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Published online: 29 Aug 2019.

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Testing the validity of Gibrat's law in the context of profitability performance

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ABSTRACT

The purpose of the article is to investigate whether the profitability of firms affects the validity of Gibrat's law. We begin with the thesis that small firms have less access to outside financial sources (especially bank loans) than large companies, so the role of profit in generating growth varies depending on firm size and is probably more important for smaller companies. We divided a large sample of companies (about 30,000 firms) into three profitability groups (lower 25%, middle 50%, and upper 25% of firms) to examine whether the size-growth relationship is influenced by profitability. Gibrat's law was verified both at the aggregate level and at the industry level (using one-digit NACE classification). The results show that the validity of Gibrat's law is not significantly influenced by the amount of firm profit at the aggregate level or at the industry level. In most sectors and profitability groups, smaller firms grow faster than their larger counterparts do.

1. Introduction

Robert Gibrat (1931) investigated French manufacturing firms and concluded that firm growth is a random effect, independent of firm size. This idea is known as Gibrat's law or the law of proportionate effect. Many studies have followed from Gibrat's work and are devoted to empirically testing the validity of Gibrat's law. A review of these studies and a summary of their conclusions can be found, for instance, in Santarelli, Klomp, and Thurik (2006); another review of more recent studies was presented in Nassar, Almsafir, and Al-Mahrouq (2014).

The results of studies testing the validity of Gibrat's law vary significantly. Some studies reject Gibrat's law; others confirm it or present mixed results. This raises the question: Why are the findings of empirical studies so different? Some of the factors that can affect the validity of Gibrat's law have been very well investigated. These include the minimum efficient scale (MES) of production (e.g. Daunfeldt & Elert, 2013; Teruel-Carrizosa, 2010), type of ownership (e.g. Djankov & Murrell, 2002;

Estrin, Hanousek, Kočenda, & Svejnar, 2009; Ivandić, 2015), industry uncertainty (Daunfeldt & Elert, 2013; Lensink, van Steen, & Sterken, 2005), and ownership structure (e.g., Bottazzi & Secchi, 2006; Fagiolo & Luzzi, 2006; Variyam & Kraybill, 1992). Very little attention has been paid to profitability as a factor that could affect the size-growth relationship. To fill this gap in the literature, this study investigates the influence of the 'profitability' factor.

The aim of this article is to examine if the profitability of companies affects the validity of Gibrat's law.

Like Mukhopadhyay and AmirKhalkhali (2010), we begin with the thesis that large firms can obtain outside funding (especially bank loans) or new registered capital more easily than their smaller counterparts. Thus, the facilitating role of profit in generating growth differs depending on the size of a company, and it is probably more important for the smaller companies than for the larger ones. Hence, the validity of Gibrat's law may vary depending on profit. As small firms have less access to external sources of financing, there could be a tendency for low-profitability large companies to grow faster (due to better access to bank loans) than low profitability small ones. Gibrat's law should be valid for highly profitable firms where the need for external financing is lower.

In contrast to most previous studies, we: (1) test the validity of Gibrat's law in the context of profitability as we mentioned above, only one previous study deals with this issue; (2) use a large sample of about 30,000 firms; (3) prove the relationship on an industry level; and (4) present the first findings about the size-growth relationship in the context of profitability for the Czech Republic.

This article is organised as follows: Section 2 focuses on a literature review; Section 3 describes the data used and methodology applied; Section 4 shows the empirical results, discusses the achieved results, and compares them with the findings of previous studies; and the last section, titled Conclusion, deals with a concise recapitulation of the main findings.

2. Literature review

Many researchers have focused on the relationship between firm growth rate and firm size. Some studies accepted the validity of Gibrat's law and concluded that firm growth was independent of firm size. These studies were focused mostly on large and mature companies, including Buckley, Dunning, and Pearce (1984), Hart and Prais (1956), and Simon and Bonini (1958). Hart and Prais (1956) examined quoted companies in Great Britain for selected years during 1885–1950. Simon and Bonini (1958) chose the 500 largest U.S. industrial firms from 1954 to 1956. Buckley et al. (1984) investigated the validity of Gibrat's law using data from the world's largest companies. Gibrat's law was also confirmed on a sample of high-tech Norwegian firms (Klette & Griliches, 2000), Austrian manufacturing companies (Pfaffermayr & Bellak, 2000), Italian manufacturing firms (Del Monte & Papagni, 2003), and Portuguese firms (Leitão, Serrasqueiro, & Nunes, 2010). Fujiwara, Guilmi, Aoyama, Gallegati, and Souma (2004), who examined firms from 45 European countries, also validated Gibrat's law.

