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Testing the validity of Gibrat's law for Slovenian farms: cross-sectional dependence and unit root tests

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ABSTRACT

This paper studies the validity of Gibrat's law for the growth of Slovenian farms between 2007 and 2015 using Farm Accountancy Data Network datasets. Cross-sectional dependence test and four different groups of panel unit root tests are applied to study the relationship between farm size and the farm size growth. It revealed evidence of cross-sectional dependence in farm sizes. Both input (land and labour) and output (economic) sizes of variables as proxy for the measures of farm size are applied. The results suggest that Gibrat's law is valid for Slovenian farms independently from the measures of farm size and types of panel unit root tests. Slovenian smaller farms are not growing faster than larger ones and thus all farm sizes tend to contribute to an increase in average farm size in generally relatively small- to medium-size farm structures.

1. Introduction

Since the mid of the twentieth century, the number of farms has declined sharply in developed countries (Lowder, Skoet, & Raney, 2016). During the last three decades, similar phenomena was observed in Central and Eastern European (CEE) countries with transition from a centrally planned to a market economy (Eurostat, 2019b). Corollary to the decrease in the number of farms, there is the increase in the remaining farms' average size. The farm size distribution and farm size growth with changes in farm structures have become a challenge research issue with implications for international farm and agricultural productivity differences (Adamopoulos & Restuccia, 2014).

In this paper, special attention is given to investigating the relationship between farm size and the farm size growth. This idea in the literature is known as Gibrat's law or the law of proportionate effect, which was developed by Gibrat (1931) for French manufacturing firms and concluded that firm growth is a random effect,

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independent from firm size. The existing theories and applied research of the association between farm size and the farm size growth give mixed results by countries and over time (Akimowicz, Magrini, Ridier, Bergez, & Requier-Desjardins, 2013; Bakucs, Bojnec, Ferto, & Latruffe, 2013; Brenes-Muñoz, Lakner, & Brümmer, 2016). More specifically, the objective of the paper is to test the validity of Gibrat's law for Slovenian farms between 2007 and 2015 using Farm Accountancy Data Network (FADN) datasets.

The issue of the farm size growth refers specifically to that of structural change, which is a permanent and irreversible change in the agricultural sector. If growth of farms is non-linear pertained to their sizes, then there is a structural change in the importance of different farm sizes. If smaller farms are growing faster than larger ones, then on long-term this might lead to catching up in farm size of the former, and *vice versa* if smaller farms are growing slower than larger farms, then the latter experience rapid increase in concentration of agricultural factor resources and outputs. Different patterns in the development of farm size and their growth can be important not only for farm restructuring, but also for agricultural and rural development policies targeting farm size growth and farm efficiency objectives as well as for farm and local rural employment development since farm labour size can be one of measures of farm size as well as of the measures of farm job creation or job destruction.

This different patterns in the development of farm size and their growth raise the question: Why it is important to study the validity of Gibrat's law specifically in Slovenia? On average, Slovenia can be included in a group of countries with smaller farms (Bojnec & Latruffe, 2013; Bakucs et al., 2013; Eurostat, 2019b). Similar to other countries on the territory of the former Yugoslavia and Poland, smaller farms in Slovenia are the legacy of failed communist collectivization process and later survival within institutional limitations in the growth of smaller family farms. Therefore, the empirical results and findings can be important for Slovenia as well as for other countries in the CEE region with similar farm structures. In addition to the countries on the territory of the former Yugoslavia and Poland, some other CEE countries such as Albania, Bulgaria, Romania and some former Soviet countries have a similar smaller farms structure due to de-collectivization, restitution, privatisation and farm restructuring of former state and collective farms (Burkitbayeva & Swinnen, 2018; Guiomar et al., 2018; Lerman & Sedik, 2018).

Therefore, this paper fills the gap in the literature examining the farm size-farm growth relationship in the CEE country. We (1) employ three different measures of farm size: two on physical input size and one on value of output size at constant prices; (2) test hypothesis of cross-sectionally independent residuals in panel data; (3) test the validity of Gibrat's law on the proportional relationship between farm growth rate and farm size by applied four different unit root tests and (4) present the results and findings for the Slovenian FADN farms.

