Fiala, Roman

Article

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Testing Convergence toward Gibrat's Law for Czech Manufacturing Firms

*Roman FIALA**

Abstract

The paper attempts to examine if there is any convergence toward Gibrat's law over time for the sample of Czech manufacturing firms over the time period of 2007 – 2015. Firstly, the validity of Gibrat's law over the entire period from 2007 to 2015 was investigated separately for two samples – for large companies and for small and medium-sized enterprises (SMEs). The validity of Gibrat's law was tested via the linear regression model with the first-order autoregressive process. While for large firms, there was found no relationship between firm size and firm growth, for the sample of SMEs Gibrat's law was rejected. Secondly, we tested for both samples if there is any convergence toward Gibrat's law over time. There is convergence toward Gibrat's law over time for the sample of SMEs.

Keywords: *Gibrat's law, firm size, firm growth, manufacturing, linear regression model*

JEL Classification: L11, L26

Introduction

A number of scholars have focused on the relationship between the firm growth and firm size. Researchers who deal with this issue have been significantly influenced by Robert Gibrat (1931), who investigated the size distribution of French manufacturing plants over the time period of 1896 – 1921. He stated that the firm growth is a stochastic process resulting from many unobserved random variables, and is independent of the size of a firm at the beginning of the examined period (Sutton, 1997). Gibrat's law (the Law of Proportionate Effect) states that firm growth is a random walk, independent of the company size.

* Roman FIALA, College of Polytechnics Jihlava, Department of Economic Studies, Tolstého 16, 586 01 Jihlava, Czech Republic; e-mail: roman.fiala@vspj.cz

There are two aims of this paper. Firstly, to test the validity of Gibrat's law over the entire period from 2007 to 2015, and secondly, to investigate whether there is any convergence toward Gibrat's law over time. Both goals will be tested for two datasets – the small and medium-sized manufacturing enterprises (SMEs) and large firms from manufacturing industry in the Czech Republic.

We have found no study dealing with testing Gibrat's law for Czech firms first focused only on large, and secondly on small and medium-sized enterprises investigating the convergence toward a Gibrat-like behaviour over time.

This paper is organized as follows: section 1 deals with literature review, section 2 describes the applied data and methodology, section 3 shows the empirical results and discussion about the achieved results and compares these with findings of previous studies and the last section titled Conclusions and suggestions for further research is focused on concise recapitulation of main findings of the paper.

1. Literature Review

We can sort the studies focused on the testing Gibrat's law into three categories. (1) The studies in which the validity of Gibrat's law was verified; (2) the studies which rejected Gibrat's law and (3) the studies with mixed results (partly verifying and partly rejecting the validity of the law).

1.1. Studies Verifying Validity of Gibrat's Law

Hart and Prais (1956) and Simon and Bonini (1958) focused on large and mature companies. Hart and Prais (1956) investigated quoted companies in the UK for the chosen years of 1885 – 1950. Simon and Bonini (1958) selected 500 largest US industrial firms from 1954 to 1956. Buckley, Dunning and Pearce (1984) also dealt with large firms. They found that the relationship between the firm growth and firm size was viewed as stable but not statistically significant. Klette and Griliches (2000) used the sample of Norwegian firms and focused on the hightech industry. Pfaffermayr and Bellak (2000) investigated Austrian manufacturing companies (foreign-owned companies and domestically-owned companies). Del Monte and Papagni (2003) confirmed the validity of Gibrat's law for a sample of Italian manufacturing firms. Fujiwara et al. (2004) examined firms from 45 European countries. Gibrat's law was validated by Leitão, Serrasqueiro a Nunes (2010), too. Seven of the eight above mentioned studies investigated companies with more than 10 employees and six studies studied firms with more than 20 employees. In the paper by Leitão, Serrasqueiro and Nunes (2010), the average number of employees was 58 and the median was 19.

1.2. Studies with Mixed Results

Some authors focused on more samples in their papers or used more indicators for measuring the firm size. Gibrat's law was confirmed only for some samples in these studies. Mansfield (1962) selected three sectors of manufacturing in the USA (steel, petroleum, tires), and subdivided the time for each industry into more time periods. The steel and petroleum industries were divided by Mansfield (1962) into four periods and the tires sector into two periods. Gibrat's law was rejected in more than a half of the cases.

Hall (1987) dealt with publicly traded companies in the USA. Gibrat's law was rejected for small firms and confirmed for large companies.