Many other studies found that smaller firms grew faster than their larger counterparts, so Gibrat's law was rejected in these papers. A large part of these studies focused on the manufacturing industry in the U.S. (Evans, 1987a, 1987b), Germany (Almus & Nerlinger, 2000), Portugal (Oliveira & Fortunato, 2006a), Spain (Calvo, 2006), France (Levratto, Tessier, & Zouikri, 2010), and Iran (Feizpour, Mahmoudi, & Soltani, 2010).

Some researchers, including Dunne and Hughes (1994), Falk (2008), Bentzen, Madsen, and Smith (2012), and Fiala and Hedija (2015), chose to analyse more industries. Dunne and Hughes (1994) verified the link between firm growth rate and firm size in 19 industries. Falk (2008) investigated the manufacturing industry, business services industry, and the mining and energy industry. Fiala and Hedija (2015) tested the size-growth relationship for all industries of the Czech private sector. Bentzen et al. (2012) focused on seven industries: primary industries, manufacturing, construction, wholesale and retail sales and hotels, transport services, financial services, and the publicly regulated sector and social services. In contrast to previous studies, they surprisingly concluded that big firms grew faster than smaller companies in most examined industries.

Some studies produced mixed results. Gibrat's law was confirmed only for some part of the sample in these studies. Mansfield (1962) analysed three sectors of the manufacturing industry in the U.S., with each sector divided into more periods. Gibrat's law was rejected in more than half of the cases. Hall (1987), Chen and Lu (2003), Aslan (2008), and Hedija (2016) found similar mixed results. The last of these studies examined the size-growth relationship for 14 sectors (NACE A-N) using a sample of more than 36,000 Czech firms. The validity of Gibrat's law was confirmed only in two of the fourteen examined sectors. Small firms grew faster than their larger counterparts in the great majority of the Czech private sector.

It is clear that the results of studies testing the validity of Gibrat's law differ. For this reason, some authors have investigated selected determinants that could influence the validity. Daunfeldt and Elert (2013) used a large sample of Swedish firms and showed that the validity of Gibrat's law was industry specific. The aim of their study was to identify factors explaining the differences in the validity of Gibrat's law. They proved the importance of industry size, MES of production, industry age, R&D expenditure, liquidity, ownership, uncertainty, market concentration, and location in explaining the size-growth relationship. They showed that the likelihood that Gibrat's law would be confirmed was greater in mature industries with high market concentration and a large share of group ownership.

Other factors affecting the validity of Gibrat's law could be profitability performance and financial constraints. Empirical studies show that access to outside sources of financing varies depending on firm size; small- and medium-sized enterprises (SMEs) have less access to these funds (Donati, 2016). The reduced access of SMEs to outside sources (especially to bank loans) in comparison with large firms has also been confirmed in the Czech Republic by empirical studies (Belás, Macháček, Bartoš, Hlawiczka, & Hudáková, 2014; Lízal & Svejnar, 2002). Empirical findings support the role of profit and financial constraints in firm growth (e.g. Becchetti & Trovato, 2002; Colley & Quadrini, 2001; Donati, 2016; Oliveira & Fortunato, 2006b). Using data

from Italian firms, Becchetti and Trovato (2002) found that the availability of external financing (subsidy, leverage and financial constraints) significantly affected firm growth. Donati (2016) showed that liquidity constraints hindered the growth of small Italian firms in manufacturing. Oliveira and Fortunato (2006b) used cash flow as a proxy for financial constraints and revealed a higher sensitivity of cash flow on growth for small and younger firms, and that financial constraints hence have a higher impact on the growth of small and young firms. Colley and Quadrini (2001) supported this conclusion, confirming that the investment of small firms was more sensitive to cash flow.

