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The Validity of Gibrat´s Law: Focus on Gender Composition of Top Management[1]

*Veronika HEDIJA**

Abstract

The study is focused on relationship between firm size and firm growth in the context of gender composition of top management of the firms. In accordance with Gibrat´s law, firm growth is the stochastic process that does not depend on firm size. The aim of this study is to find out if the confirmation or rejection of Gibrat´s law validity might be related to the gender composition of management. The data for 20,073 Czech firms in the period 2008 – 2013 is used. To examine the relationship between firm size and firm growth, the linear auto-regression model is applied. The study concludes that the gender composition of top management is not the key factor affecting the validity of Gibrat´s law. The validity of Gibrat´s law is rejected at the aggregate level and also for both men-led and women-led firms. Smaller firms tend to growth faster than their bigger counterparts.

Keywords: *Gibrat´s law, firm size, firm growth, gender, management*

JEL Classification: D22, J16, L11, L21, L25

Introduction

Gibrat´s law which is also known as the Law of proportionate effect deals with the relationship between firm size and firm growth. According to this Law the firm growth is the stochastic process independent from the firm size (Gibrat, 1931). There are a lot of empirical studies testing Gibrat´s law validity and the conclusions of these are not uniform (for overview see Fiala and Hedija, 2015a or Santarelli, Klomp and Thurik, 2006). The vast majority of the studies reject the validity of Gibrat´s law at the aggregate level and conclude that smaller firms have higher growth rate compared to larger ones (Jovanovic, 1982; Almus and

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Nelinger, 2000; Daunfeldt and Elert, 2013; Sirec and Mocnik, 2014; Fiala and Hedija, 2015b). On the other hand, the validity of Gibrat´s law is more likely to be confirmed if smaller dataset is used (data for individual industries or selected group of firms) or shorter time series (year-by-year estimation) (Daunfeldt and Elert, 2013; Lotti, Santarelli and Vivarelli, 2009).

The gender composition of firm leadership could be a factor that affects Gibrat´s law validity. According to empirical evidence, the firms led by women are often smaller in terms of the number of employees, total assets and sales and report the slower growth rate as compared to men-led firms (Piacentini, 2013; Coleman, 2007; Cliff, 1998). The women-led firms have some specifics and they could differ systematically as compared with firms led by men. Hence, the gender composition of management is the factor that could affect the validity of Gibrat´s law and that had not been tested yet and this is the main contribution of this paper.

The aim of this study is to find out if the confirmation or rejection of Gibrat´s law validity might be related to the gender composition of the firm leadership.

Firm Growth, Firm Size and the Gender

The business growth is traditionally one of the fundamental objectives of the firm. Many studies are devoted to the factors affecting the performance of the company, methods of performance evaluation, identification of main sources of firm growth and explaining the differences in growth rate of individual firms (Šiška, 2015; Žižlavský, 2014; Gupta, Guha and Krishnaswami, 2013; Režňáková, Svoboda and Polednáková, 2010).

One of the factors that are often associated with firm growth is the size of the firm. Gibrat (1931) examined the relationship between firm growth and firm size and stated that firm growth is the stochastic process independent on firm size. There are many studies testing the validity of Gibrat´s law. The results of these studies are different depending on the used method, time series, country, industry and selected sample of companies.

Minor part of the studies confirms the validity of Gibrat´s law (for example Simon and Bonini, 1958; Buckley, Dunning and Pearce, 1984; Fujiwara et al., 2004; Leitão, Serrasqueiro and Nunes, 2010). These studies often use the sample of large and older firms and the number of examined firms is relatively small. Simon and Bonini (1958) demonstrated the validity of Gibrat´s law using the data of 500 large U.S. manufacturing firms during the period of 1954 and 1956. Their result was shown for total assets as a measurement of firm size. Buckley, Dunning and Pearce (1984) examined the relationship between firm size and firm growth using data of large firms around the world during the period 1972 – 1977,

the proved relationship was only insignificant. The validity of Gibrat´s law is confirmed also by Leitão, Serrasqueiro and Nunes (2010) using the sample of 39 Portuguese firms during the period 1998 – 2004. On the other hand, Fujiwara et al. (2004) confirm the validity of Gibrat´s law using the large dataset of about 260,000 large firms from 45 European countries during the relatively long period of time between 1992 and 2001. Their result showed the existence of independence between firm size and firm growth using the total assets, sales and the number of employees as the measurement of firm size.