The remaining part of the paper is structured as follows. Firstly, previous literature on relation between farm size and the farm size growth is briefly reviewed, followed by presentation of methodology, data used, empirical results and their explanation and discussion. Final section concludes and derives implication for research, farm-size specific policy, practice and possible issues for research in future.

2. Previous research

The relationship between firm growth rate and firm size has been investigated in theoretical–conceptual and applied economic literature. Santarelli, Klomp, and Thurik (2006), Nassar, Almsafir, and Al-Mahrouq (2014), and the most recently Fiala and Hedija (2019) provide a review of studies and a summary of their conclusions on the validity of Gibrat's law.

The previous empirical results in the literature on the validity of Gibrat's (1931) law are mixed (Audretsch, Klomp, Santarelli, & Thurik, 2004; Fiala & Hedija, 2019; Lunardi, Miccichè, Lillo, Mantegna, & Gallegati, 2014; Srhoj, Zupic, & Jaklič, 2018; Stam, 2010). The literature among the drivers that can affect the validity of Gibrat's law identifies different factors such as minimum efficient scale of production, type of ownership, industry uncertainty and ownership structure (Fiala & Hedija, 2019). In contrast to most previous studies, which have investigated firm growth and the validity of Gibrat's law for firms in industrial activities particularly in developed market economies, the aim of this article is to examine farm growth and the validity of Gibrat's law for the CEE country.

Only a few empirical studies have investigated Gibrat's law for farms in CEE countries (Bakucs & Fertő, 2009; Bakucs, Fertő, Fogarasi, & Tóth, 2012; Bakucs et al., 2013; Fertő & Bakucs, 2009), while most of the studies have been conducted in developed countries (Brenes-Muñoz et al., 2016; Dolev & Kimhi, 2010; Liu, Richard Shumway, Rosenman, & Ball, 2011).

As far as developed countries are concerned, Shapiro, Bollman, and Ehrensaft (1987) rejected the validity of Gibrat's law for farm growth, finding that Canadian small farms tend to grow faster than large ones. Upton and Haworth (1987) does not find evidence to reject Gibrat's law. Hallam (1993) provides an overview of previous studies on empirical tests of Gibrat's law for the US and Canadian farms underling the importance of economies of size to explain the variety of farm structures in livestock production. Weiss (1998) rejected Gibrat's law for the Upper Austrian farms, finding the faster growth for smaller farms than for farms at or above this threshold size, and the deterioration of middle size farms. In addition, Weiss (1999) concluded that farm entry and exit (farm survival) significantly contributed to structural change in the farm sector and the evolution of the farm size distribution in the Upper Austria with significant role of the off-farm employment.

Brenes-Muñoz et al. (2016) investigated organic farm size growth in Germany in the 1993–2005 period using the system generalised method of moments estimator. They found that all organic farm sizes increase area, but large farms growth more frequently than smaller ones. Organic farm area growth was influenced by subsidies for organic farming and intensity of livestock production, while farm growth measured in terms of output was driven by farm size structure, regional conditions of land market, capital, soil quality, and intensity of livestock production.

Among the CEE countries, the validity of Gibrat's law for farms was for the first time tested in Hungary. Rizov and Mathijs (2003) rejected the validity of Gibrat's law, because the growth of smaller and newer farms was found to be faster than larger and older ones, while older and larger Hungarian individual farms are more likely to survive. Similarly, as for example Rizov and Mathijs (2003), the study by

Bakucs and Fertő (2009) rejected Gibrat's law for farm growth, finding that Hungarian smaller farms tend to grow faster than larger ones, while the growth trajectory of family and corporate farms is similar.