Spanish manufacturing companies were examined by Fariñas and Moreno (2000). When they integrated failing firms in the sample, there were no significant differences between (1) the growth rate and size of the firm and (2) the growth rate and age of companies. They also found out failure rates decreased with the size and age of organizations, and the mean growth rate of successful companies declined with the size and age.

Chen and Lu (2003) decided to analyse 18 different industries, and their results were different across industries. Gibrat's law was rejected in some industries (for instance food, textile, electronics), in other industries the law was accepted (for instance automobile or tourism). Similar results to those by Chen and Lu (2003) were revealed by Aslan (2008), who investigated the sample of the 500 biggest companies in Turkey. For some industries, Gibrat's law was accepted, for others not.

1.3. Studies Rejecting Gibrat's Law

In a lot of studies, the validity of Gibrat's law have been rejected. Evans (1987a; 1987b) selected for his research the manufacturing industry in the USA. His main finding is the fact that there is a negative link between the firm growth and firm size. Almus and Nerlinger (2000) analysed 39,355 manufacturing firms in Germany for the period of 1990 – 1996, and found out that small firms grew faster than their larger counterparts. The same finding was described by Dunne and Hughes (1994) in their paper; they decided to examine British companies from 19 industries. Oliveira and Fortunato (2006) focused on Portuguese manufacturing enterprises. For their sample and for the period of 1990 – 2001, they discovered that bigger and mature companies grew faster than smaller and younger firms. Calvo (2006), who investigated Spanish manufacturing organizations, revealed the same findings. There are other authors who decided to focus on manufacturing, for instance Falk (2008), Feizpour, Mahmoudi and Soltani

(2010) or Levratto, Tessier and Zouikri (2010). Whereas Feizpour, Mahmoudi and Soltani (2010) or Levratto, Tessier and Zouikri (2010) investigated companies from one country (Feizpour, Mahmoudi and Soltani, 2010, Iran, and Levratto, Tessier and Zouikri, 2010, France), Falk used data of enterprises from 15 European countries. Bentzen, Madsen and Smith (2012) dealt with seven industries. They surprisingly found out that larger firms grew faster than smaller companies. There are few studies which verified the validity of Gibrat's law for retailing. One of this small lot is a study by Daunfeldt, Elert and Lang (2012). Kosová and Lafontaine (2010) dealt with franchise chains, and found a negative influence of the age and size on the chain growth. Fiala and Hedija (2015) examined the link between the firm growth and firm size in profit industries in the Czech Republic in the period from 2007 to 2012. Gibrat's law was rejected for all three indicators of the firm size (revenues, number of employees and total assets).

As we can see above, there is no consensus whether Gibrat's law is valid or not. Lotti, Santarelli and Vivarelli (2009) introduced the idea of the difference between the verification of Gibrat's law in the short-run and long-run. They explain this difference by means of two models of passive and active learning. The first argument for this hypothesis is a Bayesian model of noisy selection – in accordance with this model of passive learning, efficient companies grow and survive, and inefficient enterprises tend to decline and fail (Jovanovic, 1982; Lotti, Santarelli and Vivarelli, 2009). Lotti, Santarelli and Vivarelli (2009, p. 33) simply describe this model: „… firms are initially endowed with unknown, time-invariant characteristics, i.e., ex ante efficiency parameters, while ex post the prior distribution is updated as evidence comes in which leads some firms to discover that they are more efficient than others. Thus, each firm has to decide on its strategy: whether to exit, to continue at the same size, to expand, or to reduce its productive capacity“. After the noisy selection process has been completed, the law of proportionate effect tends to confirm (Tang, 2015).

The active learning model was designed by Ericson and Pakes (1995). Teruel-Carrizosa (2010, p. 360) noted that this active model is similar like passive, but "… firms could modify their own level of efficiency by increasing their investments. However, these firms have to consider investment by other firms and external shocks. This means that, while a firm makes a great effort to invest, it should also take into account investment by its competitors".

Lotti, Santarelli and Vivarelli (2009) confirmed the above stated hypothesis, so they rejected Gibrat's law (smaller companies tend to grow faster than larger firms) in the short-run, however there is convergence toward Gibrat's law over time.

2. Data and Methodology

The data for this study come from the Albertina CZ Gold Edition database. We used data about the manufacturing enterprises (SMEs) from the Czech Republic for the period from 2007 to 2015. The manufacturing industry is section C according to CZ-NACE classification.