However, majority of studies rejected the validity of Gibrat´s law or came to mixed results. Evans (1987) investigated the link between firm size and firm growth using the data of more than 27,000 U.S. manufacturing firms during the period 1976 – 1982. He concluded that firm growth depends inversely on firm size and firm age. The number of employees was used as the measurement of firm size. A similar result is shown in a study by Dunne and Hughes (1994). They investigated 2,149 British companies from 19 different industries during the period 1980 – 1985 contrary to the previously mentioned study they used total assets as the indicator of firm size. The tendency of small firms to grow faster than larger ones is confirmed by majority of studies rejecting Gibrat´s law. For example, by Almus and Nerlinger (2000) who investigated the validity of Gibrat´s law using a large sample of 39,355 German companies during the period 1989 – 1994, by Oliveira and Fortunato (2006) using sample of Portuguese firms, by Calvo (2006) for Spanish firms, by Coad (2008) for French companies and by Fiala and Hedija (2015b) for Czech firms. The mixed results are presented among others in the studies by Daunfeldt and Elert (2013), Lotti, Santarelli and Vivarelli (2009) and for the Czech Republic in the paper by Fiala (2015). The study of Daunfeldt and Elert (2013) belongs to the largest ones in terms of listed firms. They used the sample of more than 288,000 Swedish firms for 632 industries (five-digit NACE) and showed that the validity of Gibrat´s law is industry specific. They rejected the Gibrat´s law on an aggregate level and concluded that the small firms grow faster than larger ones. Using the industry level the results were mixed and they showed that the likelihood that the Gibrat´s law is confirmed is greater in mature industries with high market concentration and a large share of group ownership. Lotti, Santarelli and Vivarelli (2009) examined the validity of Gibrat´s law through time (year-by-year). They used a sample of 3,300 Italian companies in the period 1987 – 1994 and tested the relationship between firm growth and firm size during the whole period and then separately in shorter time series (year-by-year). They concluded that the smaller firms tend to grow faster than the larger ones using the whole time series. Using year-by-year estimation, they identified the significant convergence to Gibrat´s law validity. The

similar conclusions are presented in Fiala (2015) who tested the validity of Gibrat´s law using the data of 6,343 small and medium-size Czech manufacturing firms in the period 2007 – 2012. The validity of Gibrat´s law was rejected for the entire period, however there were detected the convergence toward the validity of Gibrat's law through time.

The economic theory provides various theoretical reasons for rejecting the validity of Gibrat´s law. Models of passive learning and active learning offer the explanation for faster growth of smaller firms. In accordance with these models, new entrants accelerate their growth compared to larger and more experienced counterparts to achieve efficient scale of production (Lotti, Santarelli and Vivarelli, 2009). Other argument for validity of inverse relationship between firm growth and firm size and age provide differences in attitude to innovation where the smaller firms are more active and effective in this area (Calvo, 2006; Van Dijk et al., 1997). The smaller firms (which are usually younger) are also more flexible and less risk averse as compared with their larger counterparts and these factors are presented as another source of their higher growth (Moreno and Casillas, 2007).

The gender composition of top management or owners of the company is one of the factors that could affect the firm size and firm growth measured by conventional indicators, such as the growth of sales, number of employees or total assets. Hence it could affect the testing of the validity of Gibrat´s law where the gender of managers/owner could play a role.

Many studies have been devoted to the issue of women in leadership since the early 1990s. These studies are focused on different aspects of women in leadership and examine the specifics of women-led firms. Many studies are devoted to the differences in size and performance (which is often viewed as growth rate) between women-led/owned and men-owned/led companies.

The firms led by women are less frequent and they are often smaller in terms of the number of employees, total assets and sales revenue as compared with the men-led firms. Piacentini (2013) showed that only 25% of the self-employed were women in EU-27 in 2011. Women rarely ran large business and they three times less frequently owned a company with employees as compared with men. This study also concluded that the main factors that determine the low interest of women in an entrepreneurial career are cultural norms, stereotype, the lack of role models, higher risk averse and lower confidence of women in their abilities as entrepreneurs.

Some studies show that not only the size is smaller but also the differences are identified in the field of performance. As the measurement of performance is very often used conventional measurement such as change in sales, number of employees or total assets. Most of the earliest studies concluded that the female-controlled firms underperform male-controlled ones (Brush, 1992; Rosa, Carter

and Hamilton, 1996; Cooper, Gimeno-Gascon and Woo, 1994). Brush (1992) reviewed the 57 studies devoted to specifics of women-led firms in the United States. The data showed that the performance of women-led businesses is lower than that of men-led businesses using indicators, such as profitability, sales or the number of employees. Rosa, Carter and Hamilton (1996) used the data of 600 Scottish and British small firms to explore the impact of gender of owner-manager on performance. They controlled for key factors of performance and concluded that the gender appears to be a significant determinant of firm performance. The women-controlled firms underperform as compared with men. Cooper, Gimeno-Gascon and Woo (1994) examined the determinants of new ventures' performance using the sample of 1,053 new firms operating in the United States. As a measurement of performance they selected growth rate (in employment) and marginal survival and as explanatory variables they used selected human and financial capital categories such as education, gender, race, industry, amount of capital, management know-how, industry-specific know-how. They concluded that the survival rate is not different between women-owned and men-owned ventures, on the other hand the women-owned ventures are less likely to grow than men-owned ones.

There are two theories offering the arguments for smaller size, underperformance and slower growth of female-led firms: liberal feminist theory and social feminist theory. According to liberal feminist theory the performance of women and men should be similar if the access to the opportunities is equal for both genders (Fischer, Reuber and Dyke, 1993). On the other hand, the social feminist theory states that women and men are naturally different (Fischer, Reuber and Dyke, 1993). Using notions of both theories, the reasons of underperformance of female-led firms could be differences in education, work experience, firm age, industry or discrimination of women (worse access to capital, fewer order by men) and also the dissimilar attitude and differences in preferences of male and female entrepreneurs. Brusch (1992) stated that the goals of female entrepreneurs differ frequently from those noted by male firm owners. Women often combine economic goals such as profit and growth with social goals such as customer or employees satisfaction. The high profit and growth rate may not be the main goal of women-controlled firm as compared with men. This is why women-led firms may seem underperforming if assessed on the basis of these conventional criteria. Cliff (1998) identified the important differences with respect to the wishes of male and female entrepreneurs how to expand. The maximum size of a business that is comfortable to manage and beyond which point the entrepreneurs would prefer no further expansion is smaller in case of women-led firms. The personal preference of male and female entrepreneurs about the maximum size of the business is perceived as the key factor in no-growth decision strategy.