Bakucs et al. (2013) reviewed previous studies on testing the validity of Gibrat's law in agriculture and classified three types of empirical results: the first type cannot be rejected or accepts Gibrat's law, the second type rejects Gibrat's law and the third both cannot be rejected and rejection of Gibrat's law. Bakucs et al. (2013) is also only a single study, which investigated the validity of Gibrat's law for Slovenian FADN specialized dairy and crop farms, in comparison with French and Hungarian ones, during the period 2004–2008. To avoid biases due to heterogeneous structures across the farming systems, quantile regressions were employed to control for farm size related heterogeneity in the samples. The results rejected the validity of Gibrat's law for Slovenian as well as for French dairy farms, but not for Slovenian crop farms. On the other hand, the validity of Gibrat's law is rejected for crop farms in Hungary and to a lesser extent in France. Therefore, while Slovenian smaller dairy farms grew faster than larger ones over the studied period, the rate of growth of Slovenian crop farms in terms of its land is independent from its size.

While Gibrat's law, except for Hungary and Slovenia, has not been tested for farms in any other CEE country, Petrick and Götz (2019) investigated herd growth for a sample of dairy farms in Russia and Kazakhstan using simultaneous equation framework. Among the drivers of herd growth were identified farm management and organisation, and vertical integration with milk marketing contracts, but not subsidy payments. They conclude that herd growth of smaller farms catch up.

To sum up, the question in this paper is whether the CEE country might perform differently following the transformation of economy and agriculture, integration into the enlarged European Union (EU), and during the economic recession with most recent economic recovery. This is tested for the Slovenian sample of FADN farms.

3. Methodology

Bakucs et al. (2013) provide previous literature review of studies on farm growth and specifically on testing Gibrat's law. Following previous research, Equation (1) represents the stochastic process underlying Gibrat's law:

$$\frac{S_{i,t}}{S_{i,t-1}} = \alpha S_{i,t-1}^{\beta_1 - 1} \varepsilon_{i,t} \tag{1}$$

where $S_{i,t}$ and $S_{i,t-1}$ are the size of the ith farm in the current period t and in the previous period $t - 1$, respectively. $\varepsilon_{i,t}$ is the disturbance in period t, independent from $S_{i,t-1}$. α is the common growth rate of all farms, whilst β_1 measures the effect of the initial size upon the given farm's growth rate. If $\beta_1 = 1$, then growth rate and initial farm size are independently distributed, indicating that Gibrat's law holds. If the coefficient is less than one, it follows that small farms tend to grow faster than large farms, while the opposite is the case if β_1 is greater than unity.

Rewriting Equation (1) into the form represented by Equation (2), allows testing for the significance of the coefficient β_1:

$$\log S_{i,t} = \beta_0 + \beta_1 \log S_{i,t-1} + \mu_{i,t} \tag{2}$$

where $\beta_0 = \log\alpha$ and $\mu_{i,t} = \log\varepsilon_{i,t}$, where log is the natural logarithm. Following Ward and McKillop (2005), if $\beta_1 = 1$, that is, Gibrat's law holds, then positive (negative) values of β_0 indicate a growth (decrease) in the average farm size. If, however $\beta_1 < 1$, that is, smaller farms tend to grow faster than larger ones.

The empirical analysis of Gibrat's law faces several econometric issues. The first concern is the heteroskedasticity issue which may occur when Gibrat's law is not confirmed: if small farms grow faster than their larger counterparts, the variance of growth should tend to decrease with size (see Lotti, Santarelli, & Vivarelli, 2003, for more details).

Different approaches have been developed in firm/farm level analyses to test whether Gibrat's law holds (Bakucs et al., 2013; Bakucs & Fertő, 2009; Goddard, McMillan, & Wilson, 2006; Goddard, Wilson, & Blandon, 2002; Harris & Trainor, 2005; Zimmermann & Heckelei, 2012). More recent developments in the panel data econometrics have opened up the possibility of testing Gibrat's law using pooled or panel data, rather than cross-sectional data. Most often alternative panel unit root tests have been applied to test the relationship between firm/farm growth and the measures of firm/farm size. Over the previous decade, a number of panel unit root tests have been developed (Baltagi, Bresson, & Pirotte, 2007; Reese & Westerlund, 2016).

