 percent of the industries.
Contini and Revelli (1989)	Data for Italian manufacturing firms are used for the period 1980-1986; the period is divided in two subperiods, a recession period (1980-1983) and an expansion period (1983-1986); in both subperiods data for over 1000 firms are available.	Regression results for (3 year employment) growth rates on firm size and age are obtained; due to multicollinearity squared terms and the cross product are not included; also lagged growth rates are added to the regressions; problems of heteroscedasticity and sample selection bias are mentioned.	In all regressions the firm growth rate declines significantly with size; the coefficient changes only slightly when different periods of time or when only large firms are used or when lagged growth rates is added as an explanatory variable; departures from *Gibrat's Law* are modest; in the recession period there is hardly association between growth rates and age; in the expansion period the growth rates decline with age.
FitzRoy and Kraft (1991)	A sample of 51 West German firms in the metalworking sector is used; data are available for the years 1977 and 1979.	Regression results for growth rates on size and several other explanatory variables, like age (measured by a dummy variable) are obtained; the growth rate is defined as the difference of the 1979 sales and the 1977 sales divided by the (initial) sales in 1977; the results are corrected for heteroscedasticity.	In the German metalworking sector larger firms display significantly lower growth than the smaller ones; *Gibrat's Law* seems to fail; the age dummy variable is positive, so younger firms do grow faster, controlling for employment; more innovative and more profitable firms grow faster, also firms with a higher education workforce do.

Table B Static analysis and version 2 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Variyam and Kraybill (1992)	Only small and medium sized firms, defined as businesses employing less than 500 employees, are included; a sample of 422 firms in Georgia (US) is conducted; the firms belong to various sectors, including retailing as well as manufacturing.	Regression analysis is carried out for five year (employment) growth rates on size, age and quadratic terms and the cross product of these two variables; also some dummy variables are included; the results are controlled for heteroscedasticity.	Firm growth rates decreases significantly with firm size and age; *Gibrat's Law* is rejected; holding other firm characteristics constant, the growth rate is significantly smaller for independent, single establishment firms compared to multiple establishment firms; the overall results come close to those reported by Evans (1987a).
Dunne and Hughes (1994)	Data for over 2000 UK companies covering the entire private sector are available; growth is available for the periods 1975-1980 and 1980-1985, while survival is observed only for the most recent period; small firms are underrepresented.	A probit model for survival on (asset) growth is estimated; the logarithm of size at the end of the period is regressed on the logarithm of size at the beginning of the period; the effects of age on growth and survival are only considered for quoted companies; the authors estimate a sample selection model and correct for heteroscedasticity.	Smaller companies grow faster than larger ones, *Gibrat's Law* does not hold amongst smaller firms and age is negatively related to growth; the results are not an artefact of sample selection bias; the smallest companies face the highest exit rates, but together with the largest firms they are least vulnerable to take-over.
Lensink, van Steen and Sterken (2000)	This paper used data from an annual survey among a panel of Dutch firms; Data on 811 firms for years 1995 and 1999 are used for the estimates dealing with *Gibrat's Law*.	Separate multinomial logit regressions for investment, labour demand, and expected maturity are estimated for small firms with less than 50 employees and large firms with more than 50 employees in 1995; Lensink, van Steen and Sterken check whether firm growth (measured as the difference between the number of employees in 1999 and 1995) has a different shape for small and large firms.	In general, it is argued that there is no complete clear picture that emerges from the analysis of firm size; This finding is in line with *Gibrat's Law*: firm growth is independent of firm size.
Acs and Armington (2001)	Data for the entire population of U.S. businesses with employees included in the LEEM file (approximately 6 million establishments) over the 1994-1995 period are used to analyse the relationship of their growth rates to their firm size, establishment age and establishment size.	Observations on individual establishments are grouped into cells with other establishments that had similar characteristics (as in Dunne, Roberts and Samuelson, 1989); Then average gross and net job flows are calculated for each cell, based on the aggregate over all the establishments in each cell; These constructed cells are the observations on which the regression analysis is based; Finally, variations in gross and net job growth rates are estimated as log-linear functions of the age of establishments, the size of firms, and additionally, by the establishment size in multi-unit firms.	*Gibrat's Law* holds broadly only for existing firms with multiple establishments, after taking into consideration the effects of establishment size and age on their growth rates; The employment growth rates are negatively related to the size of establishments (individual business locations), whether they were single establishments/firms or units of multi-establishment firms; However, they are not significantly related to the size of the firms that own these establishments.

Table B Static analysis and version 2 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Delmar, Davidsson and Gartner (2002)	Using data for 11748 Swedish manufacturing and service firms in existence in 1996, the Authors analyse their growth for each year during the previous 10 years (1987 to 1996); From this population of firms a sample of 1501 high-growth firms is extracted according to multiple criteria; Growth is measured using 19 different indicators, including relative and absolute sales growth, relative and absolute employee growth, organic growth vs. acquisition growth, the regularity and volatility of growth rates over the 10-year period.	A four-step approach to cluster analysis is utilised for developing a taxonomy of growth patterns; The first step is the selection of 19 growth variables as a base for clustering; Then, the population of firms is divided into a try-out sample and a hold-out sample, with the latter used to validate the results from the former; The number of clusters is determined using hierarchical clustering with Ward's method and Euclidean distances; The third step is aimed at validating the most stable solution; For this purpose, the hold-out sample is used and a K-means clustering is performed using the centroids from the try-out sample as a base: A second cluster using hierarchical clustering with ward's method is then performed; By using the lambda statistics in comparing the first clustering to the second one, it is found that the highest stability is achieved with a seven-cluster solution, which is taken as optimal from both theoretical and empirical viewpoint; In the fourth step, the seven-cluster solution is extracted on the complete high-growth population of firms, and this in order to find a stable cluster solution and thereby securing its internal validity.	Seven growth patterns are identified, leading to contrasting results as far as *Gibrat's Law* is concerned; The most interesting results are found for the following clusters: Super absolute growers: SMEs in knowledge intensive manufacturing industries exhibit high absolute growth both in sales and employment; Steady sales growers: large firms in traditional manufacturing industries exhibit rapid growth in sales and negative employment growth; Super relative growers: SMEs in knowledge-intensive service industries are found to have a somewhat erratic development of both sales and employment; Erratic one-shot growers: SMEs in low-technology services exhibit on average negative size development, with exception of one single very strong-growth year.