The recent studies dealing with the issue of firm performance use a large sample of companies and control for larger number of factors which determine the performance of the company and if it is possible they take into account also the individual goals and preferences of firm owners. The results of these studies speak rather in favour of no significant differences between performance of female and male entrepreneurs (Du Reitz and Henrekson, 2000; Robb and Watson, 2010). Du Reitz and Henrekson (2000) used the sample of 4,200 Swedish entrepreneurs from various industries with 1 – 20 employees. They confirmed lower performance of female-led companies at the aggregate level in cases of using the sales, profit and employment as the indicator of performance. However, if they controlled for structural factors (such as firm size, industry, capacity, credit application and growth prospects) the female underperformance disappeared for profit and employment and stayed valid only for sales as a measurement of firm performance. Robb and Watson (2010) used data of 3,046 Austrian and nearly 4,000 US small and medium-sized enterprises (SMEs). They chose the return on assets, survival rates and sharp ratio as the measurement of firm performance and they controlled for important demographic indicators such as firm age, firm size, gender, education and experience of the owner, industry, country. The results of the study suggested that the women-controlled firms do not underperform men-controlled firms if the survival rates and return on assets is used as a measurement of performance.

And what is the implication of gender composition of management for Gibrat´s law validity? If women leaders prefer small businesses and systematically show lower growth rates than firms run by men (either because of their different objectives or lower performance), then the existence of women-led firms is an argument for rejecting the Gibrat´s law validity. If no other factors enter into play, the small firms tend to grow slower than the large ones in this case. However, the Gibrat´s law could be valid separately for women-led and men-led firms.

Data and Methods

The data for this study are compiled from the database Albertina CZ Gold Edition and the Czech Business Register. Albertina contains information on all profit and non-profit entities in the Czech Republic, which have been assigned personal identification number (IČO). At present this database covers the data of more than 2.7 million subjects. We use panel data about profit industries (sector A – N) using CZ-NACE classification for the period 2008 – 2013. From Business Register we take the data containing gender composition of statutory body of the companies in examined period. We use the data for limited company and joint-stock company that belong to the most common form of business in the Czech Republic.

Then we narrow down the dataset to contain only the data of such companies, which had been in the industry at least for 5 years in 2008 and survived throughout the study period. The data of starting firms and firms in liquidation are specific and the results could be biased in the case of inclusion of all firms. According to economic theory and empirical evidence, the young firms (which are usually small) grow rapidly in first years after establishment to reach a minimum efficient scale of production. The empirical studies show that Gibrat´s law is more likely to be confirmed for mature industries (Jovanovic, 1982; Lotti, Santarelli and Vivarelli, 2009; Daunfeldt and Elert, 2013). Using only the sample of established firms enables to purify the analysis of the factor of firm age.

As a measurement of firm size sales are used. The sales represent the real annual sales which are calculated using consumer price index published by the Czech Statistical Office.[2] As the base period 2005 is used. The indicator annual "sales" includes revenues from sales of products, goods and services. The studies focused on relation between firm size and firm growth use an alternative way to measure firm size: total assets, profit, gross added value, sales and revenue. The number of employees is the most commonly used measurement of firm size (Nassar, Almsafir and Al-Mahrouq, 2014). We chose sales as the indicator of firm size because it is the most flexible one compared to the number of employees or total assets. Another reason is that the database Albertina does not offer accurate data on the number of employees of individual companies and using the number of employees could lead to bias in the results.[3]

When examining the impact of gender composition of statutory body on validity of Gibrat´s law we define men-led firms (MLF) and women-led firms (WLF). To identify the women-led and men-led firms, we use the composition of statutory body of the company as the decisive factor. We use two variants for determination of WLF and MLF: (1) WLF is the firm with more than 50% women in statutory body and MLF is the firm with 50 and less women in statutory body; (2) WLF(1) is the firm with only women in statutory body and MLF(1) is the firm with only men in statutory body. We use for WLF the limit of more than 50% of women, because in this case, the women dominate in the statutory body. Other firms we titled men-led firms despite the fact that it includes companies where both genders are equally represented. We assume that in this case the firm could act in the traditional way. We exclude the data of firm, where the gender composition of statutory body changes in the reference period. Finally, we use balance panel in all computations. The final dataset contains the data of 20,073 Czech firms in the period 2008 – 2013. The descriptive statistics are shown in Table 1.

[2] Sales = (nominal sales/CPI) . 100.

[3] Firms do not report the exact number of employees, but indicate the interval. The number of employees is then calculated as the average of this interval.

