Testing Gibrat's Law on Software Companies in Croatia

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Abstract. *According to Gibrat's law of proportionate effect, a company's growth rate is independent of its size at the start of the observation period. The main purpose of this paper is to test the validity of this assumption in the case of Croatian companies that offer the services of software consultancy and supply (NKD 2002; 72.2).*

In order to examine the validity of Gibrat's law for the constant sample of all surviving companies, we used the quantile regression method. For all analysed periods, our results show that a company's growth is independent of its size.

Keywords. Gibrat's law, software companies in Croatia, company growth rate

1 Introduction

Considering the significant role that the small and medium-sized companies play in generating employment and also the dynamics and innovations with which they contribute to their local economies, company growth rates represent an important field of interest for researchers and growth support policy makers alike. According to the data presented by Croatia's Ministry of Economy in its draft proposal of the Industrial Strategy 2014 – 2020 [30], the industry of computer programming, consultancy and related services shows good business indicators at the industrial level and figures as one of the „instigators" of future industrial growth in Croatia. The purpose of this paper is to examine whether the results of testing Gibrat's law point towards creating such support measures that would take into account the company size.

Growth is a complex phenomenon in itself and the specific nature of growth processes at the company level suggests heterogeneity. Despite this heterogeneity, the law of proportionate effect, also known as Gibrat's law, has been established as valid in certain sectors. In its original form it simply states that companies' expected growth rates in some specified period remain the same for all companies regardless of their size at the start of that period. Gibrat's law can be empirically tested in at least three different ways. One way is to test all companies, including those that disappeared from the market during the period of observation. In the other way, one can test only those companies that survived through the whole period of observation. Finally, it is implied that Gibrat's law applies only to those companies that are big enough to surpass the minimum efficient scale in their specific industry (since, for example, the minimum efficient scale in processing industries is greater than that in hospitality industry) [27]. Considering the fact that Gibrat's law lies at the basis of many mathematical models created to explain the shape of the company size distribution and that it also carries interesting implications for determining the intensity of industry concentration, the significance attributed to testing its validity is quite understandable [29].

2 Empirical testing of Gibrat's law and research hypotheses

While the initial empirical studies tended to confirm Gibrat's law [32; 22], newer studies have started to question its generally accepted validity. Most insights about the validity of Gibrat's law pertain to the secondary economic sector.

Edwin Mansfield's [29] contribution represents a starting point when it comes to the empirical research of industry dynamics. Mansfield [29] studied the growth rates in the oil, steel and tire industries and showed that Gibrat's law was valid more often if the analysis included only those companies that survived the observation period. This phenomenon is explained [29] by the fact that smaller companies are more likely to survive compared to big companies.

Evans [13] tested Gibrat's law on a sample of American manufacturing companies, divided into 100 sectors. A negative correlation between growth rates and sizes was found in 89 out of 100 observed industries. Hall [17] reached the same conclusion when he tested Gibrat's law on a sample of American manufacturing companies which had already reached a certain minimum size, measured in terms of employment. The smaller companies grew faster,

which was further confirmed by observing the manufacturing sectors of other countries such as India, Italy, Taiwan and the countries of southern Africa [8; 7; 25; 28].

Dunne, Roberts & Samuelson [11] tested Gibrat's law on the different age categories of manufacturing companies and confirmed that their growth rates decreased with the rise in company size for each of the observed categories. The research that MacPherson [28] conducted in five countries of southern Africa also shows the negative impact that both the size and the age of a company have on its growth. On a sample of Greek manufacturing companies, Fotopoulos & Louri [15] also proved that older companies grew slower.

Almus & Nerlinger [1] focused their research on the start-up manufacturing companies that existed for less than six years. In all observed cases, their results suggested that Gibrat's law should be rejected. Furthermore, the deviation from Gibrat's law appeared to decrease with the increase in size of a given company. In their preliminary study on the post-entry success rates of manufacturing companies, Lotti, Santarelli & Vivarelli [26] separately analysed micro companies (with less than 5 employees) and bigger companies. Although Gibrat's law was not confirmed, they gave attention to analysing the post-entry evolution of these companies and noticed a non-monotone convergence towards Gibrat's growth model.