Table C Static analysis and version 3

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Hart and Prais (1956)	Quoted companies in the UK at six years between 1885 and 1950; companies listed in the categories (Breweries and Distilleries, Commercial and Industrial and Iron, Coal and Steel) are added up.	Firms have been grouped into three approximately numerical equal classes, called small, medium and large; the distribution of growth rates (defined as final size divided by original size) of small, medium and large firms are compared for a 16-year period.	The distributions of growth rates for the three size classes are quite equal; *Gibrat's Law* tends to hold.
Simon and Bonini (1958)	500 largest US industrial corporations from 1954 to 1956; the sample of Hart and Prais (1956) is also used.	Firms have been grouped into three size classes, called small, medium and large; the distribution of growth rates are compared for the three groups; also a plot on a logarithmic scale of firm size at the beginning and the end of the time interval is drawn.	The distributions of growth rates for the three size classes are quite equal; the regression line in the plot has a slope of approximately 45^0 and the plot is homoscedastic; *Gibrat's Law* tends to hold.
Hymer and Pashigian (1962)	1000 largest US manufacturing firms of December 1946; growth rate is measured by the percentage change in the assets between 1946 and 1955.	In ten two-digit industries the firms were ranked by size into quartiles; The mean and standard deviation for the size classes are compared.	The mean growth rate is not related to the size of the firm while the standard deviation of the distribution of growth rates is inversely related to the size of the firm; *Gibrat's Law* tends to fail.
Mansfield (1962)	Almost all firms in three US manufacturing industries (Steel, Petroleum refining and Rubber tire) are observed; in each industry several periods of some 10 years between 1916 and 1957 are considered.	*Gibrat's Law* is tested in two ways; firstly by regressing the logarithm of size at the end of the period on the logarithm of size at the beginning of the period and secondly by testing the ratio of variances of growth rates of the largest firms and the smallest firms.	The regression analyses show that the results are quite consistent with *Gibrat's Law* in all 10 cases; the variances of growth rates are significantly lower for the largest firms than for the smallest firms in 6 out of 10 cases; this last result conflicts with *Gibrat's Law*.
Singh and Whittington (1975)	All quoted UK companies in some industries (Manufacturing, Construction, Distribution and Miscellaneous Services) which survived over the period 1948-1960 (1955 companies); the period 1948-1960 is divided into the subperiods 1948-1954 and 1954-1960.	*Gibrat's Law* is tested for all industries together and for 21 industries separately; the mean and the standard deviation of the growth rates are related to the size classes of the firms; for every industry a regression is carried out for the logarithms of size in 1960 on the logarithm of size in 1948.	The average growth rate of firms shows a weak positive relationship with size, while the standard deviation of growth rates declines with an increase in firm size; *Gibrat's Law* fails; regression results show that in 19 out of 21 industries the large firms grow faster; however the results are significant in only three industries.
Droucopoulos (1983)	Data for the world's largest industrial firms are collected for four time periods, 1957-1977, 1967-1972, 1972-1977 and 1967-1977; the numbers of observations are 152, 420, 551 and 396 for the periods of time respectively.	Growth rates are regressed on size and industry and country dummies; Second- and third-order results for the size variables are also given.	A weak negative relationship between growth and size is found for the bulk of the firms, although the period 1972-1977 suggests that growth is positively related to size; it seems that *Gibrat's Law* does not hold, but departures of the Law are modest and vary over time.

Table C Static analysis and version 3 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Buckley, Dunning and Pearce (1984)	Data for the world's largest firms, classified by (19) industry groups and nationality, in 1972 and 1977 are obtained; the sample consists of 636 and 866 firms in 1972 and 1977 respectively.	Growth rates and profitability are regressed on size, the degree of multinationality, quadratic terms of size and multinationality and industry and nationality dummies.	The relationship between firm growth and size is not (often) significant; *Gibrat's Law* tends to hold; however, growth rates differ significantly between nationalities and industry groups.
Hall (1987)	A sample of 1778 publicly traded manufacturing firms in the US is used; the period considered is 1972-1983; the firms cover ninety percent of the employment in the manufacturing sector in 1976 but only one percent of the firms; two subperiods 1973-1979 and 1976-1983 are considered.	Regression analysis is carried out for (employment) growth rates on size (measured by the logarithm of employment); Hall corrects for sample selection, measurement errors and heteroscedasticity and also tests for nonlinearity.	A negative relation between size and growth rates is found; the relation is almost the same for the smallest and the largest firms in the sample; *Gibrat's Law* fails; the variance of growth rates declines with size.
Bourlakis (1990)	Data on 633 corporations in the Greek manufacturing industries between 1966 and 1986 are used; 305 corporations survived over the twenty years; all limited liability and public limited corporations into twenty two-digit industries are registered.	Regression results for growth rates on size, age and other explanatory variables are obtained; the results are controlled for sample selection bias and heteroscedasticity; results are also reported separately for non-durable and durable consumers' goods and for capital goods markets.	Firm growth rates decline with age and size; *Gibrat's Law* is rejected; the effects of size and age on the growth equations are quite similar for three different types of markets.
Faggio and Konings (1999)	Firm level data from the Amadeus CD-ROM, a pan European financial database provided by Bureau van Dijk Electronic Publishing SA are available; The unbalanced panel data set contains information on 834 firms in Poland, 233 firms in Estonia, 511 firms in Slovenia and 1548 firms in Bulgaria over the period 1993-1997, and for 3776 firms in Romania between 1994 and 1997; Data on firm employment size are retrieved from company accounts published by Polish InfoCredit, Estonian Krediidiinfo AS, Intercredit Ljubljana, Creditreform Bulgaria and the Romanian Chamber of Commerce and Industry.	Faggio and Konings estimate five (one for each country) nested specifications of an employment growth model where the dependent variable is the firm annual employment growth at time t and the independent variable is the log firm size at time t–2; They further include a trade orientation dummy, two ownership dummies (foreign and state, the benchmark being "domestic private"), interactions variables between lagged firm size and ownership dummies, regional and time dummies; They follow Hamilton (1998) in using robust regression analysis to estimate the firm growth equation.	The underlying assumption is that a negative relationship between firm size and growth (implying that *Gibrat's Law* does not hold) might be interpreted as a test of initial restructuring of large enterprises, since transition requires the downsizing of large and inefficient state-owned enterprises; negative relationship between size and growth is found for all five countries, leading to a rejection of *Gibrat's Law*.