A standard assumption in panel data models is that the error terms are independent across cross-sections. This assumption is employed for identification purposes rather than descriptive accuracy. In the context of large T (panels' time dimension) and small N (cross-sectional dimension), the Lagrange multiplier (LM) test statistic can be used to test for cross-sectional dependence. However, in most cases, as in our sample, cross-sectional time series data sets come in the form of small T and large N. In this case, the Breusch–Pagan test is not valid. In our empirical analysis of convergence, the assumption of cross-sectional independence appears to be unreasonable according to the literature (Bai & Ng, 2010), because various studies indicate that time series are contemporaneously correlated (Breitung & Pesaran, 2007; Sonderman, 2012). In order to check it empirically in the database used, before carrying out a panel unit root test, firstly we investigated the potential for cross-sectional dependence (CD) in farm sizes, applying the Pesaran (2004) CD test. Pesaran's statistic follows a standard normal distribution and it is able to handle balanced and unbalanced panels.

As it revealed evidence of CD, we used a second generation panel unit root test. However, some of the second generation panel unit root tests require a panel dataset with large time dimension, for example, the Bai and Ng (2004) test. As in our dataset the time dimension is relatively small, we used the Pesaran (2007) test, which performs accurately also with small samples (Moscone & Tosetti, 2009). Thus, first, we employ second generation panel unit root tests to check the unconditional forms of Gibrat's law in Slovenian farm growth. In addition, we apply different heteroskedasticity-robust panel unit-root tests suggested in Herwartz and Siedenburg (2008), Demetrescu and Hanck (2012), and Herwartz, Maxand, Raters, and Walle (2018).

While the former two tests are robust to time-varying volatility when the data contain only an intercept, the latter test is asymptotically pivotal for trending heteroskedastic panels.

The investigation of farm size growth and the validity of Gibrat's law can be biased to the measure of farm size. Farm input size and farm output size indicators have been used in the literature as a measure of farm size (Alvarez & Arias, 2004). As farm input physical size indicators, the total utilized agricultural area (UAA) per farm or the total number of heads of livestock per farm (Bakucs et al., 2013; Summer & Leiby, 1987; Weiss, 1999), and total annual working unit (AWU) per farm (Bakucs et al., 2013) have been used. As indicators of economic size of output, total standard gross margin (SGM) per farm or turnovers per farm have been used (Butault & Delame, 2005; Summer & Leiby, 1987). Akimowicz et al. (2013) argue that the UAA per farm as an indicator of farm size seems more relevant than an economic size indicator due to the latter biases to farm produce price volatility.

4. Data

The analysis is based on farm-level data from the Slovenian FADN datasets. FADN data are collected in each EU member state for a sample of professional farms exceeding the specific minimum threshold in terms of size greater than two European Size Units (ESUs), where the value of one ESU is equivalent to 1200 euro of farm SGM. The time span used for analysis is the period 2007–2015. We employ balanced panel dataset with 138 observations per year and total 1242 observations in our panel data.

There is no single measure of farm size in agriculture, and research findings may differ according to the proxy used (e.g., Akimowicz et al., 2013). The proxy of farm size mainly depends on farms' production specialization and technology used. Physical size of inputs – the total UAA per farm and total AWU per farm – and value indicator of economic size of holding expressed in 1000 euro of standard output (SO) per farm were used.

Since the financial year 2010 onwards, the SO of an agricultural product or farm has been introduced as the average monetary value of the agricultural output at farm-gate price. It can be expressed in euro per hectare of crop or per head of livestock. The sum of all the SO per hectare of crop and per head of livestock in a farm is a measure of its overall economic size, expressed in euro. The SO has been used to classify agricultural holdings by economic size (Eurostat, 2019a). Prior to 2010, economic farm size was measured by SGM, which was defined in terms of ESU. In the Slovenian standard FADN results, systematic data on economic size in the form of SO is available from 2004 onwards, and the SGM is available between the years 2004 and 2009 (European Commission, 2019). The European Commission has adjusted the calculations in its application so that data for previous accounting years prior to 2010 are also available on the basis of SO. The principle of both concepts SGM and SO is the same; only the way they are calculated differs: $SGM = Output + Direct\ Payments - Costs$, while $SO = Output$. The decision to leave SGM was driven by the Common Agricultural Policy (CAP) of the EU moving from coupled to decoupled

Table 1. Descriptive statistics of farm size variables.

