# GIBRAT'S LAW: ARE THE SERVICES DIFFERENT?

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# Gibrat's Law: Are the Services Different?

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# 1. Introduction

In his exhaustive survey in the Journal of Economic Literature, John Sutton (1997, p. 40) recently 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 Sutton (1997), Caves (1998) and Geroski (1995) 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), Caves (1998) and Sutton (1997) 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.

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 services. Systematic differences in the size-growth relationship between services and manufacturing may reflect underlying structural differences shaping the dynamics of industrial organisation in 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

[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."

in manufacturing. The comprehensive longitudinal data base 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, the empirical evidence indicates that, in contrast to manufacturing, *Gibrat's Law* unambiguously holds for services. 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). Sutton (1997), Caves (1998) and Geroski (1995) 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, both he and Sutton (1997) are quick to point out that, in fact, not every study rejects *Gibrat's Law*. 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. 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." Just as the earlier studies based solely on large manufacturing industries typically found support for *Gibrat's Law* (Hart and Prais, 1956), so have the most recent studies (Geroski and Machin, 1993). By contrast, those studies, both pioneering (Samuels, 1965; and Prais, 1976) and more recent (Evans, 1987a and 1987b, Hall, 1987; and Dunne, Roberts and Samuelson, 1988 and 1989), including small firms in the sample typically concluded that growth rates tend to be negatively related to the size of (surviving) firms. Lotti, Santarelli and Vivarelli (1999) show that Gibrat's Law fails to hold for Italian manufacturing firms in the year immediately after start-up. Thus, 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 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).

As Sutton (1997) makes clear, the ambiguity created by different results for different samples becomes resolved when the empirical evidence is weighed through these three different lenses. *Gibrat's Law* holds under the third version but not under the first two.

## 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 distributed 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 existence, 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 divergences 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 greater 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. While large chains and franchising may be more characteristic of the United States, the Dutch hospitality sector consists largely of family-owned and independent businesses. 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.

## 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.[3]

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.

***Table 1 about here***

## 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.

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

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 can not 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*.[4] Parts A, B, and C deal with the static analyses, while parts D and E cover the studies focusing on the persistence of growth.[5] 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.[6] 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 $\chi^2$ statistic.[7]

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. 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).

***Table 2 about here***

## 5.2. Persistence of Growth

In this section the other main methodology used to *Gibrat's Law* is used to test the hypothesis that firm growth is independent of size.[8] As developed by Chesher (1979),

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

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).

If *Gibrat's Law* is valid and firm growth rates are distributed independently of firm size, the parameter $\beta$ should be equal to unity.[9] If $\beta \leq 1$ large firms are expected to grow more slowly than their smaller counterparts; if $\beta \geq 1$ 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

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

[5] 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.

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

[7] 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.

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

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

period.[10] Thus, *Gibrat's Law* can be rejected even when the parameter $\beta$ is (about) equal to one.[11] 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 $z_{t,i}$, $z_{t-1,i}$, 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 $\beta$ and $\rho$. *Gibrat's Law* is considered to be valid if the joint hypotheses $(\beta\ \rho) = (1\ 0)$ is accepted. Assuming that the estimators of $\beta$ and $\rho$ are asymptotically normally distributed, the test-statistic for the joint hypothesis is (asymptotically) chi-squared distributed with two degrees of freedom.[12]

The estimation results for equation (3) are shown in Table 3.[13] 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 ($\rho$) are positive and statistically different from zero, while $\beta$ is close to unity. For the results in Table 3 only negligible or very modest autocorrelation coefficients are found.[14]

***Table 3 about here***

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 $\beta$ 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.[15] For 1990 the second order autoregressive coefficient $\rho_2$ differs significantly from zero for cafeterias, cafes and hotels. In all three business groups the coefficient of $\rho_2$ 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

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

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

[12] See Malinvaud (1980).

[13] 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.

[14] 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.

[15] 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.