The studies that tested Gibrat's law on samples of service companies predominately confirmed the results of those studies done on samples of manufacturing companies. In the service sectors also, smaller companies grow faster [24; 21; 20]. Harhoff, Stahl & Woywode [19] analysed the sample of 10 902 West German companies belonging to construction, transport, service and manufacturing industries. The results they obtained confirmed the results of previous studies about the negative correlation between a company's employment rate and its size and age. When they tested Gibrat's law, among other things, Faggio & Konings [14] showed that the negative correlation between growth rates and company sizes also existed in the majority of samples of the companies situated in transition countries (Poland, Estonia, Slovenia, Bulgaria and Romania).

Besides the above mentioned studies, which provide additional weight to the claim that smaller companies grow faster, there is also a lesser body of research proposing that a company's growth is independent of its size. Using a starting sample of 231 British life insurance companies in the period of 1987 – 1991 and 1992 – 1996, [18] concluded that Gibrat's law was valid for the period of 1992 – 1996, while the same was not confirmed for the earlier period. By studying a sample of Italian companies belonging to different industries, Becchetti & Trovato [3] concluded that the hypothesis of independence between a company's growth and its starting size could not be dismissed when it came to larger companies with more than 100 employees, as opposed to smaller companies with less than 100 employees. Testing the validity of Gibrat's law on a sample of Dutch companies belonging to different segments of hospitality industry in the period of 1987 – 1991 gave results that showed Gibrat's law to be generally valid for the samples which contained only surviving companies or those companies that had reached their minimum efficient scale, but not for the sample which included all analysed companies [2]. Piergiovanni et al. [31] also reached similar results when they analysed Italian hospitality companies in the period of 1989 – 1994.

Furthermore, Singh and Whittington [33] analysed the relationship between the size and growth of a company on a sample of British manufacturing and service companies and they noticed the existence of a slight positive correlation between the observed variables, which means that larger companies grow faster. The research of Geroski et al. [16] encompassed a long period of 30 years in which they observed British manufacturing and service companies and concluded there were differences in growth rates among companies of different sizes, but also that these differences were not permanent.

Based on this elaborate overview of empirical studies on Gibrat's law, we can conclude that Gibrat's law does not appear to be valid empirically in great majority of cases [34; 4] because we see that small companies grow faster. Still, the results indicate that there are differences in dynamics between the manufacturing and service sectors, and also that Gibrat's law applies in certain service industries. Certainly, what is more important than simply determining the validity of Gibrat's law is to explain when and why it is valid and when and why it is not. Based on their research results, Daunfeldt and Elert [9] emphasize the importance of general industrial context for confirming or rejecting Gibrat's law (such as the minimum efficient scale of an industry, market concentration levels, the number of young companies in an industry etc.).

Given that the software industry belongs to the service sector, in which Gibrat's law has been confirmed for certain industries, and its noticeable importance in Croatia, we find the testing of Gibrat's law in this area intriguing because of the implications it might have for support policies when it comes to company sizes. The software industry is characterized by low entry barriers, which is evident in its small minimum efficient scale, low capital intensity coefficient [23] and low industry concentration levels [30]. These are exactly the characteristics that suggest the acceptance of Gibrat's law. Namely, in the industries with minimal sunk costs and the non-significant role of capital intensity and economies of scale, the small-company survivorship bias tends to disappear. Such industries typically have growth rates that are independent of company sizes.

Having in mind the theoretical background on different ways of testing Gibrat's law, we set the following research hypothesis:

H1: The growth rate of a company in the software supply and consultancy industry is independent of its size at the start of the observation period.

3 Data and methodology

The data used for this research is the longitudinal panel data on all Croatian companies in the software supply and consultancy industry (NKD 2002 72.2) for the period of 2002 to 2007. Financial Agency (FINA) database was used for the purposes of this research.

In order to avoid the potential problem of attrition bias, we excluded from our initial sample the companies without employees or income in certain years, as well as those companies that disappeared from the market or entered the market during the observation period. In this paper we tested the second version of the law, i.e., the version that considers only surviving companies. The final balanced data set consists of 292 companies.

The regression equation that was tested is the logarithmic specification of Gibrat's law

$$\ln S_{i,t} = \beta_0 + \beta_1 * \ln S_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

in which the dependent variable is the company size i in time t ($\ln S_{i,t}$), and the independent variable is the company size i in time t-1 ($\ln S_{i,t-1}$), while the relation error (the non-systematic component of the model) is defined as $\varepsilon_{i,t}$. The size of a company is determined in terms of its total income. According to Chesher [5], if we take the antilogarithm (exponentiate) for both sides of the equation, it becomes evident that if β_1 equals 1, we can conclude that the growth rate and the initial size of a company are independently distributed and that Gibrat's law is valid. If $\beta_1 < 1$, we can conclude that smaller companies have systematically higher growth rates compared to big companies. In the case of $\beta_1 > 1$, we can state the opposite. The mentioned restriction on parameter β_1 was tested using the Wald test.

