

THE RELATIONSHIP BETWEEN FIRM SIZE AND FIRM GROWTH: THE CASE OF THE CZECH REPUBLIC

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Abstract

FIALA ROMAN, HEDIJS VERONIKA. 2015. The Relationship Between Firm Size and Firm Growth: The Case of the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 63(5): 1639–1644.

This paper deals with the investigation of the relationship between firm size and firm in the Czech Republic during 2007–2012. The study aims to examine to what extent the confirmation or rejection of Gibrat's law depends on the indicator of firm size. For measuring firm size we use three indicators: revenues, number of employees and total assets. The study uses data collected from the database Albertina CZ Gold Edition. Final dataset includes the data about more than 35,000 firms. The validity of Gibrat's law was tested with the help of linear regression model with first-order autoregressive process. Gibrat's law is rejected for all three indicators of firm size. Hence, the selected indicator of firm size is not proved to be important factor in verification of Gibrat's law validity. It is also found out that the small firms in profit industries (A-N according to CZ-NACE classification) grow faster than their larger counterparts in the Czech Republic.

Keywords: firm growth, firm size, Gibrat's law, Law of proportionate effect, OLS estimator

INTRODUCTION

Many researchers have focused on the questing: "Is firm growth influenced by firm size?" Researchers, which deal with this topic, have been significantly affected by Robert Gibrat (1931), who investigated the size distribution of French manufacturing plants during time period 1896–1921. He stated that the firm growth is a stochastic process resulting from many unobserved random variables and it is independent of the size of firm at the beginning of the examined period (Sutton, 1997). Gibrat's law which is known as the Law of proportionate effect as well states that firm growth is a random walk, independent of company size.

The study aims to test the validity of Gibrat's law in the Czech Republic and to examine to what extent the confirmation or rejection of Gibrat's law depends on the indicator of firm size in the Czech Republic. For measuring firm size we use three indicators: revenues, number of employees and total assets.

We have found no study focusing on testing Gibrat's law for Czech firms. The contribution

of this study is to verify the validity of the Gibrat's law in the Czech Republic and to find whether the confirmation or rejection the Law depends on firm size indicator.

This paper is organised as follows: section 2 deals with literature review, section 3 describes the data and methodology, which was applied, section 4 shows the empirical results and discussion about the achieved results and compares these with findings of previous studies and section 5 titled Conclusion is focused on concise recapitulation of main findings of the paper.

Literature Review

Many studies are devoted to the issue of relationship between the firm size and growth. As we can see from the results of studies below, the findings of these studies are not unified. A lot of studies have rejected Gibrat's law, other studies tended to confirm the Law of proportionate effect and some authors rejected Gibrat's law only in some industries.

Firstly, we introduce studies, which rejected the validity of Gibrat's law. Evans (1987a) investigated

this relationship for a sample of 27,046 US manufacturing companies between 1976 and 1982 and he found that firm growth decreases with firm age and firm size. Firm size is measured by employment. Very similar results found Evans (1987b), who examined all firms in 100 US manufacturing industries in the period 1976–1980. Firm growth goes down with the number of employees, which is indicator for plant size. Goddard, Wilson and Blandon (2002) dealt with 443 Japanese manufacturing firms for years 1980–1996. The Law of proportionate Effect was rejected. Nominal assets were used as an indicator of company size. Feizpour, Mahmoudi and Soltani (2010) focused on manufacturing sector (12,712 plants) in Iran for the period 1995–1998. Firm size was measured with the help of number of employees. Smaller firms grow faster, thus The Law of proportionate Effect was rejected. Dunne and Hughes (1994) examined 2,149 UK companies over the period 1980–1985. For measuring firm size they used net assets. Main finding of their study is that smaller firms grow faster than larger companies. Oliveira and Fortunato (2006) investigated 7,653 Portuguese manufacturing firms in the period 1990 to 2001 and they found, that large and mature firms grow more slowly than small and young firms. They measured firm size by number of employees. Almus and Nerlinger (2000) examined the validity of the Gibrat's law on the West German manufacturing sector over the period 1989 to 1994. They found out, that smaller firms grow faster than larger ones. In this study, company size was measured with the help of number of employees. AmirKhalkali and Mukhopadhyay (2008) examined the Law of proportionate effect on the sample of 418 Canadian firms in the period 2004–2006. According the results of this study, smaller firms grow faster than larger counterparts. Firm size is measured by revenues.

On the other hand, some studies validated the Law of proportionate effect, for instance Del Monte and Papagni (2003), Hart and Prais (1956) or Simon and Bonini (1958). Del Monte and Papagni (2003) tested Gibrat's law using the sample of 500 Italian manufacturing firms. In the period from 1989 to 1997, they found that Gibrat's law is confirmed. Sales were used as an indicator of company size. Hart and Prais (1956) examined quoted companies in the UK for selected years during 1885–1950. The rates of growth of these companies were independent of their sizes. They used market valuation for measuring firm size. Simon and Bonini (1958) selected 500 largest US industrial firms from 1954 to 1956. According their results, Gibrat's law tends to hold.