Table D Temporal analysis and version 2

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Mansfield (1962)	Almost all firms in three US manufacturing industries (Steel, Petroleum refining and Rubber tire) are observed; in each industry several periods of some 10 years between 1916 and 1957 are considered.	Mansfield analyses the amount of mobility in an industry i.e. the extent to which firms change their relative positions in the size distribution.	Tentative findings, based on only 10 observations, are reported; it is suggested however, that the amount of mobility in an industry depends significantly on its size and its market structure; *Gibrat's Law* seems to fail.
Contini and Revelli (1989)	Data for Italian manufacturing firms are used for the period 1980-1986; the period is divided in two subperiods, a recession period (1980-1983) and an expansion period (1983-1986); in both subperiods data for over 1000 firms are available.	Regression results for (3 year employment) growth rates on (3 year) lagged growth rates, on firm size and on firm age are obtained; for the period 1983-1986 also estimates for only large firms (more than 10 employees) are given; the problems of heteroscedasticity and sample selection bias are mentioned.	The authors argue that small firms (which form the largest part of the data) often have expansions and contractions, measured over periods of 3-4 years, in alternating sequence; this explains the negative relation between growth and lagged growth; when only larger firms are selected the lagged growth changes sign and becomes significantly larger than zero; overall the departures from *Gibrat's Law* are modest.
Wagner (1992)	Data for 7000 firms which formed the manufacturing sector of the German federal state Lower Saxony between 1978 and 1989 are used; in most industries only firms in which at least 20 persons are employed are included; results are given for various subperiods.	Chesher's (1979) method, regressing the deviation of the logarithm of the firm size from the mean of the logarithms of the firm sizes at year t (z_t) on the similar deviations one and two years before, is applied; like Chesher a first order auto-regressive process is assumed; results are reported for different periods of time and a distinction is made between firms producing basic products and firms producing consumer goods.	In 18 out of 20 regressions where no distinction in firm size has been made *Gibrat's Law* is rejected, although the (consistent) estimates for the coefficient in the regression of z_t on z_{t-1} is close to one in each of the 20 regressions; in general positive autocorrelation between growth rates is found; neither in the case of firms producing basic products nor in the case of firms producing consumer goods small firms grow systematically faster or slower compared to large firms, or vice versa.
Tschoegl (1996)	Data (employment size) on 66 Japanese regional banks over the 1954-1993 period are available.	A logarithmic model and a percentage growth model are estimated, each of which incorporates the possibility of serial correlation of growth rates in the equation.	The results suggest that *Gibrat's Law* does not hold, since larger Japanese regional banks tend to grow more slowly than smaller ones; Nevertheless, the magnitude of the deviation from one in the logarithmic specification is not large: the minimum estimate is 0.940 and the maximum 1.016; Controlling for sample selection was not necessary in this particular study because no Japanese regional bank has failed during the period of observation.

Table D Temporal analysis and version 2 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Harhoff, Stahl and Woywode (1998)	Data for 10902 German manufacturing firms extracted from the Creditreform Database are used for the 1989-1994 period; Size is measured in terms of employment.	Chesher's (1979) method, regressing the deviation of the logarithm of the firm size from the mean of the logarithms of the firm sizes at year t (z_t) on the similar deviations in the initial year and one year before is applied; like Chesher a first order autoregressive process is assumed; Log of size in the last year for which data are available is regressed on log of initial size for the entire period; The problems of sample selection bias (Heckman's (1979) method), heteroscedasticity and the persistence of growth are analysed.	Evidence against *Gibrat's Law* is found, and the marginal effect of firm size is negative for 93.8% of all observations in the sample; The effect of firm age is less pronounced: it si negative for 86.4% of the observations and only weakly significant for the majority of cases.
Hardwick and Adams (1999)	Two samples of UK life insurance companies extracted from the Synthesis Life Database are analysed; The first sample comprises of 210 firms operating in 1987 and surviving at least until 1991, whereas the second one comprised of 210 firms operating in 1992 and surviving at least until 1996; Size is measured in terms of total assets.	Chesher's (1979) method, regressing the deviation of the logarithm of the firm size from the mean of the logarithms of the firm sizes at year t (z_t) on the similar deviations one and two years before, is applied; like Chesher a first order auto-regressive process is assumed.	*Gibrat's Law* is rejected for the 1987-91 period, when smaller life insurance companies are found to grow faster than larger ones; Conversely, no significant difference between the growth rates of small and large firms is identified for the 1992-96 period; When firm-specific determinants of asset growth are analysed, no evidence is found that the growth of life insurance companies is inversely related to profitability.
Hart and Oulton (1999)	Data for 29000 UK independent firms divided into 12 size (employment) classes over the period 1989-1993.	Estimation of a Galton regression model in which Galtonian regression towards the geometric mean occurs when $\beta < 1$; A first group of estimations is run disaggregating the model to size classes, a second one disaggregating the model to ten SIC (1980) divisions.	Small companies grow more quickly than larger companies with more than eight employees, therefore leading to rejection of *Gibrat's Law*; The *within* size regressions show that the smallest size classes have the largest Galtonian regression towards the mean, which implies that the smaller companies created proportionately more jobs; Disaggregation of the Galton regression model to SIC divisions shows that in each SIC divisions (including "Distribution and hotels") the regression slope is below unity.