In view of the positively skewed asymmetrical data distribution, we used quantile regression (QR) to test our regression model, as a robust estimation alternative to the ordinary least squares method (OLS). This method is based on the least absolute deviations (LAD) estimator, which fits the median to the linear function of regression variables. In accordance with this, the estimates are robust against deviations from normality, homoscedastic errors and the presence of outliers. We tested the model for the whole period of observation and for each one-year period in particular to see if there was any convergence towards validating Gibrat's law with the passage of time.

Also, considering the possible occurrence of persistence in companies' growth rate patterns, which is basically in contradiction with the assumption of Gibrat's law about proportional growth rates, we tested this on the basis of annual growth rates by using a first-order autoregressive model (AR (1)), as previously done by Kumar [24] and Dunne and Hughes [10]. The tested model is shown in eq.2.

$$G_{i,t} = \beta_0 + \beta_1 * G_{i,t-1} + \varepsilon_t \quad (2)$$

$G_{i,t}$ is the annual growth rate of the company i in the period t, while $G_{i,t-1}$ is the annual growth rate of the company i in the period t-1. The random variable in the model is defined as ε_t.

This model showed no persistence in growth rates in any of the observed years or the whole observation period so, consequently, we did not expand the initial model. All regression analyses were carried out using Eviews 7 software package.

4 Results

Descriptive data analysis shown in Table 1 suggests the existence of positive asymmetry in the company size distribution, measured both in terms of income size and the number of employees. According to the company size categorisation [6], micro companies are prevalent in this sector and these companies usually have only one employee. The biggest company in this sector is a mid-sized company and there are no big companies. On average, there were no income rises at the sector level in the period of 2003 – 2007.

Table 2 shows the results of testing Gibrat's law for the whole period of observation and for each particular one-year period, estimated using the quantile regression method based on the median. Table 3 shows the results of testing growth persistence.

The results of testing the model of company growth dependent on company size, using the quantile regression method (QR) based on the median, suggest that the growth of companies in the software supply and consultancy business (NKD 2002 72.2) does not depend on their size at the start of observation. This applies to each particular one-year period, as well as the whole period of observation.

Consequently, we can find no convergence appearing through the years that would validate Gibrat's law. According to our analysis, an income growth of 1% in one period leads to proportional median income growth in the following period.

Table 1. Income, employee and income growth rate numbers in the software supply and consultancy sector

Year	2003	2004	2005	2006	2007
INCOME (HRK)					
Mean	2,584,713	2,694,514	2,584,713	3,484,142	3,948,311
Median	736,986	821,957	736,986	896,589	880,449
Standard Deviation	6,821,893	7,186,775	6,821,893	9,523,023	11,224,608
Kurtosis	63.41	52.07	63.41	47.61	72.14
Skewness	7.15	6.70	7.15	6.40	7.52
Minimum	34,101	12,939	34,101	5,512	22,816
Maximum	75,820,120	70,877,524	75,820,120	94,126,325	134,000,000
NUMBER OF EMPLOYEES					
Mean	5.34	5.68	6.03	6.45	7.06
Median	3	3	3	3	3
Mode	1	1	1	1	1
Standard Deviation	7.89	8.37	9.44	10.74	12.52
Kurtosis	39.54	31.31	35.34	32.40	34.32
Skewness	5.32	4.77	5.08	4.96	5.12
Minimum	1	1	1	1	1
Maximum	75	76	93	101	120
GROWTH RATE					
Median (%)	1.05	0.01	0.02	0.05	0.05
Skewness	16.93	13.18	16.41	3.77	2.45

Table 2. Quantile regression results (median)