Mukhopadhyay and AmirKhalkhali (2010) tested the size-growth relationship in the context of financial constraints and profitability performance of firms using a sample of 191 large U.S. firms. Return on equity (ROE) was used to measure profitability in this study. They concluded that large firms tended to grow faster than smaller ones regardless of the profitability of companies. We followed this study to re-examine its results using a very large sample of Czech firms and to estimate the validity separately for individual sectors using alternative measures of profitability.

3. Data and methodology

The analysis is based on panel data from the Albertina CZ Gold Edition database for the period from 2007 to 2012. The Albertina database contains information about all companies in the Czech Republic that have an organisation identification number. Because of the specific characteristics of the public sector, we test the validity of Gibrat's law only for private sector firms, with the private sector defined as industries A-N according to the Statistical Classification of Economic Activities in the European Community (NACE).

We narrowed the sample and used only the data of such companies that had already been in the industry for five years before 2007, survived throughout the study period, and did not change their primary economic activity (using one-digit NACE). We used a balanced panel of firms; the final sample covers the data of 29,437 Czech firms.

Removing the start-up firms and firms that left the market enables us to monitor the development of mature companies in the industry. The development of start-up and ending companies is specific, since start-up companies tend to be smaller, and their initial growth is very dynamic. In contrast, firms in liquidation mostly report a decline or minimum activity regardless of size. Empirical studies show that the Gibrat's law is more likely to be valid in mature industries (Daunfeldt & Elert, 2013; Lotti, Santarelli, & Vivarelli, 2009).

We used sales as the indicator of firm size. Sales, total assets, and number of employees are among the most frequently used measurements of firm size in empirical studies (Nassar et al., 2014). We chose 'sales' because it is the most flexible indicator of the three. The 'sales' indicator includes real annual revenues from sales of products, goods, and services. We used the year 2005 as the base period. Real sales were calculated using the consumer price index published by the Czech Statistical Office.[1]

To assess the validity of Gibrat's law in the context of firm profitability, we used two profitability ratios as indicators of profitability: return on assets (ROA) and ROE. ROA is defined as earnings before interest and taxes divided by total assets. ROA is a very frequently used measurement for profitability in empirical studies (for an overview, see Hult et al. 2008, including studies by Czech researchers, e.g., Šiška, 2009). ROE is defined as earnings after taxes (net profit) divided by equity. We also employed this indicator since the ROE includes the leverage, which is an important factor to consider when a bank provides a loan to a firm. In comparison to ROA, ROE encounters problems when both earnings and equity are negative. Firms in this situation seem to be falsely positive ROE (Trimbath, 2006). To minimise this problem, we used the absolute value of equity to compute the value of ROE. The descriptive statistics are shown in Table 1.

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

$$lnS_{jt}^i = \alpha_{j0} + \alpha_{j1}.lnS_{j(t-1)}^i + \theta_{jt}.T_t + u_{jt.} \tag{1}$$

where S_{jt}^i 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 whether Gibrat's law is valid. Gibrat's law holds if $\widehat{\alpha_{j1}}$ equal to one. A value smaller than one implies that small firms grow faster than large ones; a value higher than one implies that large firms grow faster than small firms do.

The advantages of this model are its simplicity and relatively low data input requirements. It also includes time-specific fixed effects. Hardwick and Adams (2002) showed that business cycles could play a role and this model makes it possible to

Table 1. Summary statistics by sector (average for the period 2007–2012).

NACE	Number of firms	Average sales in 2005 prices (in thousands of CZK)	
		Mean	Standard deviation
A – agriculture, forestry and fishing	1,519	48,374.37	91,316.12
B – mining and quarrying	69	143,943.00	275,332.50
C – manufacturing	5,795	126,547.50	289,679.10
D – electricity, gas, steam and air-conditioning supply	241	105,045.70	271,763.60
E – water supply, sewerage, waste management and remediation activities	319	90,643.93	184,490.70
F – construction	2,748	59,033.53	154,261.90
G – wholesale and retail trade, repair of motor vehicles and motorcycles	7,794	80,026.82	208,929.60
H – transportation and storage	807	105,458.00	229,522.20
I – accommodation and food service activities	739	18,705.85	74,452.52
J – information and communication	1,020	59,184.98	209,558.90
K – financial and insurance activities	228	121,056.80	362,262.10
L – real estate activities	3,998	8,742.12	47,593.88
M – professional, scientific and technical activities	3,461	26,037.05	113,464.70
N – administrative and support service activities	699	68,621.94	230,629.50
A-N	29,437	68,514.80	201,645.20