T a b l e 1

Average Summary Statistics

	2008	2009	2010	2011	2012	2013	2008 – 2013
Sales (in thousand CZK)	69 133.56 (219 335.2)	58 670.96 (187 151)	61 294.48 (197 914.6)	64 057.07 (207 153.5)	62 719.75 (205 455.8)	62 712 (209 276.4)	63 097.97 (204 644)
Proportion of women (in statutory body)	0.1705 (0.3086)	0.1716 (0.3090)	0.1722 (0.3088)	0.1730 (0.3089)	0.1738 (0.3091)	0.1736 (0.3093)	0.1724 (0.3090)
N	20 073	20 073	20 073	20 073	20 073	20 073	120 438

Note: Standard errors in brackets.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

Table 1 shows the average sales and average proportion of women in statutory body of the firms in the period 2008 – 2013. We can see that the real sales are higher in the year 2008, then they decrease sharply in 2009. On average they reach 63 million CZK in the analysis period. The proportion of women in statutory body is about 17% across examined period. The sales and proportion of women in statutory body differ in individual industries as we can see in Table 2. The average real sales range from 6 million in real estate activities to 183 million in mining and quarrying in 2013. The significant disparity could be identified also in representation of women in statutory body of firms in various sectors. The proportion of women in statutory body is the lowest in sector D, E and F where it amounts to less than 10%. On the other hand, the highest proportion of women in statutory body is in sector I, L, M and N. Here the women represent more than 20% of statutory body members on average. The indicators WLF and WLF(1) show the proportion of women-led firms in individual sectors.

To verify the validity of Gibrat´s law we use linear auto-regression model proposed by Daunfeldt and Elert (2013). They estimate the validity of Gibrat´s law using this model

$$nS_{jt}^{i} = \alpha_{j0} + \alpha_{j1} \,.\, ln\, S_{j(t-1)}^{i} + \theta_{jt} \,.\, T_t + u_{jt} \qquad (1)$$

where

S_{jt}^{i} – the size of *i*-th firm of *j*-th industry in time *t*,

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

α_{j0}, α_{j1} – the regression coefficients of the model,

u_{jt} – a disturbance term.

The values of parameter α_{j1} indicate if the Gibrat´s law is valid or not. The advantage of this model is its simplicity and the fact that it includes time specific fixed effects. Hardwick and Adams (2002) showed that business cycles could play

a role and this model enables us to consider this fact. The aim of Daunfeldt and Elert (2013) was to prove the validity of Gibrat´s law in individual industries using five-digit NACE classification for industry. This study sets a slightly different goal.

T a b l e 2

Average Summary Statistics in 2013 by Sectors

NACE	Sales (in thousand CZK)	Proportion of women in statutory body	WLF	WLF(1)	N
A	54 857.68	0.1337	0.0366	0.0307	1010
	(125 949)	(0.2227)	(0.1880)	(0.1726)	
B	182 576.6	0.1269	0.0227	0.0227	44
	(382 865.3)	(0.2312)	(0.1508)	(0.1508)	
C	132 599.3	0.1106	0.0510	0.0401	3863
	(323 467)	(0.2465)	(0.2200)	(0.1963)	
D	166 110.2	0.0633	0.0083	0.0083	120
	(471 870)	(0.1687)	(0.0913)	(0.0913)	
E	100 485.8	0.0899	0.0269	0.0269	186
	(242 757.4)	(0.2121)	(0.1622)	(0.1622)	
F	42 119.42	0.0681	0.0189	0.0159	2 009
	(127 678.7)	(0.1883)	(0.1363)	(0.1252)	
G	68 876.75	0.1854	0.1160	0.1063	5 147
	(206 299.3)	(0.3317)	(0.3202)	(0.3082)	
H	109 700.4	0.1161	0.0494	0.0441	567
	(248 253.1)	(0.2531)	(0.2169)	(0.2055)	
I	11 500.56	0.2318	0.1518	0.1411	560
	(34 507.31)	(0.3618)	(0.3591)	(0.3484)	
J	44 823.27	0.1042	0.0537	0.0467	707
	(171 501.5)	(0.2493)	(0.2257)	(0.2111)	
K	93 016.12	0.1775	0.1049	0.0769	143
	(307 105.1)	(0.3077)	(0.3075)	(0.2674)	
L	6 292.69	0.2931	0.2062	0.1099	2 822
	(47 833.07)	(0.3384)	(0.4047)	(0.3128)	
M	17 939.63	0.2394	0.1660	0.1552	2 404
	(93 330.93)	(0.372)	(0.3721)	(0.3621)	
N	62 892.78	0.2121	0.1405	0.1242	491
	(236 547.2)	(0.3493)	(0.3479)	(0.3302)	
Total	62 712	0.1736	0.1042	0.0829	20 073
	(209 276.4)	(0.3093)	(0.3056)	(0.2757)	

Note: A – agriculture, forestry and fishing; B – mining and quarrying; C – manufacturing; D – electricity, gas, steam and air conditioning supply; E – water supply, sewerage, waste management and remediation activities; F – construction; G – wholesale and retail trade, repair of motor vehicles and motorcycles; H – transportation and storage; I – accommodation and food service activities; J – information and communication; K – financial and insurance activities; L – real estate activities, M – professional, scientific and technical activities; N – administrative and support service activities, standard errors in brackets.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

To prove the validity of Gibrat´s law, we modify the model like Fiala and Hedija (2015b) and Fiala (2015) where industry is added into the model as explanatory variable. The growth of the firm is apart from the firm age determined by the industry specific factors such as maturity of the industry, concentration rate, minimum efficient scale (MES) of production, technology and capital intensive

or uncertainty (Daunfeldt and Elert, 2013). To at least partly filter out the effect of these factors, we include the industry fixed effects into model.

$$lnS_{it} = \alpha_0 + \alpha_1 \,.\, lnS_{i(t-1)} + \alpha_{2t} \,.\, T_t + \alpha_3 \,.\, NACE_i + \alpha_{4t} \,.\, T_t \,.\, NACE_i + u_t \quad (2)$$

where

S_{it} – the size of *i*-th firm in time *t*,
$NACE_i$ – the dummy variable for industry using 5-digit NACE classification of *i*-th firm,
$\alpha_{2t} \,.\, T_t$ – the vector of time fixed effects,
$\alpha_3 \,.\, NACE_i$ – the vector of industry specific fixed effects,
$\alpha_{3t} \,.\, T_t \,.\, NACE_i$ – a vector of time and industry specific fixed effects.