For definition of small and medium-sized manufacturing enterprises Commission Recommendation 2003/361/EC of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises was used. The small and medium--sized enterprises employ fewer than 250 employees and have an annual turnover not exceeding 50 million EUR, and/or an annual balance sheet total not exceeding 43 million EUR. Firms were divided on the basis of the data from the year of 2007.

According to Daunfeldt and Elert (2013), we use only data from such companies which had been in 2007 at least for 5 years in the industry and survived throughout the entire period from 2007 to 2015. In case of inclusion of all firms, the results could be biased because smaller companies have a higher expected probability of going out of business than their larger counterparts. There are not included new entrants from 2007 to 2015 in the data because such new firms may have undergone a specific development.

We use the revenue and total assets as indicators of the firm size because of the results of comparing both of these indicators. The revenue represents the real revenues which are calculated using consumer price index published by the Czech Statistical Office (2015). The indicator "revenue" includes revenues from sales of goods and services. These indicators count among the most used for measuring the firm size and firm growth; and this methodology provides not only comparison but also a bigger robustness of the gained results.

The descriptive statistics are shown in Tables 1 and 2.

T a b l e 1

Revenues and Total Assets in CZK Thousands – Small and Medium-sized Enterprises

Year	N	Revenues		Total assets	
		Mean	Std. Dev.	Mean	Std. Dev.
2007	2 902	147 909.7	248 739.1	81 641.0	149 374.7
2008	2 902	139 290.7	231 704.6	87 284.8	161 298.6
2009	2 902	114 863.8	194 843.8	85 013.3	159 209.2
2010	2 902	125 898.3	222 503.6	90 462.1	168 448.4
2011	2 902	138 183.0	248 030.9	96 213.2	178 667.3
2012	2 902	136 582.9	249 331.8	98 044.0	180 418.8
2013	2 902	137 223.3	245 850.1	103 681.3	191 329.2
2014	2 902	149 018.5	267 920.9	110 920.6	206 006.6
2015	2 902	153 890.6	274 678.7	114 737.0	210 355.2

Source: Bisnode (2015); own calculation.

T a b l e 2

Revenues and Total Assets in CZK Thousands – Large Enterprises

Year	N	Revenues		Total assets	
		Mean	Std. Dev.	Mean	Std. Dev.
2007	270	1 044 124.0	745 083.1	724 156.9	685 254.9
2008	270	936 633.3	668 653.8	715 915.7	672 300.6
2009	270	761 552.8	566 684.2	682 594.9	677 060.0
2010	270	833 134.8	601 737.2	711 192.2	687 546.2
2011	270	884 219.5	660 117.9	734 841.1	693 231.9
2012	270	872 877.2	657 795.3	747 423.3	687 707.8
2013	270	875 390.3	670 875.7	781 892.2	714 830.8
2014	270	965 760.5	753 837.7	825 919.1	749 906.4
2015	270	991 620.2	770 200.8	835 404.3	737 984.3

Source: Bisnode (2015); own calculation

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

$$lnS^{i}_{jt} = \alpha_{j0} + \alpha_{j1}.ln\,S^{i}_{j(t-1)} + \theta_{jt}.T_t + u_{jt} \tag{1}$$

where

S^{i}_{jt} – the size of the *i*-th firm of the *j*-th industry at time *t*,

$\theta_{jt}.T_t$ – a vector of time specific fixed effects.

To estimate the Gibrat's law validity, we modify the original model (equation 1) and use the following formula

$$lnS_{it} = \alpha_0 + \alpha_1.ln\,S_{i(t-1)} + \alpha_2.NACE_i + \alpha_{3k}.T_t.NACE_i + u_t \tag{2}$$

where

S_{it} – the size of the *i*-th firm at time *t*,

$NACE_i$ – a dummy variable for the industry using the 5-digit NACE classification of the *i*-th firm,

$\alpha_2.NACE_i$ – a vector of industry specific fixed effects,

$\alpha_{3k}.T_t.NACE_i$ – a vector of time and industry specific fixed effects.

The values of parameter α_1 indicate whether Gibrat's law is valid or not. Gibrat's law is valid if $\widehat{\alpha_1}$ equals to one. A value smaller than one implies that a small firm grows faster than a large one, and the value higher than one indicates that a large firm grows faster than a small one.

Following Daunfeldt and Elert (2013), to estimate the model parameters, we use the ordinary least squares (OLS) estimator. Because of heteroskedasticity and the problem of serial correlation, we use the OLS estimator with cluster-robust standard errors. To confirm or reject Gibrat's law, we test the null hypothesis $H_0 : \left(\widehat{\alpha_1}\right) = 1$ versus $H_1 : \left(\widehat{\alpha_1}\right) \neq 1$ using F-test.

