

Firm Size, Firm Growth, and Persistence of Chance: Testing GIBRAT's Law with Establishment Data from Lower Saxony, 1978–1989*

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ABSTRACT. Using data for some 7000 manufacturing establishments from Lower Saxony for 1978–1989 we tested for the validity of *GIBRAT's Law of Proportionate Growth*. We found that the law is only valid for very few groups of firms in some of the periods covered. However, we did not find that small firms grew systematically faster or slower than larger firms, or vice versa. On the other hand, we found 'persistence of chance' in the sense that a firm grows faster if it happened to grow faster in the past, too.

1. Introduction

It is well-known that the distribution of companies by size is approximately log-normal. This regularity was termed a 'stylized fact' recently by Richard Schmalensee (1989, p. 994). This form arises if each firm faces the same distribution of growth possibilities, and each firm's actual growth is determined by random sampling from that distribution, i.e. if *GIBRAT's Law of Proportionate Growth* holds (see, e.g., Scherer and Ross (1990, p. 141)). Several empirical investigations have sought to determine whether this law holds, and whether firm growth rates are independent of firm size. However, there is as yet no evidence on this issue based on comprehensive sets of establishment level data for Germany. The aim of this study is to contribute to the literature on the nexus of firm size and firm growth by providing an empirical investigation based on data for some

7000 establishments from the manufacturing industries in Lower Saxony, one of the federal states of Germany.

The rest of the paper is organized as follows: Section 2 discusses the relevance of the topic from the perspectives of economic policy and economic theory, Section 3 shortly reviews findings from previous empirical studies, Section 4 gives some information on the data, in Section 5 the method used in the empirical investigation is described, Section 6 reports the results, and in Section 7 some conclusions are given together with perspectives for future research.

2. Who cares?

Why is GIBRAT's Law important? And for whom? There are (at least) two answers to this question that can motivate an empirical study of the kind done here.

The first motive for an interest in the question whether GIBRAT's Law holds or not is related to issues of industrial and regional policy. Imagine that the answer for the region considered is 'no', and that the results unambiguously point to a much faster rate of growth of small firms (that play an important role in the region as employers, too). If unemployment is a serious problem, this finding should act as an incentive to think of programs that promote birth and growth of small firms by, e.g., subsidies, consulting activities offered at no or low costs, or activities of any kind to 'make more winners'. If, on the other hand, large firms turn out to grow much faster than small ones, regional industrial policy might be driven towards programs that promote the location of big firms inside the region by incentives that either 'keep them

Final version accepted on July 17, 1991

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here' or 'bring them in'. If, however, GIBRAT's Law holds and growth is independent of size, this indicates that size (alone) should *not* be a cause for concern in establishing policy programs to promote firms.

There is a second (and, in my view, even more important) reason why economists should care for the validity of GIBRAT's Law. Recently, Nobel laureate Herbert Simon argued (in a paper published at a prominent place — in the *Journal of Economic Perspectives* 'Symposium on Organizations and Economics'):

Over a span of years, a large fraction of all economic activity has been gathered within the walls of large and steadily growing organizations. . . . Ijiri and I have suggested that the growth of organizations may have only a little to do with efficiency (especially since, in most large-scale enterprises, economies and diseconomies of scale are quite small), but may be produced mainly by simple stochastic growth mechanisms. . . . Without the introduction of very particular ad hoc assumptions, unbuttressed by empirical evidence, neoclassical theory provides no explanation for the repeated appearance of Pareto distributions of business firm sizes in virtually all situations where size distributions have been studied. . . . These observed distributions are difficult to reconcile with any notions that have been proposed for optimal firm size, but are easily explained by simple, plausible probabilistic mechanisms that make no appeal to optimality. (Simon 1991, pp. 42 and 29)

This is why the role played by chance in the process of firm growth needs to be identified: the answer might influence the way economists look at reasons for success or failure of firms.

3. A short review of empirical investigations

Several empirical investigations have sought to determine whether GIBRAT's Law holds, and whether firm growth rates are independent of firm size. Table I gives a short summary of some of the classical and more recent studies.