The value of parameter α_1 indicates if Gibrat´s law is valid or not. Gibrat´s law holds if $\widehat{\alpha_1}$ equals to one. The value smaller than one implies that small firms grow faster than large ones and the value higher than one implies that large firms grow faster than small ones.

Because of heteroscedasticity and serial correlation problem, we use OLS estimator with cluster-robust standard errors. To confirm or reject Gibrat´s law, we test null hypothesis $\mathrm{H0}: \widehat{\alpha_1} = 1$ versus $\mathrm{H1}: \widehat{\alpha_1} \neq 1$ using F-test.

To take into account the gender of firm leadership and its impact on Gibrat´s law validity, we expand the model for explanatory variable women-led firm reflecting gender composition of statutory body as follows

$$nS_{it} = \alpha_0 + \alpha_1 \,.\, lnS_{i(t-1)} + \alpha_{2t} \,.\, T_t + \alpha_3 \,.\, NACE_i + \alpha_{4t} \,.\, T_t \,.\, NACE_i + \alpha_5 \,.\, WLF_i + u_t \quad (3)$$

where

WLF_i – dummy variable for women led firms.

Firstly, we use full sample of firm and estimate the validity of Gibrat´s law using equation (2) and (3). Then we use equation (2) and estimate the relationship between firm size and firm growth separately for the sample of firms led by women (WLF an WLF(1)) and firms controlled by men (MLF and MLF(1)) to find out if Gibrat´s law could be confirmed separately for individual groups (women-led and men-led firms).

Finally, the validity of Gibrat´s law is proved separately for selected industries. Because the proportion of female firms differs across industries and it is very low in many of them (see Table 2) we choose four sectors having the highest proportion of female firms using CZ-NACE classification: sector I, L, M and N. Similarly, the relationship between firm size and firm growth is estimated for both the full sample of firms in given industry and separately for the sample of women-led firms and men-led firms.

Results and Discussion

To estimate Gibrat´s law validity in examined period, the equation (2) is used. The results are shown in Table 3 in model (1) and (2), where model (1) covers only time fixed effects and model (2) time fixed effects and industry fixed effects. We use F-test to confirm or reject Gibrat´s law validity. In both variants of the model we reject the null hypothesis that growth of the firm is random walk ($H0: \widehat{\alpha_1} = 1$) at 1% level. Our results indicate that smaller firms tend to growth faster than bigger ones ($\widehat{\alpha_1} < 1$).

T a b l e 3

Gibrat´s Law Validity Estimation – Whole Sample

	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
$\ln.S_{t-1}$ (α_1)	0.9809***	0.9672***	0.9797***	0.9664***	0.9793***	0.9669***
	(0.0009)	(0.0015)	(0.0010)	(0.0015)	(0.0012)	(0.0018)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
WLF	–	–	–0.0395***	–0.0370***	–	–
			(0.0053)	(0.0055)		
WLF(1)	–	–	–	–	–0.0371***	–0.0369***
					(0.0061)	(0.0065)
Constant	0.0345***	0.3492***	0.0491***	0.3618***	0.0463***	0.3706***
	(0.0100)	(0.0899)	(0.0106)	(0.0858)	(0.0131)	(0.1025)
R^2	0.9442	0.9470	0.9443	0.9470	0.9392	0.9424
N	100 365	100 365	100 365	100 365	75 785	75 785
F-test[a]	426.75	471.01	435.48	479.40	292.98	340.41
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1}$ = 1.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

These conclusions are consistent with the conclusions of many previous studies where the authors rejected Gibrat´s law validity for an aggregate level and concluded that the small firms have a tendency to grow faster than their large counterparts. For example, Lotti, Santarelli and Vivarelli (2009) that tested the validity of Gibrat´s law for Italian firm, Daunfeldt and Elert (2013) who examined the relationship between firm size and firm grow for Swedish firms, Fiala (2015) and Fiala and Hedija (2015b) who used the sample of Czech firms.

In this study, we used sales as the indicator of firm size. There are many other indicators, such as the number of employees and total assets which are frequently used as the measurement of firm size. Here, the results could be influenced by the choice of firm size indicator to some extent. However, Fiala and Hedija (2015b) tested the validity of Gibrat´s law using three different indicator of firm

size: sales, total assets and the number of employees. They used the data for Czech private sector firms in the period 2007 – 2012 and concluded that the results are similar for all three indicators of firm size. The validity of Gibrat´s law was rejected in all cases. Hence, the results that we will be obtained using alternative indicators of firm size would be probably the same.