	2003 – 2004	2004 – 2005	2005 – 2006	2006 – 2007	2003 – 2007
β_0	-0,037406	-0,112015	0,040491	0,029011	0,048628
σ_{β_0}	0,188169	0,249053	0,188818	0,201179	0,422269
β_1	1,004001***	1,010034***	1,001143***	1,001256***	1,010280***
σ_{β_1}	0,013510	0,017773	0,013238	0,013994	0,030532
pseudo R^2	0,767341	0,737230	0,766720	0,776966	0,552024
Wald (χ^2) β_1=1	0,087724	0,318728	0,007456	0,008059	0,113359
Prob. (Wald)	0,7671	0,5724	0,9312	0,9285	0,7364
n	292	292	292	292	292

*** significant at 99% confidence level; ** significant at 95% confidence level; * significant at 90% confidence level

Table 3. Growth persistence testing results

	2003 – 2004	2004 – 2005	2005 – 2006	2006 – 2007	2003 – 2007
β_0	0,152453*	0,416242	0,140956***	0,148947***	0,138841***
σ_{β_0}	0,078558	0,256078	0,031910	0,032497	0,029051
β_1	0,000169	-0,154483	-0,004451	-0,057789	9,08E-05
σ_{β_1}	0,000225	0,180929	0,007972	0,065582	8,32E-05
R^2 adj.	-0,001495	-0,000754	-0,002371	0,000561	0,000660
F	0,565489	0,780872	0,311758	1,163336	1,192215
White[1]	0,006528	5,524004*	0,177786	7,597540**	0,153338

*** significant at 99% confidence level; ** significant at 95% confidence level; * significant at 90% confidence level

[1] In the case of heteroskedasticity (a level of confidence of at least 90%), a consistent covariance matrix was used (White`s correction).

5 Conclusion

Since it is a manufacturing industry with small minimum efficient scale, the validation of Gibrat's law in the case of Croatia's software industry matches Teruel-Carrizos' [35] conclusion that small companies in the service industries with small efficient scale tend to grow slower than small companies in the manufacturing industry. Furthermore, the West Midlands ICT cluster (as cited in [12]) identified five different entrepreneurial strategies that appeared in the ICT services. They note that the entrepreneurs whose companies offer software services favour those strategies that do not strive for growth (lifestyle entrepreneurs). There are also those companies that face certain limitations to potential growth due to their weak production portfolio or their failure to penetrate the market (survivalists). Also, some companies show a certain growth potential but face different limitations such as their size or competition (low growth companies).

Therefore, in order to create the support policies that would suit this industry as one of the more prosperous industries in Croatia, it is necessary to conduct a thorough analysis of static and dynamic features of these software companies in the period before and during recession. Furthermore, it seems equally important to broaden this analysis by conducting a qualitative research about the needs of different entrepreneurs, because of the existing heterogeneity in resources and strategies at the company level. Further research and analyses are important to ensure that the support policies for this industry would not be inefficient or even harmful.

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References

[1] Almus, M; Nerlinger, E.A. Testing "Gibrat's Law" for Young Firms – Empirical Results for West Germany. *Small Business Economics*, 15(1):1-12, 2000.

[2] Audretsch, D.B; Klomp, L; Santarelli, E; Thurik, A.R. Gibrat's law: are the services different? *Review of Industrial Organization*, 24(3):301-324, 2004.

[3] Becchetti, L; Trovato, G. The determinants of growth for small and medium sized firms. The role of the availability of external finance. *Small Business Economics*, 19(4):291-306, 2002.

[4] Caves, R.E. Industrial organization and new findings on the turnover and mobility of firms. *Journal of Economic Literature*, 36:1947-1982, 1998.

[5] Chesher, A. Testing the Law of Proportionate Effect. *The Journal of Industrial Economics*, 17(4):403-411, 1979.

[6] Commission of the European Communities. Commission Recommendation 2003/361/EC, Official Journal of the EU L 124, http://www.sustainable-design.ie/EU-SMEs.pdf, downloaded: April 15th 2014.

[7] Contini, B; Revelli, R. The relationship between firm growth and labor demand. *Small Business Economics*, 1(4):309-314, 1989.

[8] Das, S. Size, age and firm growth in an infant industry: The computer hardware industry in India. *International Journal of Industrial Organization*, 13(1): 111-126, 1995.

[9] Daunfeldt, S; Elert, N. When is Gibrat's law a law? *Small Business Economics*, 41(1):133-147, 2013.

[10] Dunne, P; Hughes, A. Age, Size, Growth and Survival: UK Companies in the 1980s. *The Journal of Industrial Economics*, 42(2):115-140, 1994.

[11] Dunne, T; Roberts, M.J; Samuelson, L. The growth and failure of U.S. manufacturing plants. *The Quarterly Journal of Economics*, 104(4):671-698, 1989.