The studies differ widely as regards the samples used and the methods applied. Therefore, comparing the results is not always possible in a straightforward way. The overall impression, however, is that GIBRAT's Law is *not* valid. Furthermore, from the most careful recent studies, using new, large data sets from the United States it follows that growth rates tend to decline with firm size (cf.

Schmalensee (1989, p. 994) or Scherer and Ross (1990, p. 144)). This was labeled a "*Stylized Fact*" recently by Acs and Audretsch (1990b, p. 12).

The aim of this paper is to make two contributions to this literature: On the one hand it presents the first empirical evidence about GIBRAT's Law for Germany based on a comprehensive set of establishment level data from Lower Saxony. Though the data are from one of the federal states, results should be valid for the "old" part of Germany as a whole, because we have no evidence for any systematic difference as regards the growth of firms in Lower Saxony and the rest of the (old) federal states. On the other hand, the paper explicitly considers the role of 'persistence of chance' in the growth process. This important point was discussed in the studies by Singh and Whittington (1975), Chesher (1979), and Kumar (1985) for the U.K., but has been neglected in the recent studies using large data sets from the U.S.

4. Data

The empirical investigation is based on establishment level data (i.e., data for local production units) from some 7000 firms which formed the manufacturing sector of the German federal state *Lower Saxony* between 1978 and 1989. Data were collected in the official monthly survey of firms. Usually, all establishments from manufacturing industries have to reply to the survey, provided that at least 20 persons are working in either the local production unit itself or in the company that owns the unit (the boundary line is lower in some industries — details are available on request). To measure the size of a firm, we used the average number of persons working in it in a given year, computed from the numbers reported in the monthly surveys. Growth is measured by the percentage change of size from year to year.

Some peculiarities of the data should be mentioned. First, only firms with at least the minimum size are in the sample. Therefore, only some of the very small establishments can be considered here. Furthermore, if the number of persons working in a firm falls below the minimum size in one period this unit is not in the data set then, but may be in it again in the next period if employment has grown. 'Entries' and 'exits', therefore, must not represent

TABLE I
Empirical investigations on GIBRAT's Law: A review of selected studies

Author (year of publication)	Country (period)	Sample	Important results	Conclusions and remarks
Hymer and Pashigian (1962)	U.S. (1946–1955)	1000 largest manufacturing firms	Average growth rates not related to firm size; standard deviations of growth rate inversely related to size	GIBRAT's Law not valid
Mansfield (1962)	U.S. (ca. 1916–1957)	Practically all firms in three industries: steel, petroleum, and rubber tire	Smaller firms were more likely than the larger ones to leave the industry; smaller firms often had higher and more variable growth rates	GIBRAT's Law not valid
Singh and Whittington (1975)	U.S. (1948–1960)	All quoted companies in manufacturing, construction, distribution, and miscellaneous services (about 2000)	Weak positive relationship between size and growth; standard deviation of growth rates declines with increasing firm size; definite but relatively small degree of persistence in the growth rates of firms	GIBRAT's Law not valid
Chesher (1979)	U.K. (1960–1969)	183 quoted companies classified as 'commercial and industrial'	Size and growth unrelated, but evidence for 'persistence of chance factors' found	GIBRAT's Law not valid (paper is seminal for method of testing)
Kumar (1985)	U.K. (1960–1976)	Ca. 2000 quoted companies from manufacturing and services	Mild tendency for firm growth to be negatively related to size; some persistency in firm growth over time; larger firms have lower dispersion in growth rates	GIBRAT's Law not valid
Evans (1987a)	U.S. (1976–1982)	Approx. 2000 manufacturing firms	Firm growth decreased with firm age and size	GIBRAT's Law not valid (discusses the following issues, too: — effect of sample selection; — effect of heteroscedasticity)
Evans (1987b)	U.S. (1976–1980)	All firms operating in 100 manufacturing industries; results for separate 4-digit industries (overall sample size: 42339)	Firm growth, variability of firm growth, and the probability of failure decrease with firm age; firm growth decreases at a diminishing rate with firm size (even after controlling for the exit of slow growing firms)	GIBRAT's Law fails although the severity of the failure decreases with firm size
Hall (1987)	U.S. (1972–1983)	1778 publicly traded manufacturing firms (subsamples)	Negative coefficient on firm size in growth rate equation; smaller firms have a larger variance of growth rate	GIBRAT's Law is weakly rejected for smaller firms and accepted for the larger firms (discusses problems of sample selection bias and measurement error, too)
Contini and Revelli (1989)	Italy (1980–86)	Manufacturing firms	(See conclusions)	Departures from GIBRAT's Law are modest; law holds or nearly holds especially among firms with more than 100 employees