Table D Temporal analysis and version 2 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Fariñas and Moreno (2000)	Fariñas and Moreno used a sample of 1971 manufacturing firms drawn from the Encuesta sobre Estrategieas Empresariales (ESEE) carried by the Ministry of Industry in Spain; Average annual growth rates are considered over the period 1990-1995, for a total number of 6 861 observations on non-failing firms; Size is measured in terms of employment.	The empirical model examines how the mean growth rate varies across size and age of firms, controlling for industry and year categories.	Application of Wald statistics using robust variance estimates shows that size and age have significant effects on growth patterns, with the mean growth rates of non-failing firms which decrease with firm size and firm age; When coefficients are examined for a given size category, mean growth rates are decreasing with age although this relationship is less pronounced for the largest category of firms with more than 500 employees.
Machado and Mata (2000)	The data set includes all firms operating in 155 industries in Portuguese manufacturing in 1983 (18552 firms) and 1991 (26515 firms); Information comes from an inquiry conducted by the Portuguese Ministry of Employment and covers the whole range of firm sizes.	Machado and Mata use the Box-Cox quantile regression model to analyse the firm size distribution (FSD); In particular, the effect of selected industry attributes is estimated on the location, scale, skewness, and kurtosis of the conditional FSD; The model is estimated by Generalised Least Squares and a normality test is performed on the standardized estimated residuals.	Industry attributes are found to affect the size of firms in the same direction across the distribution, but their effects are much greater at the largest quintiles; Over time, the FSD shifts toward smaller firms, due to the way the economy responds to industry characteristics; Accordingly, the prediction of lognormality, implied by *Gibrat's Law*, is rejected by the observed distribution of firm sizes.
Heshmati (2001)	A sample of Swedish firms (5913) with a taxable turnover exceeding SEK 10,000 over the period 1993-1998 is considered; Size is measured in terms of employment, total assets and total sales.	Three distinct panel models are estimated for employment growth, assets growth and sales growth respectively; In estimation of each model; The estimation methods account for heterogeneity among firms not reflected in their age and size differences; In the estimation of the growth rate Heshmati controls for various factors characterizing the sample firms, their performance, human capital and local labour market conditions.	The relationship between firm size and firm growth is found to be negative in the employment model, while it is positive in the sales model, which implies the presence of scale effects when sales are considered; The size effect is instead not statistically significant in the assets model.

Table D Temporal analysis and version 2 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Vander Vennet (2001)	Data on the size of the aggregate banking sectors in 23 OECD countries over the 1985-1994 period are available; Two measures of size are employed: 1) the total asset volume of the aggregated banking sector, calculated for the broadest possible sample of credit institutions; 2) a measure of adjusted total asset (ATA) incorporating an estimate of off-balance-sheet activities.	Panel data estimates for the entire 1985-1994 period and the 1985-1989 and 1990-1994 sub-periods are conducted for each of the two measures of size; Chesher's (1979) method, regressing the deviation of the logarithm of the size of market from the mean of the logarithms of market sizes at year t (z_t) on the similar deviations in the previous year is applied; like Chesher a first order auto-regressive process is assumed.	It is found that the 1985-89 period was characterized by size convergence, implying that smaller bank sectors were expanding more rapidly; However, in the 1990-1994 period the pattern reversed to proportionate growth; From this evidence, Vander Vennet argues that the shift in the growth pattern of the bank markets is related to other determinants of their expansion, including the macroeconomic growth performance of the economy and the degree of operational efficiency of the banking sector.
Fotopoulos and Louri (2001)	Data on 2640 Greek manufacturing firms operating in both 1992 and 1997 are used; Information on employment, age and share of foreign ownership is available.	A non parametric kernel density estimation is performed; The data on the logarithm of firm size in 1997 are taken in deviation from their mean, so that the resulting variable has a zero mean; Besides, quantile regressions are performed at various quantiles.	Firm growth is not quite random, since both firm size and age have a definitely negative effect on growth, which is more important for the faster growing firms.
Del Monte and Papagni (2001)	A sample of 659 Italian manufacturing firms over the period 1989-1997 is considered; Size is measured in terms of total sales (deflated with the industry deflator of value added) and employment.	Distinct panel models are estimated for firms classified by sectors in Pavitt's (1984) sense and employment size class; A unit root test is employed based on the estimates carried out on the time series of each firm; The null hypothesis of unit root is $H_0: \beta_i = 0$ for all *i*; A test based on individual Lagrange multiplier (introduced by Im, Pesaran and Shin, 1995) is employed on a sub-sample of firms relative to sales.	Test of *Gibrat's Law* performed by applying a panel unit root test confirms the hypothesis put forward by Gibrat on the stochastic features of the rate of growth of firms.