Some studies found mixed results and in some cases they rejected Gibrat's law and in some cases confirmed this Law. Daunfeldt and Elert (2013) investigated 288,757 Swedish firms during 1998–2004. For an aggregate level, they rejected Gibrat's law (small firms grow faster than larger ones). However, if firms were divided into five

digit industries and only firms which survived throughout to the year 2004 were included, the Law was confirmed in about 50% of industries. They measured firm size with the help of two indicators – employment and revenue. Daunfeldt and Elert (2013) also found that Gibrat's law is more likely to hold in mature industries, in industries with a high degree of market concentration or in industries with a high share of firms in the industry that belong to an company group. Gibrat's law is more probably to be rejected for larger industries, with high minimum efficient scale (MES) and high share of companies located in big cities (metropolitan areas). Lotti, Santarelli and Vivarelli (2009) focused on Italian radio, TV, and communication equipment industry (total sample contains 3,285 firms) over the period 1987–1994. They rejected Gibrat's law (smaller companies tends to grow faster than larger firms) in the short run (*ex ante*), however there is convergence toward Gibrat's law through time (*ex post*). They used employment as an indicator of firm size. Fotopoulos and Giotopoulos (2010) used the data of 3,685 Greek manufacturing firms during period 1995–2001 and rejected Gibrat's law for total sample of firms. However, they divide the firm into group according to the firm age and size and examine the validity of Law for these narrowed subsamples. They rejected the validity of Gibrat's law for micro and small firms (smaller companies grow faster than their larger counterparts) and on the other hand accepted it for medium, large and old firms. Total assets were used for measuring company size.

Studies, which are focused on the investigation of the Law of proportionate effect differ in many aspects: used data, chosen empirical model and firm size measurement. That is a reason, why is hard to compare main findings of these studies. In this article we focus on the last mentioned aspect, the indicator of firm size. There are several ways how to measure firm size as we can see above. Number of employees, assets, sales, revenue and market value of firm are used as measurement of firm size in the studies dealing with the issue of Law of proportional effect. The number of employees is the most commonly used indicator (Nassar, Almsafir and Al-Mahrouq, 2014). However, the disadvantage of this indicator is its relative rigidity. The growth or decline in real output of the company could be reflected in the indicator with a considerable delay. That is a reason, why we will use alternative indicators of firm size (number of employees, assets and revenue) to find out, whether the results vary depending on used indicator of firm size.

DATA AND METHODOLOGY

The statistical analyses in this paper are based on the data from the database Albertina CZ Gold Edition offered by the company Bisnode. We used panel data about profit industries A-N (according to NACE) for the period 2007 to 2012. According

I: Average Summary Statistics in Natural Logs

Variable	Samples according to data availability			Similar samples		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Revenue	178,250	8.909	2.301	130,889	9.506	1.965
Number of employees	130,889	2.479	1.400	130,889	2.479	1.400
Total assets	178,250	9.188	1.990	130,889	9.438	1.954

to Daunfeldt and Elert (2013) we select only companies, which were in 2007 at least in 5 years in the industry and survived throughout the study period. The results could be biased in case of inclusion of all firms, because smaller companies have a higher expected probability of exit than larger firms. The descriptive statistics are shown in Tab. I.

The revenue represents the real revenues which are calculated using consumer price index published by the Czech Statistical Office¹ (Czech Statistical Office, 2014). The indicator “revenue” includes revenues from sales of goods and services. Number of employees is calculated as full time equivalent. There are not available all affordable data about all three indicators of firm size for all companies. Hence, we use two samples. First sample “according to data availability” includes data of 35.656 firms (in case of firm size indicators revenue and total assets) and 28.172 firms (in case of firm size indicator number of employees). There are data of 28.172 companies in the second “similar sample”.

To verify the validity of Gibrat's law we use the approach of Daunfeldt and Elert (2013). They estimate the validity of Gibrat's law using this model

$$\ln S_{it}^j = \alpha_{j0} + \alpha_{j1} \ln S_{it-1}^j + \theta_{jt} T_t + u_{jt} \quad (1)$$

Where S_{it}^j is the size of i -th firm of j -th industry in time t , $\theta_{jt} T_t$ is a vector of time specific fixed effects. The values of parameter α_{j1} indicate if the the Gibrat's law is valid or not. The Gibrat's law holds if $\hat{\alpha}_{j1}$ equal to one. The value smaller than one implies that a small firm grows faster than a large one and the value higher than one signifies that large firm grows faster than small one.