Source: Database Albertina, author's computations.

consider this. A disadvantage is that it does not address the potential non-linearity of the relationship (for example, see Park & Jang, 2010). However, this model is frequently used in empirical studies and it allows comparability of results (e.g., Daunfeldt & Elert, 2013; Peric & Vitezic, 2016; Tang, 2015).

To estimate the validity of Gibrat's law, we modify the original model (equation 1) to filter out the industry-specific fixed effects. We use this form:

$$lnS_{jt}^i = \alpha_{j0} + \alpha_{j1}.lnS_{j(t-1)}^i + \alpha_{j2}.T_t + \alpha_{j3}.NACE_j^i + \alpha_{j4k}.T_t.NACE_j^i + u_{jt.} \qquad (2)$$

where S_{jt}^i is the size of i-th firm of j-th industry by one-digit NACE in time t, $NACE_j^i$ is the dummy variable for industry using five-digit NACE classification of i-th firm, $\alpha_{j2}.T_t$ is the vector of time-specific fixed effects, $\alpha_{j3}.NACE_j^i$ is the vector of industry-specific fixed effects, $\alpha_{j4k}.T_t.NACE_j^i$ is a vector of time and industry-specific fixed effects. The values of parameter α_{j1} indicate whether Gibrat's law is valid. Gibrat's law holds if $\widehat{\alpha_{j1}}$ is equal to one. A value less than one implies that small firms grow faster than large ones; a value higher than one implies that large firms grow faster than small ones.

To consider the validity of Gibrat's law in the context of the industry and profitability of the firm we divided the firms from every sector (one-digit NACE) into three groups according to profitability: lower 25%, middle 50%, and upper 25% of firms (as in Mukhopadhyay & AmirKhalkhali, 2010). We used the mean of ROA/ROE for the examined period as the indicator for the inclusion of a company in the profit group. We then tested the validity of Gibrat's law using Equation (2). We estimated the model for the whole private sector and then separately for each industry on the level of one-digit NACE and every profitability group.

To allow for heteroskedasticity and serial correlation problem, we used the OLS estimator with cluster-robust standard errors. To confirm or reject Gibrat's law, we tested the null hypothesis $H0 : (\widehat{\alpha_1}) = 1$ versus $H1 : (\widehat{\alpha_1}) \neq 1$ using F-test.

4. Results and discussion

We investigated the validity of Gibrat's law on the whole sample of private sector companies (NACE A-N) using Equation (2), including industry-specific fixed effects and time-specific fixed effects and their combination, capturing industry and time variant heterogeneity in growth rates. Companies were divided into three profitability groups on the basis of their profitability performance. We used two profitability ratios as the measurement of profitability for more robust results: ROA and ROE Results are shown in Table 2. Coefficient α_1 is the key indicator for rejection or confirmation of the validity of Gibrat's law. The validity of Gibrat's law could be confirmed if $\widehat{\alpha_1} = 1$. F-test was used to test this hypothesis.

If profit is an important factor determining the validity of Gibrat's law, the size-growth relationship should differ across individual profit groups. Considering the difficulties for small firms in accessing external sources of financing, low-profit larger firms (from the lower 25%) could tend to grow faster. Using the sample of more profitable firms (in the middle 50% and upper 25%) with less need for outside funds,

Table 2. Testing Gibrat's law validity – by profit groups.