Variable	Obs	Mean	Std. dev.	Min	Max
SO (in euro at 2010 constant prices per farm)	1242	27.6	29.8	2.4	341.5
Labour (in AWU per farm)	1242	2.1	2.6	0.2	46.1
Land (UAA in ha per farm)	1242	16.3	12.2	2.8	110.6

Source: Own calculations based on FADN data.

payments (Eurostat, 2019a). Since decoupled direct payments cannot be attributed to any specific production, they were excluded from the SO calculation. The main differences between SO and SGM are: SO excludes direct payments and includes the production costs; the fodder requirement in the case of some livestock characteristics is included in the calculation of the SO; and the unit used to measure SO is the euro and not ESU as in the SGM classification (Eurostat, 2019a).

Although statistics on farm size generally refer to land in terms of UAA per farm, this indicator is often irrelevant for livestock farms. In this paper, UAA (which consists of owned- and leased-land) per farm is used as a farm size. More specifically, within a specific farm specialization, technology (such as capital or land intensity) may be different and may thus render difficulties in the comparison between crop farm size (in terms of UAA) and livestock farm size (in terms of livestock units). For this reason, in this paper, farm size is also measured with the amount of labour used: the number of full-time equivalent workers per year on the farm (in AWUs per farm). Finally, we employ an output indicator, SO as a proxy for farm size.

To sum up, in this paper we apply both input and output sizes as proxy for farm size, namely total UAA per farm and farm employment in terms of AWU per farm on input size, and total economic size measured by SO per farm on output size.

5. Results and discussion

5.1. Descriptive statistics

As expected, there is heterogeneity in farm size according to each of three analysed farm size measures (Table 1). On average, farms in the sample employ 2.1 units of labour in AWU and cultivate 16.3 ha of UAA. However, there is substantial difference between the smallest and the largest farms. In case of labour, it ranges between 0.2 and 46.1 AWU per farms, while in case of land it ranges between 2.8 and 110.6 ha of UAA. In reality, average UAA farm size is smaller, because FADN sample includes more viable farms, which are a slightly bigger than farms in different size groups (Bojnec & Latruffe, 2013). Not only in case of use of inputs, there is also considerable difference in size of output. On average, it is 27.6 SO, but ranges from 2.4 to 341.5 SO per farm.

5.2. Cross-sectional dependence

Understanding of cross-sectional dependence in panel data is conducted by Pesaran (2004) CD tests for null hypothesis (Ho) of cross-sectionally independent residuals. As can be seen from Table 2, in case of land size in UAA per farm, p value is greater than .05 and Ho cannot be rejected, while in cases of output size (SO per farm) and

Table 2. Pesaran (2004) CD tests.

Variable	CD test	p Value
log SO	181.35	.000
log labour	32.68	.000
log land	0.40	.687

Source: Own calculations based on FADN data.

Table 3. Panel unit root tests for log land.

Variable	Lags	Zt-bar	p Value
(A) Pesaran (2007) panel unit root test (CIPS)			
	Specification without trend		
log land	0	−0.392	.347
log land	1	−0.670	.251
	Specification with trend		
log land	0	3.850	1.000
log land	1	29.289	1.000

Variable	Lags	Statistic	p Value
(B) Herwartz and Siedenburg (2008) panel unit root test			
	Specification without trend		
log land	0	−1.2189	.1114
log land	1	−1.0930	.1372
	Specification with trend		
log land	0	−1.1779	.1194
log land	1	−0.3867	.3495
(C) Demetrescu and Hanck (2012) panel unit root test			
	Specification without trend		
log land	0	−0.7704	.2205
log land	1	−0.8302	.2032
	Specification with trend		
log land	0	−0.9552	.1697
log land	1	0.3927	.6527
(D) Herwartz, Maxand, and Walle (2018) panel unit root test			
	Specification with trend		
log land	0	−1.0213	.1536
log land	1	0.1619	.5643