The advantage of this model is its simplicity and the fact, that it includes time specific fixed effects for every sector. Hardwick and Adams (2002) showed that business cycles could play a role and this model enables to consider this fact.

Daunfeldt and Elert (2013) use OLS estimator and five-digit NACE classification for industry. To estimate the Gibrat's law validity, we modify the original model (equation 1) and use this form

$$\ln S_{it} = \alpha_0 + \alpha_1 \ln S_{it-1} + \alpha_2 \cdot NACE_i + \alpha_{3k} T_t \cdot NACE_i + u_i \quad (2)$$

Where S_{it} is the size of i -th firm in time t , $NACE_i$ is the dummy variable for industry using 1-digit and

5-digit NACE classification of i -th firm, $\alpha_2 \cdot NACE_i$ is the vector of industry specific fixed effects, $\alpha_{3k} T_t \cdot NACE_i$ is a vector of time and industry specific fixed effects. The values of parameter α_1 indicate if the the Gibrat's law is valid or not. The Gibrat's law holds if $\hat{\alpha}_1$ equal to one. The value smaller than one implies, that small firm grows faster than large one and the value higher than one, that large firm grows faster than small one.

We use three indicators of firm size: revenue, employment and total assets and compare the results of the model (equation 2). Because of heteroskedasticity and serial correlation problem, we use OLS estimator with cluster-robust standard errors. To confirm or reject Gibrat's law, we test null hypothesis $H_0: (\hat{\alpha}_1) = 1$ versus $H_1: (\hat{\alpha}_1) \neq 1$ using F-test.

RESULTS AND DISCUSSION

We estimate validity of Gibrat's law using three version of equation (2). Model (1) includes only the time specific fixed effect, which capture time-variant heterogeneity in growth rates. Model (2) and model (3) contain also industry specific fixed effect and industry and time specific fixed effect capturing industry-variant heterogeneity in growth rates. For comparison purpose, we use 1-digit CZ-NACE classification in model (2) and 5-digit CZ-NACE classification in model (3).

We examine validity of Gibrat's using two samples. Firstly, we use samples according to data availability. Results are shown in Tab. II. Here, the number of firms for indicator number of employees differs from other two firm size indicators. To get more comparable results for all three indicators, we estimate the validity of Gibrat's law using second sample containing the same number of observations. The results shows Tab. III.

The results presented in Tabs. II and III indicate that $\alpha_1 < 1$ for all three indicators of measuring firm size and for both samples. The results are not influenced by used indicator of firm size (revenue, number of employees and total assets), which is important finding of this paper. As we quoted above number of employees is the most commonly used indicator of firm size in the scientific papers. For Czech companies, it is much easier to find data about total assets or revenue than about number of employees, where this indicator is not usually

1 Revenue = (nominal revenue/CPI).100.

II: Samples according to data availability

	Revenue			Number of employees			Total assets		
	Model (1)	Model (2) ^b	Model (3) ^c	Model (1)	Model (2) ^b	Model (3) ^c	Model (1)	Model (2) ^b	Model (3) ^c
$\ln.S_{t-1}(\alpha_1)$	0.977*** (0.001)	0.972*** (0.001)	0.963*** (0.001)	0.972*** (0.001)	0.968*** (0.001)	0.960*** (0.001)	0.989*** (0.001)	0.987*** (0.001)	0.983*** (0.001)
T_t fixed effects	Yes	-	-	Yes	-	-	Yes	-	-
$NACE_t$ fixed effects	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes
$T_t, NACE_t$ fixed effects	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes
Constant	0.161*** (0.008)	0.222*** (0.014)	0.011 (0.305)	0.074*** (0.002)	0.064*** (0.008)	0.078*** (0.028)	0.140*** (0.007)	0.195*** (0.010)	0.324*** (0.123)
R ²	0.939	0.940	0.942	0.943	0.943	0.945	0.961	0.961	0.962
N	178,250	178,250	178,250	130,889	130,889	130,889	178,250	178,250	178,250
F-test ^a	947.59***	878.14***	989.48***	1749.51***	1555.21***	1745.65***	315.48***	376.07***	461.54***

Notes: *** significant at the 1 per cent level, ** significant at the 5 per cent level, * significant at the 10 per cent level, robust standard errors in brackets, a. F-test of $H_0: \alpha_1 = 1$, *** rejection of H_0 at the 1 percent level, ** rejection of H_0 at the 5 percent level, * rejection of H_0 at the 10 percent level, b. 1 digit NACE classification, c. 5 digit NACE classification