		Profit groups by ROA			Profit groups by ROE		
	All firms	Lower 25%	Middle 50%	Upper 25%	Lower 25%	Middle 50%	Upper 25%
$\ln.S_{t-1}$ (α_1)	0.977***	0.954***	0.978***	0.979***	0.955***	0.979***	0.976***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
T_t fixed effects	yes	yes	yes	yes	yes	yes	yes
$NACE_j$ fixed effects	yes	yes	yes	yes	Yes	yes	yes
$T_t.NACE_j$ fixed effects	yes	yes	yes	yes	yes	yes	yes
Constant	0.175***	0.324***	0.177***	0.179***	0.287***	0.169***	0.228***
	(0.014)	(0.041)	(0.017)	(0.030)	(0.039)	(0.017)	(0.036)
R^2	0.947	0.916	0.954	0.951	0.917	0.958	0.944
N	14,7185	36,800	73,585	36,800	36,795	73,590	36,800
F-test[a]	561.42***	406.08***	266.62***	139.76***	386.35***	271.62***	133.79***

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: $\widehat{\alpha}_1 = 1$, ***rejection of H0 at the 1% level, **rejection of H0 at the 5% level, *rejection of H0 at the 10% level.
Source: Database Albertina, author's computations.

the industry should tend validate Gibrat's law. As Table 2 shows, Gibrat's law is rejected both for the whole sample and for all three profitability groups. The findings are similar for both indicators of profitability (ROA and ROE). The results indicate that smaller enterprises grow faster than their larger counterparts in all profitability groups of companies ($\widehat{\alpha}_1 < 1$).

These results suggest that profit is not an important determinant of size-growth relationship at the aggregate level. This finding is in harmony with the study by Mukhopadhyay and AmirKhalkhali (2010), who investigated large U.S. industrial firms and concluded that the profitability performance did not influence the size-growth relationship. They also concluded that in many cases large firms tended to grow faster than their smaller counterparts. Their findings contradict the vast majority of previous studies confirming the higher growth dynamic of smaller firms. This result could be explained by their chosen sample of companies. Unlike our study and the majority of studies testing the validity of Gibrat's law, Mukhopadhyay and AmirKhalkhali (2010) used a sample of the 191 largest U.S. industrial companies. Here, economies of scale could play an important role in supporting the higher growth of large firms.

According to data from the Czech Ministry of Industry and Trade (2013), the importance of profit and other sources of funding differs across industries (see Table 3). Hence, the impact of profit on the validity of Gibrat's law could vary in individual sectors. Profit and funding both represent important sources of finance in most industries and approximately 30% of total liabilities on average. Significant differences are also found in the use of bank loans and financial accommodations.

The importance of profit in funding is relatively low in sector I, where it amounts to 0% and in sector L, where it represents 14% of total liabilities. Other sources, especially bank loans and financial accommodations, predominated in these sectors. If we assume that small firms were more constrained in obtaining outside funds, the validity of Gibrat's law could differ for both low and high-profit firms in these sectors and these differences could be significant. In contrast to the sectors in which other

Table 3. The share of individual funding sources on total liabilities by sector in 2012 (in %).

NACE	Equity	Registered capital	Profit + funds	Other sources	Reserves	Payables	Loans	Accruals
A	**87.5**	17.1	70.4	**12.4**	3.7	5.8	2.9	**0.1**
B	**59.1**	19.7	39.3	**40.9**	12.3	23.6	5.0	**0.1**
C	**52.2**	21.4	30.8	**47.0**	3.0	33.3	10.7	**0.8**
D	**47.9**	22.7	25.2	**48.2**	3.7	40.0	4.5	**3.9**
E	**71.1**	47.3	23.7	**28.0**	2.2	20.4	5.4	**0.9**
F	**41.0**	17.1	23.9	**57.3**	6.8	44.1	6.5	**1.7**
G	**40.0**	17.5	22.5	**59.2**	1.6	44.1	13.4	**0.8**
H	**64.0**	41.3	22.7	**35.1**	1.6	30.1	3.5	**0.9**
I	**12.8**	13.0	−0.2	**84.8**	0.2	34.9	49.7	**2.4**
J	**55.2**	19.5	35.7	**40.4**	1.9	25.5	13.0	**4.5**
L	**31.7**	18.2	13.5	**66.7**	0.6	21.8	44.2	**1.7**
M	**63.2**	31.4	31.9	**36.1**	1.0	26.9	8.2	**0.7**
N	**40.2**	17.6	22.6	**57.3**	0.9	28.8	27.6	**2.5**

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; L – real estate activities, M – professional, scientific and technical activities, N – administrative and support service activities. Data are not available for sector K – financial and insurance activities.
Source: Ministry of Industry and Trade (2013).

sources (especially bank loans and financial accommodations) are not such important funding sources, differences in the validity of Gibrat's law according to profit groups cannot be expected. In this case, restricted access to outside funds for smaller firms could not be an important factor affecting the size-growth relationship.