Table E Temporal analysis and version 3

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Hart and Prais (1956)	Quoted companies in the UK at six years between 1885 and 1950; companies listed in the categories (Breweries and Distilleries, Commercial and Industrial and Iron, Coal and Steel) are added up.	The mobility of firms is considered for five periods of time; for the firms the consecutive ranks in the distributions and the deviations of the firm size from the mean size in the period are analysed; the birth of new firms, the exits of firms and the changes in size distributions of incumbents are looked after separately.	In any period of time business units that cease to exist are smaller, by about a half than the average size of units alive at the beginning of the period; *Gibrat's Law* holds for the period from 1885 till 1939; in the period from 1939 till 1950 the smaller companies grow much faster than the larger ones; *Gibrat's Law* fails for the last period.
Singh and Whittington (1975)	All quoted UK companies in some industries (Manufacturing, Construction, Distribution and Miscellaneous Services) which survived over the period 1948-1960 (1955 companies); the period 1948-1960 is divided into the sub-periods 1948-1954 and 1954-1960.	The growth rates in the period 1954-1960 are regressed on the growth rates in the period 1948-1954; the "opening" size is also added as an explanatory variable to the regression analysis.	There is a significant tendency that firms which have an above (or below) average growth rate over the first 6-year period also have an above (or below) average growth rate in the subsequent 6-year period; so *Gibrat's Law* fails; the values of R^2 are uniformly low (about 0,05) for the different industries.
Chesher (1979)	A sample of 183 quoted companies in the UK that are classified as "Commercial and Industrial" is used; only companies that are in existence in 1960 and in 1969 are included; in each year of the period 1960-1969 data are available.	Regression analysis is proposed for the deviation of the logarithm of the firm size from the mean of the logarithms of the firm sizes at year t on the similar deviation one year before; Chesher assumes a first order autoregressive process in the disturbances to get consistent estimates for the regression coefficient.	The estimation of the regression coefficient is close to unity (which is consistent with *Gibrat's Law*), but the first order autoregressive correlation coefficient is quite large and positive; For the various years the hypothesis that the regression coefficient is equal to one *and* the first order autoregressive coefficient is equal to zero is rejected; *Gibrat's Law* is not valid.
Kumar (1985)	Over 2000 quoted companies for the UK over the period 1960-1976 are used; five sub-samples for different periods are available; internal growth rates and acquisition growth rates are distinguished; five different size measures are used.	Five year growth rates are regressed on growth rates in the period five years before and on the (initial) firm size; three different assets growth rates are used; negligible heteroscedasticity was found, so no correction was made; regression results for acquisition growth rates on past acquisition growth rates and (initial) size are also obtained.	There was some persistency in firm growth rates over time, but is was weaker than in Singh and Whittington (1975); R^2_{adj} is about 0.02; there was a mild tendency for firm growth to be negatively related to size; *Gibrat's Law* is not valid; the results are quite robust for the use of different growth measures and time periods.
Amirkhalkhali and Mukhopadhyay (1993)	The data set consists of 231 firms, chosen from the Fortune list of the largest firms in the US, who maintain their identity over the 1965-1987 period; the sample is broken down into four sub-periods.	Growth rates are regressed on growth rates in the preceding period and on the (initial) firm size; a dummy variable for (76) R&D-intensive and (155) non-R&D-intensive firms is used; the authors mention the problem of sample selection.	The results suggest that *Gibrat's Law* does not hold; the autocorrelation between growth rates appears to be positive; moreover a weak negative relationship between firm size and growth is found.

Table E Temporal analysis and version 3 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Amaral, Buldyrev, Havlin, Leschhorn, Maass, Salinger, Stanley and Stanley (1997)	The Compustat database is used for analysis of all US manufacturing publicly-traded firms (with SIC code from 2000 to 3999) during the 1974-1993 period.	Standard and separate panel tests of *Gibrat's Law* are conducted, based on regression of log growth on initial log firm size; Tests include a set of time dummy variables, to control for macro-economic or other influences on growth common to all firms and specific to each time period, and a full set of interaction dummies between sectors and time periods, to control for sector-specific shocks in each time-period; Monte Carlo methods are used to investigate the sampling distributions and power functions of the tests.	The results, besides pointing to a limitation of the cross-sectional test - which suffers of a loss of power and therefore has difficulty in rejecting *Gibrat's Law* - support the hypothesis that log firm size are mean-reverting (with the tendency towards mean-reversion that is stronger during periods of sluggish economic growth than when growth is high), possibly towards heterogeneous individual firm effects; Accordingly, *Gibrat's Law* is rejected.
Geroski, Lazarova, Urga and Walters (2000)	Data on real total net assets for a sample of 147 large, quoted UK firms over the 1955-1985 period are used; These firms represent a balanced sub-sample of the DTI-Meeks-Whittington data set.	Geroski *et al*. test the hypothesis that firms converge towards a common long run size by applying the standard logarithmic model to each firm taken in turn; To check whether the individual time series are integrated, they examine the null hypothesis of non-stationarity by using Dickey-Fuller (DF) tests augmented with one lagged dependent variable, with and without deterministic trends; Since the DF tests are likely to suffer from small sample problems, Geroski *et al*. then use the tests proposed by Im, Pesaran and Shin (1995) and by Maddala and Wu (1999) to overcome this problem.	The results suggest that the growth rates of firms who survive long enough to record 30 years of history are random; Besides, firm size displays no tendency to converge to either a common, steady state optimum firm size or to a set of stable size differences between firms.
Pfaffermayr and Bellak (2000)	Corporate level data for 700 large, both domestic and foreign-owned firms in Austrian manufacturing over the period 1996-1999 are available.	Standard estimate of *Gibrat's Law* is conducted, based on regression of log growth on initial log firm size; Accordingly, *Gibrat's Law* cannot be rejected.	Firms' growth turns out to be mainly randomly determined and idiosyncratic with systematic influence being of minor importance.