Table 1 (Continued)

Author (year of publication)	Country (period)	Sample	Important results	Conclusions and remarks
Dunne, Roberts and Samuelson (1989)	U.S. (1967–1982)	Over 200000 plants that entered manufacturing sector between 1967 and 1977	Plant failure rates decline with size and age as do the growth rates of nonfailing plants; when failure probability is integrated into analysis, relationship between plant growth and size is negative for plants owned by single plant-firms but positive for plants owned by multiplant firms	GIBRAT's Law not valid
Acs and Audretsch (1990a)	U.S. (1976–1980)	Data aggregated at the industry level; four firm-size classes	In about 40 percent of the industries growth rates were significantly different across firm-size classes; pattern varies considerably across sectors	Validity of GIBRAT's Law depends on sectors considered (importance of incorporating the impact of exits is discussed)
Bourlakis (1990)	Greece (1966–1986)	633 manufacturing corporations	Negative growth-size and growth-age relationships	GIBRAT's Law not valid
Dunne and Hughes (1990)	U.K. (1975–1985)	All quoted plus larger unquoted companies in the financial and nonfinancial sectors	Small firms grew faster than large firms; variance of growth rates declined with increasing firm size; younger companies grew faster than old	GIBRAT's Law not valid
FitzRoy and Kraft (1991)	Germany (1977–1979)	51 firms from the metalworking sector	Larger firms display significantly slower growth; younger firms grow faster	GIBRAT's Law not valid (authors argue that results "are not of course in any way representative for the FRG")

new firms or firms that closed down permanently. Second, if an establishment is relocated from (or to) Lower Saxony to (or from) another federal state or country it is recorded as an 'exit' ('entry') without having been closed down (newly founded).

To state it differently, provided that the answers reported in the official survey are correct the data give a reliable picture for all establishments in the manufacturing sector of Lower Saxony between 1978 and 1989 which had more than the minimum number of persons (given in the survey law) working in it during all the years. As far as 'entries' and 'exits' are considered, however, the picture becomes fuzzy. By now it is impossible to differentiate between the various possible reasons for, e.g., a firm being in the sample in 1988 but not in 1989: Has the establishment closed down? Or has it been relocated to another federal state or country? Or did it switch his main activities from the

manufacturing sector to the services sector? Or did the number of persons working in it fall below the minimum size? Therefore, it was decided only to consider establishments in the empirical investigation that 'survived' for the whole period under study. To minimize the survival bias (that cannot be corrected here by a straightforward application of standard econometric techniques because of the vagueness of the reason for an exit) we considered a sequence of short three years periods beginning with 1978–1980, and ending with 1987–1989. The sample used for a period consists of all establishments that reported the number of persons working in it in each of the three years.