3. Results and Discussion

We estimate validity of Gibrat's law using the linear regression model with the first-order autoregressive process using equation 2. Firstly, Gibrat's law was investigated for the entire period of 2007 – 2015. Two versions of the equation were used.

Model (1) contains only the time specific fixed effect which captures time-variant heterogeneity in growth rates. Model (2) includes also the industry specific fixed effect and industry and time specific fixed effect capturing industry variant heterogeneity in growth rates.

As you can see in Tables 3 and 4, if we added the time and industry specific fixed effect and the industry specific fixed effect (key model 2), there is a statistically positive relationship between the firm size and firm growth for the sample of small and medium-sized firms ($\widehat{\alpha_1} < 1$) and thus, Gibrat's law was rejected for this model (2). Results are the same for both indicators of the firm size – revenues and total assets.

T a b l e 3

Estimation of Gibrat's Law Validity for the Period of 2007 – 2015: Revenues as an Indicator of the Firm Size – Small and Medium-sized Enterprises

	Model (1)	Model (2)
ln S_{t-1} (α_1)	0.9967***	0.9916***
	(0.0021)	(0.0026)
T_t fixed effects	Yes	–
$NACE_j$ fixed effects	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes
Constant	–0.0171	0.0283
	(0.0246)	(0.0466)
R^2	0.9564	0.9611
N	23 216	23 216
F-test	2.54	10.60**

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

Our results are consistent with one of few studies dealing with small and medium-sized firms – Almus and Nerlinger (2000). They focused on the situation in West Germany in the period from 1990 to 1996 and found out that smaller companies had higher growth potential than larger firms.

For the sample of large firms, there is no relationship between the firm size and firm growth (see Tables 5 and 6) for key model (2), thus we can confirm Gibrat's law. This confirmation for model (2) holds for both indicators of the firm size.

T a b l e 4

Estimation of Gibrat's Law Validity for the Period of 2007 – 2015: Total Assets as an Indicator of the Firm Size – Small and Medium-sized Enterprises

	Model (1)	Model (2)
ln S_{t-1} (α_1)	0.9996***	0.9959***
	(0.0015)	(0.0018)
T_t fixed effects	Yes	–
$NACE_j$ fixed effects	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes
Constant	0.0534**	0.1107***
	(0.0180)	(0.0346)
R^2	0.9740	0.9761
N	23 216	23 216
F-test	0.06	5.07*

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

T a b l e 5

Estimation of Gibrat's Law Validity for the Period of 2007 – 2015: Revenues as an Indicator of the Firm Size – Large Enterprises

	Model (1)	Model (2)
ln S_{t-1} (α_1)	0.9840***	0.9835 ***
	(0.0079)	(0.0115)
T_t fixed effects	Yes	–
$NACE_j$ fixed effects	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes
Constant	0.1030	0. 1140
	(0.1056)	(0.1694)
R^2	0.9306	0.9614
N	2 160	2 160
F-test	4.13*	2.06

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

Validation of Gibrat's law for large enterprises is consistent with the idea mentioned by Geroski (1995), Lotti, Santarelli and Vivarelli (2009) or Tang (2015), i.e. Gibrat's law is not valid generally but only for large and mature companies (which already reached the minimum efficient scale (MES), not for smaller firms operating at sub-optimal scales. This theory was also empirically confirmed in other previous studies focused on large firms, as in Hart and Prais (1956), Simon and Bonini (1958), Buckley, Dunning and Pearce (1984) or Fujiwara et al. (2004).

In Lotti, Santarelli and Vivarelli (2009), Gibrat's law was investigated year-by--year (eight separate estimates) using equation (2) to reveal whether there is any convergence toward Gibrat's law over time. The results for the sample of SMEs

presented in Tables 7 and 8 indicate convergence toward a Gibrat-like behaviour over time. Whereas in the first two periods (2007 – 2008 and 2008 – 2009) Gibrat's law was rejected (for both size indicators), for the following periods Gibrat's law was confirmed. What makes these results very interesting is the fact that they are the same for both indicators of the size – revenues (see Table 7) and total assets (see Table 8). On the basis of these findings, we can conclude that convergence toward Gibrat's law over time is relatively fast for the sample of SMEs. Here it is important to remind the reader that we examined only data about such firms which entered the industry no later than in the year of 2001.