To take into account the gender aspects of firm leadership we use gender composition of statutory body as one of the explanatory variables. The validity of Gibrat´s law is proved using equation (3). The results are shown in Table 3 in model (3), (4), (5) and model (6). We can conclude that the gender composition of the firm statutory body is a statistically significant factor explaining the level of sales. Companies having a dominant proportion of women in the statutory body report sales lower approximately by 4% than firms led mostly by men. The results are very similar for both concepts of women-led firms (WLF and WLF (1)). It suggests that to promote women's managerial style, the majority of women in the statutory body is sufficient. Even filtering out the influence of the composition of the statutory body does not permit to confirm Gibrat´s law validity. The results show that small firms tend to grow faster than large ones also in this case.

Finally, we use equation (2) and prove the validity of Gibrat´s law separately for women-led firms and men-led firms. The results are shown in Table 4. The Gibrat´s law is rejected for both WLF and MFL. In both cases the smaller firms tend to grow faster than the bigger ones. When we use stricter criterion for defining the women-led and men-led firms and apply WLF(1) and MLF(1), the results stay similar. Gibrat´s law is valid neither for WLF(1) nor for MLF(1).

T a b l e 4

Gibrat´s Law Validity Estimation – Separately for Women- and Men-led Firms

	WLF		**MLF**		**WLF(1)**		**MLF(1)**	
	Model (1)	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**
$\ln.S_{t-1}$ (α_1)	0.9686***	0.9533***	0.9809***	0.9676***	0.9662***	0.9546***	0.9806***	0.9680***
	(0.0031)	(0.0051)	(0.0010)	(0.0016)	(0.0038)	(0.0058)	(0.0013)	(0.0019)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
Constant	0.1463***	0.1048***	0.0324***	0.4152***	0.1646***	0.0953**	0.0271*	0.4440***
	(0.0271)	(0.0378)	(0.0112)	(0.0755)	(0.0340)	(0.0430)	(0.0138)	(0.0874)
R^2	0.9276	0.9394	0.9429	0.9459	0.9220	0.9368	0.9373	0.9410
N	10460	10460	89905	89905	8115	8115	67670	67670
F-test[a]	105.96	83.55	347.61	399.65	78.99	60.90	229.84	282.10
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

The obtained results show and confirm that the gender composition of statutory body is not key factor affecting the Gibrat´s law validity. There are other factors that could be significant. Empirical studies show that the specifics of individual industries could affect the validity of Gibrat´s law. Important role could play age of the industry, uncertainty, minimum efficient scale of production, industry size and competition in the sector. The growth of the firm is more likely random walk in mature industries because of lower proportion of new entrants. New firms are more likely smaller than mature firms and tend to grow dynamically to achieve the MES. The lower rate of new firms is more likely with industries having high uncertainty in terms of profit achieved and with very high MES which could be a barrier for entrance. On the other hand, the very low MES could be the reason for validity of Gibrat´s law, because small firms are not forced to grow faster than large firms. Concentration in the industry is another factor affecting the validity of law from the theoretical point of view. The high concentration prevents new firms from entering and monopoly power of larger firms is the barrier for fast growth of small firms in this industry. Empirical studies confirm that the Law is most likely to be valid in mature industries, small industries, industries with less competition, higher degree of uncertainty and in sectors with low or, conversely, very high MES (Coad, 2008; Daunfeldt and Elert, 2012; Lotti, Santarelli and Vivarelli, 2009). Inclusion of industry fixed effects into the model could not be sufficient to filter out any sector specifics.

Because the validity of Gibrat´s law could be influenced by industry specific factors, we proved the validity using industry specific data according to CZ-NACE classification and examined the role of gender composition of statutory body on Law validity once again. The impact of female managers may also vary in individual sectors due to differences in proportion of female-led firms into sectors. We choose four industries that report the highest proportion of women-led firms: sector I, L, M and N. For testing the relationship between firm size and firm growth, equation (2) and (3) are used. The results are shown in Table 5 – 12 in Annex.

On the aggregate level, the validity of Gibrat´s law was rejected for all four sectors. In all sectors the smaller firms tend to grow faster than bigger ones. Nevertheless, where we test the validity of Gibrat´s law separately for women-led and men-led firms, the results vary for individual sectors. The Gibrat´s law is more likely to be valid for women-led firms. In sector I, the validity of Gibrat´s law for women-led firms cannot be rejected at the 1% level and in sector N at the 10% level of significance. On the other hand, in sector L and M, the validity of Law is rejected for this type of firms.

However, the validity of Law in sector I and N could be attributed to industry specific factors to some extent. According to Hedija (2016) these sectors belong to the sector with lower rate of competition and relative lower MES. There is

also relatively small number of women-led companies in these sectors (less than 100 firms in both sectors). For the fact that other factors also play a role speaks also the fact that the validity of Gibrat´s law was confirmed in sector N not only for women-led firms but also for men-led firms. The hypothesis that Gibrat´s law is rather valid for women-led firms could be tested in further research.

Conclusion

This study is devoted to the examination of the relationship between firm size and firm growth in the context of gender composition of management. The relationship between firm size and firm growth is described by Gibrat´s law. According to this Law, the growth rate of a given firm is independent of its size. The majority of studies testing the validity of Gibrat´s law reject it and conclude that the smaller firms tend to grow faster than larger counterparts. However, the findings of some studies show that the validity of Gibrat´s law is industry specific and it depends on the characteristics of the examined market (Daunfeldt and Elert, 2012). The gender composition of management is the factor that had not been tested yet as the factor affecting the validity of the Gibrat´s law, this was the aim of this study.