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.[16]

## 6. Conclusions

In the most influential surveys about the intra-industry dynamics of firms, Sutton (1997), Caves (1998) and Geroski (1995) examine what has by now become a large literature and independently conclude that the empirical evidence does not support *Gibrat's Law*. While neither Geroski nor Sutton qualify their conclusions, it is important to note that they are based almost exclusively upon evidence from manufacturing. The results of this paper do not find that small firms tend to have systematically higher growth rates than their larger counterparts. What Geroski (1995) concludes is a Stylised Result for manufacturing does not appear to hold for services. The evidence in this paper clearly suggests that, for the Dutch services, *Gibrat's Law* is generally valid. The only 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. By contrast, we find that *Gibrat's Law* holds for not just large firms, but also for the other two main types of samples that have been tested in the literature – all firms (including exiting enterprises) and surviving firms.

This discrepancy in the validity of *Gibrat's Law* between manufacturing and services suggests that the structure of 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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[16] 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 $\beta$ are still statistically equal to one. This implies that there is no relationship between firm size and growth rates. For restaurants the autocorrelation coefficients ($\rho$) 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.

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

| Business Group | Version 1[1] | | | Version 2[2] | | | Version 3[3] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Growth[4] | Size[5] | N[6] | Growth[4] | Size[5] | N[6] | Growth[4] | Size[5] | N[6] |
| Restaurants | 4.10 | 2219.70 | 213 | 17.48 | 2392.09 | 172 | 18.89 | 3440.93 | 116 |
| Cafeterias | 8.56 | 616.41 | 124 | 37.95 | 695.34 | 102 | 26.34 | 1653.58 | 34 |
| Cafes | 1.09 | 296.24 | 305 | 21.30 | 309.98 | 223 | 11.88 | 996.15 | 34 |
| Hotels | 10.19 | 4221.89 | 241 | 21.44 | 4351.79 | 206 | 9.70 | 11718.92 | 52 |
| Camping Sites | 25.72 | 805.31 | 103 | 36.05 | 810.22 | 91 | 34.18 | 1874.09 | 23 |
| Entire Hospitality Sector[7] | 12.20 | 1848.93 | 1170 | 27.22 | 2013.08 | 944 | 20.83 | 4544.76 | 291 |

1 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.

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

3 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.

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

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

6 N stands for the number of observations.

7 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.

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

| Chi-Square Value<br>Degrees of Freedom<br>Level of Significance | | | |
|---|---|---|---|
| Business Group | Version 1[1] | Version 2[2] | Version 3[3] |
| 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 |
| | 0.031 | 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 |

1 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.

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

3 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.

**Table 3 Empirical results for equation (3):**

$$z_{t,i} = (\beta+\rho)z_{t-1,i} + (-\beta\rho)z_{t-2,i} + v_{t,i}, \quad t = 1989, 1990 \text{ or } 1991$$

| Business Group | | Dependent variable $z_{91}$ | $z_{90}$ | $z_{89}$ |
|---|---|---|---|---|
| Restaurants | $\beta$ | 1.0203* | 1.0105 | 0.9838* |
| | | (0.0098)[2] | (0.0067) | (0.0073) |
| | $\rho$ | – 0.0519 | – 0.0869 | 0.1419* |
| | | (0.1111) | (0.0864) | (0.0565) |
| | $\chi^2$ [1] | 4.117 | 3.739 | 10.334** |
| Cafeterias | $\beta$ | 1.0135 | 1.0172 | 0.9492** |
| | | (0.0169) | (0.0136) | (0.0145) |
| | $\rho$ | 0.0672 | 0.0454 | 0.0925 |
| | | (0.1303) | (0.0895) | (0.0588) |
| | $\chi^2$ | 1.151 | 1.755 | 15.108** |
| Cafes | $\beta$ | 0.9986 | 1.0035 | 0.9870 |
| | | (0.0134) | (0.0122) | (0.0176) |
| | $\rho$ | 0.0838 | – 0.1317* | 0.1652* |
| | | (0.0617) | (0.0648) | (0.0776) |
| | $\chi^2$ | 1.869 | 4.098 | 4.791 |
| Hotels | $\beta$ | 0.9653** | 0.9986 | 0.9954 |
| | | (0.0104) | (0.0067) | (0.0089) |
| | $\rho$ | 0.1935* | – 0.0811 | 0.1564* |
| | | (0.0782) | (0.0670) | (0.0622) |
| | $\chi^2$ | 18.271** | 1.552 | 6.450* |
| Camping Sites | $\beta$ | 0.9976 | 1.0150 | 0.9833 |
| | | (0.0146) | (0.0131) | (0.0127) |
| | $\rho$ | 0.0061 | – 0.2009 | – 0.1342 |
| | | (0.0985) | (0.1116) | (0.1125) |
| | $\chi^2$ | 0.020 | 4.616 | 3.344 |
| Entire Hospitality Sector | $\beta$ | 0.9954 | 1.0018 | 0.9964 |
| | | (0.0039) | (0.0032) | (0.0038) |
| | $\rho$ | 0.0697* | – 0.1009* | 0.0975** |
| | | (0.0337) | (0.0335) | (0.0300) |
| | $\chi^2$ | 5.224 | 9.152* | 11.089** |