Table E Temporal analysis and version 3 (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Bottazzi, Dosi, Lippi, Pammolli and Riccaboni (2001)	The data set consists of 443 manufacturing firms quoted on the First or Second Divisions of the Japanese Stock Exchange, for which continuous annual data on total assets are available for the period 1980-1996; The firms are classified in thirteen broad industrial sectors.	Standard and separate panel tests of *Gibrat's Law* are conducted, based on regression of log growth on initial log firm size; Tests include a set of time dummy variables, to control for macro-economic or other influences on growth common to all firms and specific to each time period, and a full set of interaction dummies between sectors and time periods, to control for sector-specific shocks in each time-period. Monte Carlo methods are used to investigate the sampling distributions and power functions of the test.	The results, besides pointing to a limitation of the cross-sectional test - which suffers of a loss of power and therefore has difficulty in rejecting *Gibrat's Law* - support the hypothesis that log firm size are mean-reverting (with the tendency towards mean-reversion that is stronger during periods of sluggish economic growth than when growth is high), possibly towards heterogeneous individual firm effects; Accordingly, *Gibrat's Law* is rejected.
Goddard, Wilson and Blandon (2002)	The data set consists of 443 manufacturing firms quoted on the First or Second Divisions of the Japanese Stock Exchange, for which continuous annual data on total assets are available for the period 1980-1996; The firms are classified in thirteen broad industrial sectors.	Standard and separate panel tests of *Gibrat's Law* are conducted, based on regression of log growth on initial log firm size; Tests include a set of time dummy variables, to control for macro-economic or other influences on growth common to all firms and specific to each time period, and a full set of interaction dummies between sectors and time periods, to control for sector-specific shocks in each time-period; Monte Carlo methods are used to investigate the sampling distributions and power functions of the tests.	The results, besides pointing to a limitation of the cross-sectional test - which suffers of a loss of power and therefore has difficulty in rejecting *Gibrat's Law* - support the hypothesis that log firm size are mean-reverting (with the tendency towards mean-reversion that is stronger during periods of sluggish economic growth than when growth is high), possibly towards heterogeneous individual firm effects; Accordingly, *Gibrat's Law* is rejected.

Table F The post-entry performance of new firms

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Dunne, Roberts and Samuelson (1988)	The data set covers firms producing in each four-digit manufacturing industry in the US in the years 1963, 1967, 1972, 1977 and 1982; there are approximately 265,000 firms present in each of the first three years and 295,000 in the last two years; information is available on different types of entrants, the entry and exits over time and the post entry performance of the entrants.	Results for market shares, relative average size of surviving firms and cumulative failure rates for each entry cohort in each year are presented; means and standard deviations across 387 four-digit industries are given; the results are also disaggregated for three types of entrants, (1) new firms, new plant, (2) diversifying firm, new plant and (3) diversifying firm, product mix.	The market share of each cohort declines, on average in each census year following entry; the relative size of each cohort's surviving firms increases as the cohort ages; the cumulative failure rates increases at diminishing rates over time for each cohort; diversifying firms entering with new plants have the largest relative size of the three types of entrants, and the lowest exit rates.
Dunne, Roberts and Samuelson (1989)	The sample of data contains US manufacturing plants that entered in 1967, 1972 or 1977; in order to minimize the effects of potential measurement error only firms that have at least five employees in at least one year are included; this results in a total of 219,754 different plants and in a total of 326,936 plant/year observations because of the multiple time periods.	Plant (employment) growth rates and failure rates are regressed on dummies for age categories and size classes; regressions for mean growth rates and variance of growth rates are carried out for successful plants and for all plants; separate results are given for single-unit and multi-unit plants.	Failure rates are lower for older plants, regardless of ownership type, and for larger plants, particularly those owned by multi-plant firms; mean growth rates of successful plants and variance of growth rate of successful plants decline with firm size and age for both single unit and multi-unit plants; for single-plant and multi-plant firms *Gibrat's Law* is rejected in the case of including only successful plants as well as in the case of including all plants.
Phillips and Kirchhoff (1989)	The database covers approximately 93 per-cent of full time business activity in the US for the period 1976-1986; the "new firms", defined as single, new establishment firms with 500 or fewer employees, are selected.	Survival rates and growth rates are reported for different periods of time; results are differentiated for nine sectors such as manufacturing and retail trade; survival and growth are also differentiated by age.	On average 39.8 per-cent of new firms survive six or more years; the survival rates however more than double for firms that grow; the proportion of firms that grow increases with age; the opportunities for growth varies substantially from industry to industry.
Audretsch and Mahmood (1994)	The post-entry performances of approximately 11,300 manufacturing new firms started in the US in 1976 are observed bi-annually throughout the subsequent ten-year period; it is known if a start-up is a single-plant firm or a multi-plant firm.	The mean firm growth rates and failure rates are given over time; the results are also presented for 19 manufacturing sectors; regression of new firm (employment) growth and survival rates are carried out for different time periods; the explanatory variables used are, firm size, innovative activity, scale economies, capital intensity, industry growth and a dummy for multi-plant firms.	Firm growth is found to be (significantly) negatively influenced, by firm size over all periods of time; firm growth is found to be positively related to the innovative activity, the extent of scale economies, the capital intensity, the industry growth and the multi-plant dummy; the survival rates are positively affected by firm size, industry growth, capital intensity and negatively affected by the extent of scale economies and the multi-plant dummy.