5. Method

Following the method developed in Chesher's (1979) seminal paper we tested for the validity of GIBRAT's Law by estimating

$$z_{i,t} = g_1 \cdot z_{t-1,i} + g_2 \cdot z_{t-2,i} + u_{t,i} \quad (1)$$

using ordinary least squares, where t is an index for time, i is an index for the firms, $z_{t,i}$ 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 ($z_{t-1,i}$ and $z_{t-2,i}$ are defined in an analogous manner), u is a disturbance, and g_1 and g_2 are the parameters to be estimated. As is shown by Chesher $g_1 = b + r$ and $g_2 = -b \cdot r$, and the validity of GIBRAT's law implies that $b = 1$ and $r = 0$, i.e., the growth of the firm is independent of its size in the base year and the disturbances are not autocorrelated. Therefore, a test of the validity of GIBRAT's law requires testing the null hypotheses $g_1 = 1$ and $g_2 = 0$. Given the estimated values of g_1 and g_2 , estimated for b and r can be computed from

$$(b, r) = 0.5 \cdot [g_1 \pm (g_1^2 + 4g_2)^{0.5}]. \quad (2)$$

To take care of peculiarities in different industries the samples were divided into four subsamples made of firms from each of the so-called 'main groups' ('Hauptgruppen'), i.e., manufacture of basic products, manufacture of capital goods, manufacture of consumer goods, and manufacture of food, beverages and tobacco products (details are available on request). It should be noted that we are not allowed to publish results from a more disaggregated study of industries because of the data protection laws governing the use of the data from official surveys.

For each of the 10 three years period we considered all establishments from each of the industry groups together. Furthermore, the firms were divided into three size classes according to the number of persons working in them on average in the last year of the respective period: *small firms* with less than or equal to 50 persons, *medium firms* with more than 50 but less than or equal to 250 persons, and *large firms* with more than 250 persons.

6. Results

The results are given in Tables II and III where estimates for b and r are reported together with the number of firms (for the ten periods, two of the four industry groups, and all firms plus the three size classes).¹ A star (*) indicates that the test

rejected the validity of GIBRAT's Law at a conventional level of five percent.

As can be seen from the results of the tests the null hypothesis of the validity of the law is rejected for all but a few groups of firms in some of the periods. To put it differently, only for small firms from the manufacture of basic products the tests indicate that the law was valid in more than half of the periods under study.

A closer look at the values for b and r reveals that b is nearly always very close to one without having values above or below one in all periods covered. Therefore, small firms did neither grow faster nor slower than larger ones, and this differs from the evidence reported in recent studies with data for the United States mentioned in the introductory section above, where growth rates were found to tend to decline with firm size. These different findings might be caused by the different methods used to test for the validity of GIBRAT's Law, because the U.S. studies did not look at persistence.

On the other hand nearly all of the values for r are positive and some are quite large compared to zero. This suggests that there is 'persistence of growth' in the sense that a firm grew faster in the second part of the period if it happened to grow relatively fast in the first. According to our results, therefore, growth rates for a given firm from year to year are not independent, as assumed by GIBRAT's Law. Because we did not model the factors causing this persistence it shows up in positively autocorrelated errors here, and can be termed '*persistence of chance*'. To illustrate the kind of decision that might be responsible for this Scherer and Ross (1990, p. 144) mention the example of a lucky chief executive officer choice that may affect growth favorably for a decade or more.

7. Conclusions

To summarize our results we found that GIBRAT's Law is only valid for very few groups of firms in some of the periods covered in this study. However, we did not find that small firms grew systematically faster or slower compared with larger firms, or vice versa. What we did find is 'persistence of chance' in the sense that a firm grows faster if it happened to grow faster in the past, too.