T a b l e 6

Estimation of Gibrat's Law Validity for the Period of 2007 – 2015: Total Assets as an Indicator of the Firm Size – Large Enterprises

	Model (1)	**Model (2)**
ln S_{t-1} (α_1)	0.9968***	0.9958***
	(0.0040)	(0.0068)
T_t fixed effects	Yes	–
$NACE_j$ fixed effects	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes
Constant	0.0211	0.0581
	(0.0540)	(0.0921)
R^2	0.9705	0.9827
N	2 160	2 160
F-test	0.65	0.37

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

T a b l e 7

Year-by-year Estimation of Gibrat's Law for SMEs (Model 2) – Revenues as an Indicator of the Firm Size

Years	**2007 – 2008**	**2008 – 2009**	**2009 – 2010**	**2010 – 2011**	**2011 – 2012**	**2012 – 2013**	**2013 – 2014**	**2014 – 2015**
ln S_{t-1} (α_1)	0.9485***	0.9709***	0.9983***	0.9913***	1.0047***	1.0033***	1.0052***	1.0013***
	0.1262	(0.0075)	(0.0080)	(0.0084)	(0.0067)	(0.0068)	(0.0067)	(0.0065)
NACE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.5382***	0.2815***	–0.0469	0.08827	–0.0370	–0.0375	–0.0830	–0.0543
	(0.1548)	(0.9781)	(0.0952)	(0.1063)	(0.0844)	(0.0845)	(0.0837)	(0.0798)
R^2	0.9517	0.9488	0.9513	0.9593	0.9685	0.9671	0.9701	0.9673
N	2 902	2 902	2 902	2 902	2 902	2 902	2 902	2 902
F-test	16.64***	15.12***	0.05	1.07	0.49	0.24	0.60	0.04

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

The very same results as in this paper can be found in the studies by Tang (2015) and Lotti, Santarelli and Vivarelli (2009), in which Gibrat's law was

rejected for the entire period (for this paper a sample of SMEs), but convergence toward this law occurs over time. The reason for this finding can be explained by models of active and passive learning mentioned above.

T a b l e 8

Year-by-year Estimation of Gibrat's Law for SMEs (Model 2) – Totals Assets as an Indicator of the Firm Size

Years	**2007 – 2008**	**2008 – 2009**	**2009 – 2010**	**2010 – 2011**	**2011 – 2012**	**2012 – 2013**	**2013 – 2014**	**2014 – 2015**
ln S_{t-1} (α_1)	0.9806***	0.9829***	0.9904***	0.9901***	1.0006	1.0076***	1.0060***	1.0054***
	(0.0081)	(0.0044)	(0.0053)	(0.0072)	(0.0043)	(0.0043)	(0.0045)	(0.0043)
NACE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.2719**	0.1850***	0.0826	0.1192	–0.0219	–0.0325	–0.0577	–0.0873
	(0.0903)	(0.0567)	(0.0602)	(0.0853)	(0.0508)	(0.0600)	(0.0547)	(0.0525)
R^2	0.9634	0.9735	0.9734	0.9720	0.9814	0.9824	0.9803	0.9807
N	2 902	2 902	2 902	2 902	2 902	2 902	2 902	2 902
F-test	5.72*	14.92***	3.29	1.91	0.02	3.07	1.77	1.57

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

Eight separate estimates were also calculated for large companies and the results are shown in Tables 9 and 10. We can see that Gibrat's law was confirmed for each year of the time period. For large firms, there is no relationship between the firm growth and firm size not only in the short-run, but also in the long-run.

T a b l e 9

Year-by-year Estimation of Gibrat's Law for Large Enterprises (Model 2) – Revenues as an Indicator of the Firm Size

Years	**2007 – 2008**	**2008 – 2009**	**2009 – 2010**	**2010 – 2011**	**2011 – 2012**	**2012 – 2013**	**2013 – 2014**	**2014 – 2015**
ln S_{t-1} (α_1)	0.9720***	0.9585***	0.9388***	1.0054***	0.9440***	1.0104***	0.9879***	1.0367***
	(0.0320)	(0.0298)	(0.0364)	(0.0226)	(0.0493)	(0.0232)	(0.0258)	0.0235)
NACE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.2737	0.5730	0.7862	0.0003	0.7942	–0.1072	0.2196	–0.5260
	(0.4506)	(0.4154)	(0.5032)	(0.3154)	(0.6828)	(0.3266)	(0.3590)	(0.3291)
R^2	0.9578	0.9555	0.9547	0.9690	0.9511	0.9638	0.9671	0.9707
N	270	270	270	270	270	270	270	270
F-test	0.76	1.93	2.83	0.06	1.29	0.20	0.22	2.42
p-value	0.3832	0.1659	0.0939	0.8106	0.2574	0.6531	0.6389	0.1219

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

The findings are again the same for both size indicators – revenues and totals assets, thus both indicators have the same data validity and for the purpose of this paper could be substituted one for the other.