We used the data of 20,073 Czech firms in the period 2008 – 2013. To estimate the effect of gender composition of management on Gibrat´s law validity, we used linear auto-regression model with the real sales as the indicator of firm size and control for industry, time and gender composition of statutory body. We found out that the women-led firms reported lower sales as compared with men-led firms. Nevertheless, the validity of Gibrat´s law was rejected. We found out that smaller firms tend to grow faster than larger ones. Then we tested the validity of Gibrat´s law separately for men-led and women-led firms. The conclusion was similar. Gibrat´s law was rejected at 1% level of significance for both samples: women-led firms and men-led firms. The tendency of a smaller firm to growth faster than a larger one is valid for both, women-led and men-led firms. The effect of gender composition of management on Gibrat´s law validity was not unequivocally confirmed, when it was tested separately for four industries reporting the highest proportion of women-led firms: accommodation and food service activities; real estate activities; professional, scientific and technical activities and administrative and support service activities. There were no significant differences in confirmation or rejection the Gibrat´s law between individual industries using the women-led firms as explanatory variable.

Hence, the gender composition of management is not proving to be an important factor that affects the validity of Gibrat´s law. More important role

is probably played by the industry-specific factors as maturity of the industry, concentration rate and minimum efficient scale of production. In further research, the author will devote to the verification of the impact of selected sector-specific factors on the Gibrat´s law validity in the Czech Republic and test the Gibrat´s law validity for women-led firms in the context of these factors.

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Annex

Table 5

Gibrat´s Law Validity Estimation for Sector I (Accommodation and Food Service Activities)

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
$\ln.S_{t-1}$ (α_1)	0.9619***	0.9491***	0.9615***	0.9488***	0.9636***	0.9536***
	(0.0087)	(0.0116)	(0.0088)	(0.0117)	(0.0010)	(0.0128)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
WLF	–	–	–0.0273	–0.0220	–	–
			(0.0252)	(0.0240)		
WLF(1)	–	–	–	–	–0.0352	–0.0304
					(0.0272)	(0.0259)
Constant	0.2648***	0.2684	0.2726***	0.2778*	0.2515***	0.2428
	(0.0832)	(0.1706)	(0.0851)	(0.1680)	(0.0909)	(0.1711)
R^2	0.9129	0.9150	0.9129	0.9150	0.9169	0.9192
N	2 800	2 800	2 800	2 800	2 140	2 140
F-test[a]	19.05	19.16	19.00	19.01	13.25	13.18
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

Table 6

Gibrat´s Law Validity Estimation for Sector I – Women Led Firms and Men Led Firms

	WLF		MLF		WLF(1)		MLF(1)	
	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)
$\ln.S_{t-1}$ (α_1)	0.9714***	0.9506***	0.9596***	0.9474***	0.9653***	0.9439***	0.9633***	0.9544***
	(0.0150)	(0.0226)	(0.0102)	(0.0136)	(0.0174)	(0.0252)	(0.0117)	(0.0155)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
Constant	0.2019*	–0.0297	0.2816***	0.4307**	0.2452*	0.0012	0.2446**	0.3631*
	(0.1145)	(0.1043)	(0.0983)	(0.1675)	(0.1261)	(0.1164)	(0.1068)	(0.1905)
R^2	0.9250	0.9367	0.9100	0.9122	0.9153	0.9281	0.9163	0.9187
N	425	425	2 375	2 375	395	395	1745	1745
F-test[a]	3.63	4.80	15.80	15.06	4.00	4.96	9.89	8.70
p-value	0.0602	0.0313	0.0001	0.0001	0.0491	0.0288	0.0018	0.0034

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register, own calculation.

T a b l e 7

Gibrat´s Law Validity Estimation for Sector L (Real Estate Activities)

	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
$\ln.S_{t-1}$ (α_1)	0.9490***	0.9421***	0.9471***	0.9402***	0.9424***	0.9383***
	(0.0035)	(0.0039)	(0.0036)	(0.0040)	(0.0053)	(0.0057)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
WLF	–	–	–0.0473***	–0.0465***	–	–
			(0.0096)	(0.0097)		
WLF(1)	–	–	–	–	–0.0377***	–0.0372***
					(0.0140)	(0.0142)
Constant	0.3003***	0.4590*	0.3229***	0.4810*	0.3451***	0.2645
	(0.0257)	(0.2507)	(0.0271)	(0.2454)	(0.0409)	(0.1739)
R^2	0.9031	0.9041	0.9032	0.9042	0.8967	0.8977
N	14110	14110	14110	14110	7450	7450
F-test[a]	213.15	218.68	217.80	222.65	118.77	116.88
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

T a b l e 8

Gibrat´s Law Validity Estimation for Sector L – Women Led Firm and Men Led Firm

	WLF		**MLF**		**WLF(1)**		**MLF(1)**	
	Model (1)	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**
$\ln.S_{t-1}$ (α_1)	0.9323***	0.9265***	0.9493***	0.9423***	0.9351***	0.9348***	0.9435***	0.9390***
	(0.0089)	(0.0094)	(0.0039)	(0.0044)	(0.0112)	(0.0107)	(0.0059)	(0.0064)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
$T_t.NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
Constant	0.3832***	–0.1800***	0.3028***	0.6359***	0.3406***	–0.2209***	0.3395***	0.4135***
	(0.0569)	(0.0462)	(0.0297)	(0.2408)	(0.0709)	(0.0525)	(0.0458)	(0.1452)
R^2	0.8671	0.8687	0.9045	0.9056	0.8916	0.8952	0.8923	0.8936
N	2 910	2 910	11 200	11 200	1 420	1 420	6 030	6 030
F-test[a]	57.58	61.18	170.00	172.61	33.75	37.19	92.90	90.79
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