We next verify the validity of Gibrat's law separately for individual sectors (A–N) using one-digit NACE and model (2). The results are presented in Table 4.

Using the sample of all firms and sector levels, the validity of Gibrat's law is rejected for most sectors of the economy. Using a 5% level of significance, Gibrat's law is valid only in sectors B, D, and E; we can reject its validity for the rest of the sectors. These results are very similar to those presented by Hedija (2016), who examined the validity of Gibrat's law in individual sectors of the Czech economy and rejected the validity of Gibrat's law in the vast majority of industries. The differences in the validity of Gibrat's law among individual industries are explained by differences in concentration rate, the size of the industry, and the MES of production.

Using the profit groups, the validity of Gibrat's law is rejected in the majority of cases. The validity of Gibrat's law was confirmed only in one third of the cases in the examined groups, and it was not proved that companies with higher profits (from the middle 50% and upper 25%) tended to validate Gibrat's law. The results were very similar for both applied indicators of profitability.

We then focused on sectors in which bank loans and financial accommodations are important sources of funding (sectors I and L). We presume that the validity of Gibrat's law could vary across individual profit groups in these sectors. As the results show, using the sample of all firms, the validity of Gibrat's law is rejected for both sectors. Moreover, the size-growth relationship does not differ across individual profit groups in sectors I and L. Small companies tend to grow faster than larger ones here, independent of profit group.

Hence, these results do not prove that profitability is a significant factor affecting the relationship between firm growth and firm size. They show that the

Table 4. Testing Gibrat's Law validity by sectors.