Table F The post-entry performance of new firms (continued)

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Mata (1994)	Data for 3308 Portuguese manufacturing firms that entered in 1983 are available; firms are followed during five consecutive years.	For each of the years in the period 1984-1987 a growth and survival equation is estimated; (employment) growth rates and firm survival are assumed to depend on (employment) size in the preceding year; Mata discusses both the problems of sample selection and heteroscedasticity.	Survival increases with (start-up) firm size, but a great proportion of new firms disappear in the first years subsequent to their birth; survivors, however, grow quite fast and small firms grow faster than their larger counter-parts; *Gibrat's Law* fails.
Wagner (1994)	Data for 10743 manufacturing firms established in Lower Saxony, the second largest of the 'old' federal states of Germany, are used for the period 1978-1990; single establishment new firms with a start-up size of less than 50 employees are focused.	Survival and growth of new firms is analysed; a probit model is used to explain firm survival; exogenous variables are start-up size and four industry variables, like concentration, capital intensity, R&D-intensity and the average rate of (employment) growth; for surviving entrants the heterogeneity of growth patterns and the persistence of growth are analysed.	Entrants face a high risk of failure, hazard rates tend to increase during the first years and to decrease afterwards; firm survival is neither clearly related to start-up size nor to any of the industry variables; moreover, the actual annual growth of each new small firm seems to be determined by random sampling from the same distribution of growth possibilities; *Gibrat's Law* tends to hold.
Reid (1995)	Data for 73 less than three-year old micro-firms (with fewer than ten employees) in Scotland for the period 1985-1988 are available; The sample comprises private companies (50%), partnerships (20%), and sole proprietorships (30%).	A simultaneous equations model of growth and profitability is estimated.	*Gibrat's Law* is rejected, with smaller among new Small Business Enterprises (SBEs) growing faster than larger new SBEs; *Gibrat's Law* is rejected in favour of an alternative (managerial) hypothesis put forward in the paper which implies a growth/profitability trade-off.
Santarelli (1997)	Data for 11660 Italian start-ups in the hospitality sector for the period 1989-94 are available	Chesher 's (1979) method, regressing the deviation of the logarithm of the firm size from the mean of the logarithms of the firm sizes at year t (z_t) on the similar deviations in the initial year is applied; like Chesher a first order auto-regressive process is assumed; Twenty groups of region-level equations are estimated.	*Gibrat's Law* cannot be rejected in the case of fourteen out of twenty Italian regions, with the estimated parameters not significally different from one.

Table F The post-entry performance of new firms (continued_

Authors (year of publication)	*Data characteristics*	*Research methods*	*Major findings*
Audretsch, Santarelli and Vivarelli (1999)	Data for 1570 Italian manufacturing (13 industries) firms that entered in 1987 are available; firms are followed during six consecutive years.	Survival rates and growth rates are reported; Logit and tobit equations are estimated, in which firm survival is assumed to depend on (employment) size in the initial year; Chesher's (1979) method, regressing the deviation of the logarithm of the firm size from the mean of the logarithms of the firm sizes at year t (z_t) on the similar deviations in the initial year is applied; like Chesher a first order auto-regressive process is assumed; For the entire 1987-1993 period two groups of industry level equations are estimated: one for all firms and one for surviving firms only.	The likelihood of survival does not increase with (start-up) firm size; *Gibrat's Law* is rejected in 9 out of 13 cases in the estimations carried out for all firms, whereas in 11 out of 12 in those for surviving firms only.
Almus and Nerlinger (2000)	Data for W. German start-ups in manufacturing (both non-technology and technology intensive branches) for the period 1989-96 (sub-divided into five sub-periods: 1990-92: 784 firms; 1991-93: 1420; 1992-94: 2831; 1993-95: 3495; 1994-96: 4278) and three size classes (less than 5 employers; between 6 and 19; more than 19).	Kernel density estimations (with bandwidth parameter 2, so that to calculate the density all employment observations within the interval of the size of two employees around the number of employees chosen are included) to test whether the approx. log-normal distribution of firm size holds also for young firms.	Almus and Nerlinger find that *Gibrat's Law* is rejected in all cases with the estimated parameters smaller than one; in addition, the deviation from *Gibrat's Law* is found to decrease with increasing firm size.
Lotti, Santarelli and Vivarelli (2001)	Data for 214 Italian instruments industry firms that entered in 1987 are available; firms are followed during six consecutive years.	Chesher's (1979) method, regressing the deviation of the logarithm of the firm size from the mean of the logarithms of the firm sizes at year t (z_t) on the similar deviations in the initial year and one year before is applied; like Chesher a first order auto-regressive process is assumed; Log of size in the last year for which data are available is regressed on log of initial size for the entire period; Besides, log of size in each year is regressed on log of size in previous year; Each estimate is conducted for all firms, firms with an initial size comprised between 1 and 5 employees, firms with an initial size above 5 employees; The problems of sample selection bias (Heckman's (1979) method), heteroscedasticity and the persistence of growth are analyzed.	*Gibrat's Law* fails to hold during the first year following start-up - when smaller entrants grow faster than their larger counterparts - whereas it becomes valid once a minimum threshold in terms of size and age has been reached; Thus, smaller ones among new-born firms, having entered with a marked sub-optimal scale, adjust their size towards the mean size exhibited by larger entrants.