T a b l e 9

Gibrat´s Law Validity Estimation for Sector M (Professional, Scientific and Technical Activities)

	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
$\ln.S_{t-1}$ (α_1)	0.9601***	0.9475***	0.9582***	0.9459***	0.9593***	0.9478***
	(0.0036)	(0.0044)	(0.0037)	(0.0045)	(0.0041)	(0.0049)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
T_t.$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
WLF	–	–	–0.0435***	–0.0533***	–	–
			(0.0136)	(0.0145)		
WLF(1)	–	–	–	–	–0.0385***	–0.0521***
					(0.0144)	(0.0155)
Constant	0.2260***	0.4103***	0.2487***	0.4280***	0.2327***	0.3522***
	(0.0335)	(0.1231)	(0.0353)	(0.1237)	(0.0391)	(0.0432)
R^2	0.9017	0.9036	0.9018	0.9037	0.9008	0.9030
N	12 020	12 020	12 020	12 020	9 455	9 455
F-test[a]	123.78	139.36	125.57	144.92	97.35	114.93
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

T a b l e 10

Gibrat´s Law Validity Estimation for Sector M – Women Led Firms and Men Led Firms

	WLF		**MLF**		**WLF(1)**		**MLF(1)**	
	Model (1)	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**
$\ln.S_{t-1}$ (α_1)	0.9484***	0.9472***	0.9596***	0.9451***	0.9515***	0.9510***	0.9607***	0.9463***
	(0.0119)	(0.0133)	(0.0039)	(0.0048)	(0.0122)	(0.0137)	(0.0044)	(0.0053)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
T_t.$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
Constant	0.2919***	0.3345***	0.2337***	0.4364***	0.2694***	0.2963***	0.2167***	0.3487***
	(0.0920)	(0.0992)	(0.0376)	(0.1254)	(0.0949)	(0.1013)	(0.0420)	(0.0471)
R^2	0.8679	0.8817	0.9012	0.9034	0.8721	0.8869	0.8990	0.9015
N	1 995	1 995	10 025	10 025	1 845	1 845	7 610	7 610
F-test[a]	18.87	15.70	106.44	130.37	15.76	12.72	81.36	104.16
p-value	0.0000	0.0000	0.0000	0.0000	0.0001	0.0004	0.0000	0.0000

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

T a b l e 11

Gibrat´s Law Validity Estimation for Sector N (Administrative and Support Service Activities)

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
$\ln.S_{t-1}$ (α_1)	0.9771***	0.9736***	0.9764***	0.9723***	0.9771***	0.9724***
	(0.0075)	(0.0087)	(0.0078)	(0.0089)	(0.0087)	(0.0096)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
T_t.$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes
WLF	–	–	–0.0296	–0.0508	–	–
			(0.0280)	(0.0313)		
WLF(1)	–	–	–	–	–0.0255	–0.0504
					(0.0307)	(0.0390)
Constant	0.1101		0.1209	0.2162*	0.0951	0.2159
	(0.0746)		(0.0787)	(0.1246)	(0.0797)	(0.1422)
R^2	0.9328	0.9402	0.9328	0.9403	0.9321	0.9405
N	2 455	2 455	2 455	2 455	1 890	1 890
F-test[a]	9.30	9.30	9.23	9.59	6.90	8.30
p-value	0.0024	0.0024	0.0025	0.0021	0.0090	0.0042

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.

T a b l e 12

Gibrat´s Law Validity Estimation for Sector N – Women Led Firms and Men Led Firms

	WLF		MLF		WLF(1)		MLF(1)	
	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)
$\ln.S_{t-1}$ (α_1)	0.9779***	0.9749***	0.9761***	0.9724***	0.9704***	0.9614***	0.9785***	0.9734***
	(0.0133)	(0.0201)	(0.0089)	(0.0100)	(0.0161)	(0.0255)	(0.0100)	(0.0107)
T_t fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
T_t.$NACE_j$ fixed effects	–	Yes	–	Yes	–	Yes	–	Yes
Constant	0.0568	0.5736	0.1268	0.1678	0.1231	0.6789	0.0825	0.1452
	(0.1161)	(0.4248)	(0.0891)	(0.1290)	(0.1337)	(0.4579)	(0.0900)	(0.1457)
R^2	0.9430	0.9582	0.9292	0.9389	0.9321	0.9566	0.9288	0.9401
N	345	345	2 110	2 110	305	305	1 585	1 585
F-test[a]	2.77	1.56	7.25	7.60	3.36	2.29	4.67	6.16
p-value	0.1009	0.2162	0.0074	0.0061	0.0718	0.1354	0.0314	0.0136

Notes: ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level, robust standard errors in brackets, a) F-test of H0 : $\widehat{\alpha_1} = 1$.

Source: Albertina CZ Gold Edition, Czech Business Register; own calculation.