Note: log – the natural logarithm.
Source: Own calculations based on FADN data.

size of labour in AWU per farm, p value is less than .05 and thus Ho can be rejected. This implies that land size in UAA per farm is with cross-sectionally independent residuals, but not size of labour in AWU per farm and size of output in SO per farm, which are with cross-sectionally dependent residuals that are interconnected and can affect each other's outcomes. Cross-sectional dependence can arise due to omitted or unobserved common factors, spatial spillover effects such as from CAP policy measures (Bojnec & & Fertő, 2019b), or general residual interdependence.

5.3. Panel unit root tests

To test robustness of the results, four panel unit root tests were conducted: Pesaran (2007) with and without trend (CIPS), Herwartz and Siedenburg (2008) with and without trend, Demetrescu and Hanck (2012) with and without trend, and Herwartz, Maxand, and Walle (2017) with trend.

Table 4. Panel unit root tests for log labour.

Variable	Lags	Zt-bar	p Value
(A) Pesaran (2007) panel unit root test (CIPS)			
	Specification without trend		
log labour	0	−4.307	.000
log labour	1	−7.074	.000
	Specification with trend		
log labour	0	−2.791	.003
log labour	1	29.055	1.000

Variable	Lags	Statistic	p Value
(B) Herwartz and Siedenburg (2008) panel unit root test			
	Specification without trend		
log labour	0	−1.7751	.0379
log labour	1	−1.0117	.1558
	Specification with trend		
log labour	0	−1.7762	.0378
log labour	1	0.4356	.6684
(C) Demetrescu and Hanck (2012) panel unit root test			
	Specification without trend		
log labour	0	−1.4859	.0687
log labour	1	−1.0663	.1431
	Specification with trend		
log labour	0	−1.6113	.0536
log labour	1	−0.1897	.4248
(D) Herwartz, Maxand, and Walle (2018) panel unit root test			
	Specification with trend		
log labour	0	−1.5883	.0561
log labour	1	0.5708	.7159

Source: Own calculations based on FADN data.

As can be seen from Table 3 for *log land* farm size, *p* value for each panel unit test is different than .05, which is insignificant at all the usual testing levels. Therefore, we cannot reject the null hypothesis of a unit root and conclude that the series is nonstationary. This implies that Gibrat's law of proportionate growth cannot be rejected suggesting that the proportional rate of growth of a UAA per Slovenian farm is independent from its absolute size of UAA per farm. The law of proportionate growth may lead to a distribution that is log-normal. This finding is in line with Bakucs et al. (2013) for Slovenian crop farms, but not for Slovenian dairy farms using quantile regression during the period 2004–2008.

Table 4 presents similar panel unit root tests for *log labour* farm size. Results are mixed, but except for Pesaran (2007) panel unit root tests, most *p* values are close or greater than .05. Except in the cases, where *p* values are less than .05, we cannot reject the null hypothesis of a unit root as well as cannot be rejected the Gibrat's law of the proportional rate of growth of an AWU per Slovenian farm as independent from its absolute size of AWU per farm. However, due to some significant results (*p* values), the law of proportionate growth may lead to a distribution that is not necessary log-normal. This means that results for *log labour* size are less robust than this is the case for *log land* size. This can be explained by greater flexibility of farm labour vis-a-vis farm land for own land or leased land for a longer-period.

Similarly, as for *log land* farm size (Table 3), *p* value for each panel unit test for *log SO* farm size is different than .05 (Table 5). These insignificant usual testing levels suggest that the null hypothesis of a unit root cannot be rejected. The series is

Table 5. Panel unit root tests for log SO.