	All firms	Profit groups by ROA			Profit groups by ROE		
		Lower 25%	Middle 50%	Upper 25%	Lower 25%	Middle 50%	Upper 25%
A – agriculture, forestry and fishing							
$\ln.S_{t-1}$ (α_1)	0.986***	0.980***	0.984***	0.980***	0.979***	0.990***	0.972***
	(0.004)	(0.008)	(0.007)	(0.007)	(0.008)	(0.006)	(0.010)
R^2	0.958	0.961	0.955	0.956	0.953	0.966	0.952
N	7,595	1,895	3,800	1,900	1,895	3,800	1,900
F-test[a]	11.21***	6.55**	4.98**	8.00***	7.04***	2.56	7.31***
B – mining and quarrying							
$\ln.S_{t-1}$ (α_1)	1.005***	1.039***	0.961***	0.990***	1.062***	0.974***	0.970***
	(0.020)	(0.026)	(0.021)	(0.023)	(0.022)	(0.014)	(0.022)
R^2	0.961	0.960	0.959	0.975	0.971	0.950	0.979
N	345	90	170	85	90	170	85
F-test[a]	0.06	2.18	3.51*	0.20	8.35**	3.53*	1.79
C – manufacturing							
$\ln.S_{t-1}$ (α_1)	0.993***	0.981***	0.994***	0.981***	0.987***	0.990***	0.986
	(0.002)	(0.005)	(0.003)	(0.005)	(0.005)	(0.003)	(0.005)
R^2	0.957	0.946	0.965	0.962	0.951	0.964	0.958
N	28,975	7,245	14,485	7,245	7,245	14,485	7,245
F-test[a]	10.44***	12.66***	4.99**	17.42***	6.33**	11.99***	8.43***
D – electricity, gas, steam and air-conditioning supply							
$\ln.S_{t-1}$ (α_1)	0.958***	1.051	0.924***	0.945***	0.955***	0.993***	0.880***
	(0.021)	(0.048)	(0.031)	(0.026)	(0.028)	(0.025)	(0.061)
R^2	0.923	0.975	0.914	0.932	0.955	0.957	0.861
N	1,205	300	600	305	305	600	300
F-test[a]	3.84*	1.13	6.07**	4.34**	2.65	0.09	3.86*
E – water supply, sewerage, waste management and remediation activities							
$\ln.S_{t-1}$ (α_1)	0.978***	0.942***	1.00***	0.971***	0.965***	0.990***	0.973***
	(0.015)	(0.043)	(0.011)	(0.014)	(0.036)	(0.011)	(0.015)
R^2	0.938	0.923	0.953	0.957	0.932	0.953	0.947
N	1,595	400	800	395	400	800	395
F-test[a]	1.97	1.81	0.02	4.35**	0.95	0.74	3.15*
F – construction							
$\ln.S_{t-1}$ (α_1)	0.961***	0.938***	0.955***	0.958***	0.941***	0.962***	0.937***
	(0.005)	(0.010)	(0.007)	(0.008)	(0.010)	(0.006)	(0.011)
R^2	0.903	0.868	0.903	0.920	0.867	0.918	0.889
N	13,740	3,435	6,870	3,435	3,435	6,870	3,435
F-test[a]	72.79***	39.30***	41.67***	29.55***	34.72***	38.95***	30.95***
G – wholesale and retail trade, repair of motor vehicles and motorcycles							
$\ln.S_{t-1}$ (α_1)	0.968***	0.930***	0.972***	0.969***	0.929***	0.973***	0.974***
	(0.002)	(0.006)	(0.004)	(0.004)	(0.006)	(0.004)	(0.005)
R^2	0.940	0.900	0.947	0.957	0.899	0.951	0.951
N	38,970	9,745	19,485	9,740	9,740	19,485	9,745
F-test[a]	164.54***	129.53***	57.81***	53.43***	137.22***	57.30***	32.04***
H – transportation and storage							
$\ln.S_{t-1}$ (α_1)	0.986***	0.974***	0.978***	0.993***	0.979***	0.991***	0.968***
	(0.007)	(0.016)	(0.013)	(0.008)	(0.016)	(0.009)	(0.016)
R^2	0.938	0.922	0.932	0.956	0.917	0.944	0.942
N	4,035	1,005	2,025	1,005	1,010	2,015	1,010
F-test[a]	3.98**	2.65	2.87*	0.74	1.68	0.90	3.98**
I – accommodation and food service activities							
$\ln.S_{t-1}$ (α_1)	0.950***	0.936***	0.953***	0.937***	0.948***	0.951***	0.927***
	(0.010)	(0.025)	(0.012)	(0.023)	(0.016)	(0.013)	(0.026)
R^2	0.921	0.870	0.940	0.910	0.886	0.936	0.910
N	3,695	920	1,850	925	920	1,850	925
F-test[a]	27.34***	6.43**	15.99***	7.69***	10.53***	14.21***	7.98***
J – information and communication							
$\ln.S_{t-1}$ (α_1)	0.990***	0.964***	0.987***	1.00***	0.960***	0.987***	0.993***
	(0.005)	(0.011)	(0.006)	(0.007)	(0.012)	(0.006)	(0.007)
R^2	0.956	0.933	0.962	0.967	0.932	0.961	0.970
N	5,100	1,275	2,550	1,275	1,275	2,550	1,275
F-test[a]	5.12**	10.11***	4.90**	0.06	12.12***	4.24**	1.00

(*continued*)

Table 4. Continued.