[12] Ecorys. FWC Sector Competitiveness Studies - Competitiveness of the EU SMEs in the ICT services Industry, http://ec.europa.eu/enterprise/sectors/ict/files/study_report_ict_services_en.pdf, downloaded: March 10th 2014.

[13] Evans, D. S. The Relationship between firm growth, size, and age: estimates for 100 manufacturing industries. *The Journal of Industrial Economics*, 35(4):567-581, 1987.

[14] Faggio, G; Konings, J. Job creation, job destruction and employment growth in transition countries in the 90s. *Economic Systems*, 27(2):129-154, 2003.

[15] Fotopoulos, G; Louri, H. Firm Growth and FDI: Are Multinationals Stimulating Local Industrial Development? *Journal of Industry*, 4(3):163-189, 2004.

[16] Geroski, P.A; Lazarova, S; Urga, G. Are differences in firm size transitory or permanent? *Journal of Applied Econometrics*, 18(1):47-59, 2003.

[17] Hall, B. H. The relationship between firm size and firm growth in the US manufacturing sector. *Journal of Industrial Economics*, 35(4):583-606, 1987.

[18] Hardwick, P; Adams, M. Firm Size and Growth in the United Kingdom Life Insurance Industry. *Journal of Risk & Insurance*, 69(4):577–593, 2002.

[19] Harhoff, D; Stahl, K; Woywode, M. Legal form, growth and exit of West German firms - empirical results for manufacturing, construction, trade and service industries. *The Journal of Industrial Economics*, 46(4):453-488, 1998.

[20] Hart, P.E; Oulton, N. Gibrat, Galton and Job Generation. *International Journal of the Economics of Business*, 6(2):149-164, 1999.

[21] Hart, P.E; Oulton, O. Growth and Size of Firms. *The Economic Journal*, 106(438):1242-1252, 1996.

[22] Hymer, S; Pashigian, P. Firm Size and Rate of Growth. *Journal of Political Economy*, 70(6):556-569, 1962.

[23] Kovačević, Z; Vuković, K. Performanse poduzeća u hrvatskom sektoru informacijsko-komunikacijske tehnologije (ICT). *Ekonomska misao i praksa*, 15(2):217-240, 2006.

[24] Kumar, M.S. Growth, Acquisition Activity and Firm Size: Evidence from the United Kingdom, *The Journal of Industrial Economics*, 33(3):327-338, 1985.

[25] Liu, J; Tsou, M; Hammitt, J.K. Do small plants grow faster? Evidence from the Taiwan electronics industry. *Economics Letters*, 65(1):121-129, 1999.

[26] Lotti, F; Santarelli, E; Vivarelli, M. The relationship between size and growth: the case of Italian newborn firms. *Applied Economics Letters*, 8(7):451-454, 2001.

[27] Lotti, F; Santarelli, E; Vivarelli, M. Does Gibrat's Law hold among young, small firms? *Journal of Evolutionary Economics*, 13(3):213-235, 2003.

[28] MacPherson, M.A. Growth of micro and small enterprises in southern Africa. *Journal of Development Economics*, 48(2):253-277, 1996.

[29] Mansfield, E. Entry, Gibrat's Law, innovation, and the growth of firms. *The American Economic Review*, 52(5):1023-1051, 1962.

[30] Ministry of Economy. Industrial Strategy 2014 - 2020, http://www.mingo.hr/default.aspx?id=4980, downloaded: April 12th 2014.

[31] Piergiovanni, R; Santarelli, E; Klomp, L., Thurik, A.R. Gibrat's Law and the Firm Size/Firm Growth Relationship in Italian Services, Tinbergen Institute Discussion Paper 02-080/3, http://www.econstor.eu/handle/10419/86051, downloaded: April 12th 2014.

[32] Simon, H.A; Bonini, C.P. The Size Distribution of Business Firms. *The American Economic Review*, 48(4):607-617, 1958.

[33] Singh, A., Whittington, G. The Size and Growth of Firms. *Review of Economic Studies*, 42(1):14-26, 1975.

[34] Sutton, J. Gibrat´s Legacy. *Journal of Economic Literature*, 35(1):40-59, 1997.

[35] Teruel-Carrizosa, M. Gibrat's law and the learning process. *Small Business Economics*, 34(4):355-373, 2010.