Table G Empirical studies on firm growth rates

Study	*Type*	*Country*	*Period*	*Ind*	*GL*	*Size*	*Age*	*Lag-Grow*	*Eclss*
Mansfield (1962)	A	USA	1916-1957	M	M	na	na	na	
Acs and Audretsch (1990)	A	USA	1976-1980	M	M	na	na	na	
Fariñas and Moreno (2000)	A	Spain	1990-1995	M	A	0	0	na	s; het
Mansfield (1962)	B	USA	1916-1957	M	M	na	na	na	
Evans (1987a)	B	USA	1976-1982	M	R	–	–	na	ss; het
Evans (1987b)	B	USA	1976-1980	M	R	–	–	na	ss; het
Contini and Revelli (1989)	B	Italy	1980-1986	M	R	–	–/0	na	het
FitzRoy and Kraft (1991)	B	Germany	1977-1979	M	R	–	–	na	het
Variyam and Kraybill (1992)	B	USA	1985-1990	M/S	R	–	–	na	het
Bianco and Sestito (1993)	B	Italy	1985-1990	M/S	R	–	–	na	ss; het; mea
Dunne and Hughes (1994)	B	UK	1975-1985	M/S	R	–	–	na	ss; het
Lensink, van Steen and Sterken (2000)	B	Netherlands	1995 and 1999	M/S	A	0	–	na	
Acs and Armington (2001)	B	USA	1994-1995	M/S	M	-/0	–	na	
Delmar, Davidsson and Gartner(2002)	B	Sweden	1987-1996	M/S	M	0	na	na	
Hart and Prais (1956)	C	UK	1885-1950	M	A	na	na	na	
Simon and Bonini (1958)	C	USA	1954-1956	M	A	na	na	na	
Hymer and Pashigian (1962)	C	USA	1946-1955	M	M	na	na	na	
Mansfield (1962)	C	USA	1916-1957	M	M	na	na	na	
Singh and Whittington (1975)	C	UK	1948-1960	M/S	M	+	na	na	
Droucopoulos (1983)	C	World	1957-1977	M	M	–	na	na	
Buckley, Dunning and Pearce (1984)	C	World	1972-1977	M	A	0	na	na	
Hall (1987)	C	USA	1972-1983	M	R	–	na	na	ss; het; mea
Bourlakis (1990)	C	Greece	1966-1986	M	R	–	–	na	ss; het
Faggio and Konings (1999)	C	5 transition countries	1993/94-19944	M/S	R	-	na	na	
Mansfield (1962)	D	USA	1916-1957	M	R	na	na	na	
Contini and Revelli (1989)	D	Italy	1980-1986	M	R	-	–	+/–	ss; het
Wagner (1992)	D	Germany	1978-1989	M	R	na	na	+	
Tschoegl (1996)	D	Japan	1954-1993	S	R	–	na	+	het
Harhoff, Stahl and Woywode (1998)	D	Germany	1989-1994	M	R	–	–/0	Na	ss; het
Hardwick and Adams (1999)	D	UK	1987-91 and 1992-96	S	M	–/0	na	Na	ss; het; mea
Hart and Oulton (1999)	D	UK	1989-1993	M/S	R	–	na	na	het

Table G Empirical studies on firm growth rates (continued)

Study	*Type*	*Country*	*Period*	*Ind*	*GL*	*Size*	*Age*	*Lag-Grow*	*Eclss*
Fariñas and Moreno (2000)	D	Spain	1990-1995	M	R	–	–	na	ss; het
Machado and Mata (2000)	D	Portugal	1983 and 1991	M	R	–	na	na	het
Heshmati (2001)	D	Sweden	1993-1998	M/S	M	–	–	na	het; mea
Van der Vennet (2001)	D	OECD area	1985-1994	S	M	–/0			
Fotopoulos and Louri (2001)	D	Greece	1992-1997	M	R	–	–	na	het
Del Monte and Papagni (2001)	D	Italy	1989-1997	M	A	0	–	+	purt
Hart and Prais (1956)	E	UK	1885-1950	M	M	na	na	na	
Singh and Whittington (1975)	E	UK	1948-1960	M/S	R	0	na	+	
Chesher (1979)	E	UK	1960-1969	M	R	0	na	+	
Kumar (1985)	E	UK	1960-1976	M/S	R	–	na	+	
Amirkhalkhali and Mukhopadhyay (1993)	E	USA	1965-1987	M	R	–	na	+	
Amaral *et al.* (1997)	E	USA	1974-1993	M	R	–	na	na	
Geroski, Lazarova, Urga , Walters (2000)	E	UK	1955-1985	M/S	A	0	na	na	purt
Pfaffermayr and Bellak (2000)	E	Austria	1996-1999	M/S	A	0	na	na	
Bottazzi *et al.* (2001)	E	World	1987-1997	M	A	0	na	+	ss; het
Goddard, Wilson and Blandon (2002)	E	Japan	1980-1996	M	R	–	na	na	purt
Dunne, Roberts and Samuelson (1988)	F	USA	1963-1982	M	na	na	na	na	
Dunne, Roberts and Samuelson (1989)	F	USA	1967-1982	M	R	–	–	na	
Phillips and Kirchhoff (1989)	F	USA	1976-1986	M/S	na	na	na	na	
Audretsch and Mahmood (1994)	F	USA	1976-1986	M	R	–	na	na	
Mata (1994)	F	Portugal	1983-1987	M	R	–	na	na	
Wagner (1994a)	F	Germany	1978-1990	M	A	0	na	na	
Reid (1995)	F	UK	1985-1988	M	R	–	–	na	het
Santarelli (1997)	F	Italy	1989-1994	S	M	0/-	na	na	het
Audretsch, Santarelli and Vivarelli (1999)	F	Italy	1987-1993	M	M	-/0	na	na	het
Almus and Nerlinger (2000)	F	W. Germany	1989-1996	M	R	–	na	na	het
Lotti, Santarelli and Vivarelli (2001)	F	Italy	1987-1993	M	M	-/0	0	na	ss; het

Type (of empirical growth study)
A : Static analysis and version 1
B : Static analysis and version 2
C : Static analysis and version 3
D : Temporal analysis and version 2
E : Temporal analysis and version 3
F : The post-entry performance of new firms

Ind(ustry)
M : Manufacturing;
S : Services
G(ibrat's)L(aw)
A : Accepted
R : Rejected
M : Mixed Results

Size, Age and Lag(ged) Grow(th)
- : negative effect on growth
0 : no effect on growth
+ : positive effect on growth
na : not available

Ec(onometric)lss(ues)
ss : corrected for sample selection
het : corrected for heteroscedasticity
mea : corrected for measurement error
purt : panel unit root tests

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