Table 10

Year-by-year Estimation of Gibrat's Law for Large Enterprises (Model 2) – Totals Assets as an Indicator of the Firm Size

Years	**2007 – 2008**	**2008 – 2009**	**2009 – 2010**	**2010 – 2011**	**2011 – 2012**	**2012 – 2013**	**2013 – 2014**	**2014 – 2015**
ln S_{t-1} (α_1)	0.9857***	1.0026***	0.9832***	1.0131***	0.9675***	1.0242***	1.0122***	0.9783
	(0.0345)	(0.01882)	(0.0187)	(0.0195)	(0.0166)	(0.0136)	(0.0116)	(0.0207)
NACE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.1873	–0.0291	0.2434	–0.1143	0.3912	–0.2978	–0.1678	0.3185
	(0.4424)	(0.2408)	(0.2553)	(0.2603)	(0.2182)	(0.1758)	(0.1509)	(0.2681)
R^2	0.9656	0.9844	0.9803	0.9861	0.9805	0.9914	0.9917	0.9799
N	270	270	270	270	270	270	270	270
F-test	0.17	0.02	0.80	0.45	3.82	3.19	1.12	1.09
p-value	0.6795	0.8902	0.3718	0.5016	0.0518	0.0752	0.2902	0.2966

Notes: ***significant at the 0.1 per cent level; **significant at the 1 per cent level; *significant at the 5 per cent level, robust standard errors in brackets, F-test of $H_0 : \alpha_1 = 1$.

Source: Bisnode (2015); own calculation.

All presented results are in accordance with active and passive learning models. According to these models, expansion of companies has a steady state and Gibrat's law is rejected in the short term when smaller companies grow faster than larger (and more experienced) companies (Tang, 2015). And after the noisy selection process has been completed, Gibrat's law was confirmed in the long-run.

Whereas there is a significant link between the firm size and firm growth rate for the first two periods of the SMEs sample, there is no relationship between the firm growth rate and firm size for the examined years of 2009 – 2015. We can clearly see convergence toward a Gibrat-like behaviour over time for this SMEs sample. Large firms have reached their steady state, and that is the reason why Gibrat's law for this sample is confirmed both in the short and long-run.

4. Conclusions and Suggestions for Further Research

There were two goals of this paper. Firstly, the validity of Gibrat's law was investigated over the entire period from 2007 to 2015 and secondly, we tested if there is any convergence toward Gibrat's law over time. Gibrat's law was tested separately for SMEs and for large companies.

The findings for manufacturing firms from the Czech Republic are in accordance with the study by Lotti, Santarelli and Vivarelli (2009). For the dataset of SMEs, Gibrat's law was rejected for the period of 2007 – 2015, smaller firms grew at a higher rate than their large counterparts. Then, Gibrat's law was tested for SMEs year-by-year (eight separate estimates), and convergence toward a Gibrat-like behaviour over time was revealed. For the large firms sample, Gibrat's law was confirmed over the entire period. When the relationship between

firm the growth rate and firm size was tested, in each of eight separate estimates, there was no significant link between the firm growth and firm size; thus Gibrat's law was confirmed in all eight separate estimates.

It proves that the firm size is not the key factor which influences the firm growth of mature and large companies. This finding is confirmed not only in this paper but also in most previous studies focused on the validation of Gibrat's law for the sample of large enterprises. The key finding of this study is that there is convergence toward Gibrat's law in the long-run. It shows that active and passive learning models were confirmed for the Czech manufacturing industry. In both models, Gibrat's law, therefore, complies with only those companies that have overstepped MES and survived. This is a very important fact for the policies supporting SMEs which should be supported in the initial period when they have not exceeded MES.

One of the topics for the future research may be investigation of factors which may be important for the relationship between the firm growth and firm size. For instance, the management belongs to the most important stakeholders (Slabá, 2013), and could significantly influence the growth not only of Czech manufacturing firms. Hedija (2017) showed that the gender composition of management has no important effect on Gibrat's law validity. On the other hand, the age composition of managers and their preferences might play a role. Another essential factor which may affect the validity of Gibrat's law is social capital (e.g. Betakova et al., 2014).

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