	All firms	Profit groups by ROA			Profit groups by ROE		
		Lower 25%	Middle 50%	Upper 25%	Lower 25%	Middle 50%	Upper 25%
K – financial and insurance activities							
$\ln.S_{t-1} (\alpha_1)$	0.967***	0.976***	0.943***	1.014***	0.998***	0.928***	1.007***
	(0.013)	(0.026)	(0.019)	(0.017)	(0.020)	(0.024)	(0.012)
R^2	0.933	0.922	0.936	0.961	0.958	0.920	0.970
N	1,140	285	570	285	285	570	285
F-test[a]	5.53**	0.87	9.31***	0.64	0.01	9.14***	0.34
L – real estate activities							
$\ln.S_{t-1} (\alpha_1)$	0.946***	0.920***	0.955***	0.945***	0.917***	0.956***	0.948***
	(0.003)	(0.007)	(0.004)	(0.006)	(0.008)	(0.003)	(0.007)
R^2	0.914	0.878	0.921	0.920	0.871	0.925	0.918
N	19,990	5,000	9,990	5,000	4,995	10,000	4,995
F-test[a]	316.60***	114.57***	134.29***	77.03***	107.80***	161.50***	59.04***
M – professional, scientific and technical activities							
$\ln.S_{t-1} (\alpha_1)$	0.951***	0.918***	0.953***	0.959***	0.917***	0.951***	0.954***
	(0.003)	(0.008)	(0.005)	(0.008)	(0.009)	(0.005)	(0.008)
R^2	0.913	0.864	0.925	0.932	0.858	0.923	0.931
N	17,305	4,325	8,650	4,330	4,330	8,645	4,330
F-test[a]	199.86***	100.68***	98.00***	28.63***	84.41***	110.02***	35.85***
N – administrative and support service activities							
$\ln.S_{t-1} (\alpha_1)$	0.978***	0.935***	0.991***	0.995***	0.930***	0.997***	0.978***
	(0.007)	(0.019)	.0073471	(0.014)	(0.021)	(0.007)	(0.015)
R^2	0.934	0.910	0.949	0.958	0.906	0.954	0.943
N	3,495	875	1,745	875	875	1,745	875
F-test[a]	8.44***	11.14***	1.61	0.14	11.39***	0.15	2.17

Notes: Standard errors in brackets. ***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: $\alpha_1 = 1$. ***rejection of H0 at the 1% level. **rejection of H0 at the 5% level. *rejection of H0 at the 10% level.
Source: Database Albertina, authors' computations.

size-growth relationship does not vary systematically depending on the amount of firm profit.

Other factors that may affect the growth performance of companies in individual profit groups could play an important role as well. Empirical studies show that in addition to access to financing, foreign ownership, family control, networks, and contacts also influence firm growth (Bellak, 2004; Hamelin, 2013; Leitner, 2016). Other possible explanations could include financial and non-financial support for SMEs from European Union funds and special national funds and institutions (for example, the Czech-Moravian Guarantee and Development Bank) that can make up for missing funds (e. g. bank loans) from commercial banks to minimise the impact of financial constraints (see Ministry of Industry & Trade, 2012).

5. Conclusion

SMEs are considered to be important pillars of the economy. However, they could experience some disadvantages that large companies do not (for example, see Haverniková, 2016; Šúbertová & Meszárošová, 2015). According to our hypothesis, one disadvantage for SMEs is that they cannot obtain external financial resources as easily as large companies. This could affect the growth rate of small firms. In industries with low profitability, large firms can grow faster than the smaller ones.

This study examined the validity of Gibrat's law in the context of the profitability performance of firms. We used a large sample of firms, divided into three profitability groups (lower 25%, middle 50%, and upper 25% of firms) to examine whether profit affects significantly the size-growth relationship. We tested the validity of Gibrat's law at the aggregate level and then at the industry level (using one-digit NACE classification) using the linear auto-regression model. The results show that the size-growth relationship does not vary systematically depending on the amount of firm profit at the aggregate level or at the industry level. We identified the tendency of small firms to grow faster than their larger counterparts regardless of profit group in most sectors.

We can conclude that our results do not prove that profitability is a significant factor affecting the relationship between firm growth and firm size. The rate of profit and the differing access to outside funds do not seem to be factors that negatively affect SMEs in their growth in the Czech Republic. This is a very important finding for the policies supporting SMEs Fiala (2017) confirmed the convergence toward Gibrat-like behaviour over time for sample of SMEs. The article by Fiala (2017) and the findings of this study indicate that SMEs should be supported in the initial period when they have not exceeded the MES of production.

Although our research provides new findings, it is not without limitations. Factors other than profitability and financial constraints could influence the firm-growth relationship, including foreign ownership, family control, and SME support. We have not considered these factors in our analysis, but their influence may prevail.

Due to our relatively surprising results, the possible effect of country-specific factors, and the lack of studies on this topic, further research should focus on testing the influence of profitability on firm-size growth relationships in other countries as well as on capturing the influence of other factors on the validity of Gibrat's law, especially financial and non-financial support for SMEs.

Note

1. Sales = (revenue from sales of products, goods, and services/C.P.I.).100

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the College of Polytechnics Jihlava, under Grant no. 1170/4/186.

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