III: The similar sample

	Revenue			Number of employees			Total assets		
	Model (1)	Model (2) ^b	Model (3) ^c	Model (1)	Model (2) ^b	Model (3) ^c	Model (1)	Model (2) ^b	Model (3) ^c
$\ln.S_{t-1}(\alpha_1)$	0.986*** (0.001)	0.983*** (0.001)	0.975*** (0.001)	0.972*** (0.001)	0.968*** (0.001)	0.960*** (0.001)	0.993*** (0.001)	0.991*** (0.001)	0.988*** (0.001)
T_t fixed effects	Yes	-	-	Yes	-	-	Yes	-	-
$NACE_t$ fixed effects	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes
$T_t, NACE_t$ fixed effects	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes
Constant	0.073*** (0.010)	0.109*** (0.015)	0.078 (0.216)	0.074*** (0.002)	0.064*** (0.008)	0.078*** (0.028)	0.099*** (0.007)	0.155*** (0.011)	0.499*** (0.063)
R ²	0.937	0.937	0.940	0.943	0.943	0.945	0.965	0.965	0.966
N	130,889	130,889	130,889	130,889	130,889	130,889	130,889	130,889	130,889
F-test ^a	213.27***	249.59***	354.37***	1749.51***	1555.21***	1745.65***	105.30***	142.75***	209.31***

Notes: *** significant at the 1 per cent level, ** significant at the 5 per cent level, * significant at the 10 per cent level, robust standard errors in brackets, a. F-test of $H_0: \alpha_1 = 1$, *** rejection of H_0 at the 1 percent level, ** rejection of H_0 at the 5 percent level, * rejection of H_0 at the 10 percent level, b. 1 digit NACE classification, c. 5 digit NACE classification

referred exactly. The possibility to substitute the indicator “number of employees” would be very useful for paper focused on the Czech firms. These results imply that small companies in profit industries in the Czech Republic grow faster than their larger counterparts and there is significant inverse relationship between firm size and firm growth. On the basis of these results, Gibrat's law is rejected ($\alpha_1 \neq 1$) for all three indicators of firm size.

Results of this study are in harmony with some previous papers, which were focused on testing Gibrat's law. The vast majority of recent studies dealing with the long time series and data for the whole economy reject the validity of Gibrat's law for total sample and conclude that smaller firms have a higher growth rate than larger (for example Lotti, Santarelli and Vivarelli, 2009; Daunfeldt and Elert, 2013; Fotopoulos and Giotopoulos, 2010).

Daunfeldt and Elert (2013) rejected Gibrat's law for an aggregate level. The values of parameter are very similar in comparison with our results, thus in this case are these results consistent with our study. Using industry specific regressions, the validity of Gibrat's law was confirmed in about half of the industries. Hence, authors concluded that the industry context matters. Here is the space for other research whether these results are valid in the Czech Republic, too.

Lotti, Santarelli and Vivarelli (2009) also rejected Gibrat's law ex ante over the period 1987–1994 and in this case, their study is in accordance with our findings. However, when they tested the validity of Gibrat's law year-by-year (seven separate estimates), they found convergence toward the validity of this Gibrat's law through time. Tang (2015) found the similar results like Lotti, Santarelli and Vivarelli

(2009). Rejection of Gibrat's law validity with the help of investigation of the entire period (ex ante) do not have to lead to rejection of the Law with the help of year-by-year estimation (ex post). Thus, year-by-year estimation is interesting suggestion for further research, too.

One of the factors that might be behind this result in our case is the economic crisis of that period.

It can be assumed that companies were aware of the threat of losing their competitiveness that could potentially lead to their end. While large enterprises focused on operational efficiency and cost saving, SMEs could react to changes in the environment through innovation (Žižlavský, 2015) and take into account different types of stakeholders (Slabá, 2014).

CONCLUSION

The goal of the paper was to examine the validity of the Gibrat's law in the Czech Republic and to find out to what extent the confirmation or rejection of Gibrat's law depends on the chosen firm size indicators. Main findings of this article are following: (1) There is a negative significant relationship between firm size and firm growth in the Czech Republic for the period 2007–2012. (2) The results are not influenced of the type of firm size indicator, because for all three used indicators are results very similar. (3) Smaller firms in the Czech Republic grow faster than their larger counterparts.

On the basis of results of these studies and our findings, we cannot unambiguously reject validity of Gibrat's law in the Czech Republic. Firstly, Gibrat's law might be valid only for selected industries (for example Daunfeld and Elert, 2013). Secondly, it can be valid in the very long run, when noisy selection has been completed and markets tend to approach a steady state (Lotti, Santarelli and Vivarelli, 2009). Alternatively, it might be accepted only for selected groups of firms according to firm size (Fotopoulos and Giotopoulos, 2010). And finally, the validity could depend on age of companies (Fotopoulos and Giotopoulos, 2010). The impact of these factors on confirmation of Gibrat's law validity in the case of the Czech Republic deserves further research.

Acknowledgement

This paper was supported by the internal grant of the College of Polytechnics Jihlava „The relationship among firm size, firm growth and gender characteristics“.

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