[1] In equation (3) *Gibrat's Law* holds when the joint hypothesis ($\beta$ $\rho$) = (1 0) is accepted. The test-statistic for this joint hypothesis is (asymptotically) $\chi$2-distributed with two degrees of freedom.

[2] 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.

## Appendix A Empirical studies testing *Gibrat's Law*: A review of important results

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 (1987b); incorporating the impact of exits tends to produce more support for *Gibrat's Law* than otherwise would be found. |

## 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 underrepresented. | 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. |

*(continued on the next page)*

*(Table B continued)*

| Authors (year of publication) | Data characteristics | Research methods | Major findings |
|---|---|---|---|
| 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. |
| 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). |

*(continued on the next page)*

*(Table B continued)*

| Authors (year of publication) | Data characteristics | Research methods | Major findings |
|---|---|---|---|
| Bianco and Sestito (1993) | A sample of 288,000 firms covering the entire private sector in Italy for the period 1985-1990 is used; for computational feasibility a sub-sample of 1 over 10 firms is used in the estimation procedures. | The authors use (almost) the same growth and survival equations like Evans (1987b) did; they discuss econometric issues like the functional form to be chosen, sample selection, heteroscedasticity and measurement error. | *Gibrat's Law* is rejected in favour of Jovanovic's theory of learning; negative relationships between growth and size and growth and age are found; the correction for sample selection hardly changes the estimates; *Gibrat's Law* is accepted for firms employing more than 45 people. |
| 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 under-represented. | 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. |

## 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.* |

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*(Table C continued)*

| Authors (year of publication) | Data characteristics | Research methods | Major findings |
|---|---|---|---|
| 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. |
| 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. |

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*(Table C continued)*

| Authors (year of publication) | Data characteristics | Research methods | Major findings |
|---|---|---|---|
| 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. |

## 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 autoregressive 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. |

## 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 subperiods 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. |

*(continued on the next page)*

*(Table E continued)*

| Authors (year of publication) | Data characteristics | Research methods | Major findings |
|---|---|---|---|
| Kumar (1985) | Over 2000 quoted companies for the UK over the period 1960-1976 are used; five subsamples 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 subperiods. | 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 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 (1989b) | The sample of data contains US manufacturing plants that entered in 1967, 1972 or 1977; in order to minimise 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 multiplant 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 multiplant 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 data base covers approximately 93 percent 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 percent 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. |

*(continued on the next page)*

*(Table F continued)*

| Authors (year of publication) | Data characteristics | Research methods | Major findings |
|---|---|---|---|
| Audretsch and Mahmood (1994) | The post-entry performances of approximately 11,300 manufacturing new firms started in the US in 1976 are observed biannually 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. |
| 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 counterparts; *Gibrat's Law* fails. |
| Wagner (1994a) | 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. |

## Table G Empirical studies on firm growth rates

| Study | Type | Country | Period | Ind | GL | Size | Age | LagGrow | EcIss |
|---|---|---|---|---|---|---|---|---|---|
| Mansfield (1962) | A | USA | 1916-1957 | M | M | na | na | na | |
| Acs and Audretsch (1990) | A | USA | 1976-1980 | M | M | na | na | na | |
| 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 |
| 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 |

*(continued on the next page)*

*(Table G continued)*

| Study | Type | Country | Period | Ind | GL | Size | Age | LagGrow | EcIss |
|---|---|---|---|---|---|---|---|---|---|
| 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 | + | |
| 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 | + | |
| Dunne, Roberts and Samuelson (1988) | F | USA | 1963-1982 | M | na | na | na | na | |
| Dunne, Roberts and Samuelson (1989b) | 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 | |

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)Iss(ues)
ss = corrected for sample selection
het = corrected for heteroscedasticity
mea = corrected for measurement error

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