TABLE II
Test of GIBRAT's Law for firms from manufacture of basic products*

Period	All firms			Small firms			Medium firms			Large firms		
	Number	<i>b</i>	<i>r</i>	Number	<i>b</i>	<i>r</i>	Number	<i>b</i>	<i>r</i>	Number	<i>b</i>	<i>r</i>
1978—1980	1051	0.9969	0.0353	698	0.9868	0.0145	252	1.0038	0.0700*	101	1.0051	0.0147
1979—1981	1066	1.0134	-0.0088	725	1.0097	-0.0469	239	1.0230	0.4289*	102	1.0281	0.3439*
1980—1982	1041	1.0088	0.2617*	713	0.9925	0.2757*	233	1.0305	0.1826*	95	1.0185	0.5319*
1981—1983	1003	0.9970	0.0934*	687	0.9941	0.0530	225	0.9912	0.4000*	91	0.9926	0.4437*
1982—1984	980	1.0127	0.0774*	671	1.0174	0.0583	221	1.0099	0.0789	88	1.0354	0.7482*
1983—1985	940	1.0257	0.1154*	643	1.0171	0.0479	211	1.0648	0.4284*	86	1.0422	0.4782*
1984—1986	907	1.0000	-0.2110*	611	0.9849	-0.2643*	209	1.0132	0.2018*	87	0.9981	0.4752*
1985—1987	865	1.0066	0.0939*	564	1.0110	0.0615*	215	0.9928	0.3207*	86	1.0071	0.3817
1986—1988	872	1.0056	0.0679*	567	1.0087	0.0872	216	1.0124	0.2289*	89	1.0013	0.0224
1987—1989	864	0.9975	-0.1454*	558	0.9993	-0.1982*	221	0.9983	0.1118*	85	0.9821	0.6703*

* A * indicates that the validity of GIBRAT's Law is rejected.

TABLE III
Test of GIBRAT's Law for firms from manufacture of consumer goods*

Period	All firms			Small firms			Medium firms			Large firms		
	Number	<i>b</i>	<i>r</i>	Number	<i>b</i>	<i>r</i>	Number	<i>b</i>	<i>r</i>	Number	<i>b</i>	<i>r</i>
1978—1980	1144	0.9677	0.2573*	523	0.9774	0.4861*	512	0.8620	0.1513*	109	1.0038	0.6053*
1979—1981	1149	1.0076	0.2208*	540	1.0103	0.1903*	499	0.9882	0.2543*	110	1.0117	0.1432
1980—1982	1114	0.9998	0.1379*	549	1.0078	0.1404*	458	0.9712	0.1224*	107	1.0045	0.1953*
1981—1983	1056	0.9832	0.2332*	529	0.9734	0.2152*	426	0.9589	0.2530*	101	1.0067	0.6371*
1982—1984	1023	1.0146	0.2180*	495	1.0250	0.3888*	426	1.0071	0.0566	102	1.0193	0.5583*
1983—1985	992	1.0116	0.2345*	461	1.0243	0.1951*	426	0.9721	0.2228*	105	1.0258	0.5774*
1984—1986	967	1.0025	0.1944*	440	1.0071	0.1435	426	0.9712	0.2993*	101	1.0104	-0.0131
1985—1987	925	1.0116	0.2760*	411	1.0296	0.2149*	413	0.9736	0.3557*	101	1.0086	0.2092
1986—1988	933	0.9693	0.3589*	412	0.9819	0.3332*	416	0.8258	0.5174*	105	0.9997	0.1246*
1987—1989	926	1.0087	0.3353*	391	1.0300	0.4365*	427	0.9583	0.2691*	108	1.0089	0.3674*

* A * indicates that the validity of GIBRAT's Law is rejected.

Further research is needed to look behind the veil and to find out whether it is really only 'pure chance' what makes a successful firm. This research, however, cannot be based on data from the official surveys, because important information on, e.g., innovative activities, strategic planning, and attitude and expectations of the managers is not included. To study this aspect we need a longitudinal data set for a large number of firms from all industries and size classes — but data sets of this kind are not (yet) available for Germany, although our efforts to build them are going on.

Notes

* This paper is part of the research project "Production, Employment Growth, and Exports by Lower Saxonian Firms." The computations based on the establishment level data from the official surveys of the manufacturing sector were made possible by a special arrangement between the Ministry of Economics, the Statistical Office, and the Labour Research Group at the Department of Economics, Hannover University. I am grateful to Uwe Rode for preparing the data base, to Wilhelm Lorenz for writing a program that makes it possible to use these large data set on a PC, and to an unknown referee for helpful comments on an earlier version of this paper.

¹ The results for the capital goods industry and the food,

beverages and tobacco industry are consistent with the results shown in Tables II and III. The specific results for these two industries are available from the author upon request.

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