Variable	Lags	Zt-bar	p Value
(A) Pesaran (2007) panel unit root test (CIPS)			
	Specification without trend		
log SO	0	0.939	.826
log SO	1	7.069	1.000
	Specification with trend		
log SO	0	−0.003	.499
log SO	1	29.289	1.000

Variable	Lags	Statistic	p Value
(B) Herwartz and Siedenburg (2008) panel unit root test			
	Specification without trend		
log SO	0	−0.3399	.3670
log SO	1	−0.4042	.3430
	Specification with trend		
log SO	0	1.9994	.9772
log SO	1	1.8045	.9644
(C) Demetrescu and Hanck (2012) panel unit root test			
	Specification without trend		
log SO	0	−0.0160	.4936
log SO	1	0.2653	.6046
	Specification with trend		
log SO	0	1.9897	.9767
log SO	1	1.9699	.9756
(D) Herwartz, Maxand, and Walle (2018) panel unit root test			
	Specification with trend		
log SO	0	1.6140	.9467
log SO	1	1.9021	.9714

Source: Own calculations based on FADN data.

nonstationary and the Gibrat's law of proportionate growth cannot be rejected suggesting that the proportional rate of growth of a *log SO* per Slovenian farm is independent from its absolute size of *log SO* per farm. Therefore, the law of proportionate growth of *log SO* per farm may lead to a distribution that is log-normal.

6. Conclusions

This paper contributes to the investigation of the validity of Gibrat's law in Slovenian farms. Our results confirm the validity of Gibrat's law for Slovenian farms independently from measures of farm size and applied four different types of panel unit root tests. These results of the Gibrat's law of proportionate effect indicate that the growth rate of a given farm is independent of its size at the beginning of the examined period. These empirical results in turn suggest that Slovenian smaller farms do not tend to grow faster than larger ones and thus all farm sizes tend to contribute to an increase in average farm size. The empirical results are the most robust for *log land* (in UAA) farm size and *log SO* farm output size, but slightly less for *log labour* (in AWU) farm size.

The implications of the obtained results are for research, farm-size specific policy and practice. To test the validity of Gibrat's law, the study applies cross-sectionally independent residuals in panel data and four different unit root tests. While the method is rather simple, it gives good understanding of the results, which can be relevant also for some other CEE countries in the region with on average smaller farm sizes.

The findings for the Slovenian FADN sample of farms suggest increasing farm labour productivity that with keeping farm labour in AWU at similar levels, farms are cultivating more UAA per farm and produce increasing value of farm output expressed in SO per farm. Based on the features and nature of Slovenian small- to medium-farm sizes, and a smaller number of larger farms, their farm sizes are increasing independently of their initial size.

As a farm-size specific policy can be considered measures of direct payments, which are paid based on a farm-size of UAA and livestock inputs (Bojnec & Fertő, 2019a), and most recently specific payments for small farms. At the same time specific policy measures have been introduced for young farmers, which can be important for AWU farm size and its age structure, while direct payments from Pillar I and rural development policy measures from Pillar II of the CAP can be important for both studied inputs, land cultivation or UAA per farm and farm job creation or at least maintaining farm jobs and thus AWU per farm. The latter can be also linked to green jobs on farms, which can remain important for some farm specialization linked to more agri-environmentally friendly practices (Unay-Gailhard & Bojnec, 2019). The increase in jobs or keeping jobs in farms and rural areas can be also combined with greater role of farm and rural entrepreneurship and development of small and medium enterprises, particularly in rural areas to improve entrepreneurial and innovation activities (Gričar, Šugar, & Bojnec, 2019). Green jobs in farms and entrepreneurial activities on farms and in rural areas can be important for farm innovation activities as drivers for farm size growth in terms of labour intensity and labour employment on farms as well as for economic farm size growth.

Among limitations, the study is developed on the selected econometric approach, which is based only on applied cross-sectional dependence test and four different groups of panel unit root tests. Among issues for research in future are to apply other advanced econometric approaches, including for testing causalities and drivers of farm growth as well as to focus on different farm types. More specifically, to make direct comparisons with previous research for field crops and dairy farms as well as with other countries.

Disclosure statement

No potential conflict of interest was reported by the authors.

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