ECONOMIC AND TECHNICAL EFFICIENCY IN SLOVENIAN FARMS BY FADN DATASET

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Abstract

Many of Slovenian farms are characterised by small utilized agricultural areas with direct impacts on the level of farm net income. In order to estimate the economic consequences of financial subsidies allocated by the Common Agricultural Policy (CAP), the European Union has established an annual survey in a sample of farms called Farm Accountancy Data Network. The purpose of this paper was to investigate over the time 2004-2013 main relationships among different economic variables and technical and economic efficiency using a quantitative approach by Data Envelopment Analysis. The FADN dataset has been stratified in function of the predominant type of farming and comparing between them which is the most efficient in economic and technical terms. Findings have pointed out as high specialised farms such as wine and milk enterprises have level of efficiency close to 100% instead mixed farms have highlighted the poorest level of efficiency. Summing up, funds allocated by the first and second pillar of the CAP have acted positively and directly on the farm efficiency. The European Union by specific funds should implement the level of capital land which linked to a good use of work capital is able to get better technical and economic efficiency.

Keywords:

Data Envelopment Analysis, land capital, efficiency, rural development plan, crops specialization

Introduction

The average usable agricultural areas (UAA) in Slovenian farms is approximately lower than 8 hectares (Eurostat, 2013) which is rather poor compared to the average amount of 14.2 hectares assessed in the European Union (EU), 50.1 hectares pointed out in the European north-western regions and 12.0 hectares detected in the south European areas (European Union, 2014). According to the data published by the Slovenian National Statistic Institute, since the early 2000s there has been a significant increase of the utilized agricultural areas which has reached the peak of almost 7 hectares (Fig. 1); focusing the attention, at a glance, in Slovenia more than 26.000 farms have a surface lower than 10 hectares and one hundred farms has an agrarian surface below 100 hectares even if since 2000 to 2013 the large farms arose significantly (Fig. 2). In general, from 2000 to 2013, the number of farmers declined by 14.000 farms (Fig. 3) and this phenomenon has involved predominately small enterprises managed by family farms (Bojnec et al., 2014).

Afterward the enlargement in 2004 of the European Union Slovenian farms have received significant and specific financial supports in order to face the transition phase from a planned and centralized economy to an open one using specific programmes such as Sapard (Special Accession Programme for Agriculture & Rural Development) and other pre-accession assistant financial supports (Galluzzo, 2011; Tankosić and Stojsavljević, 2014).

A literature review has pointed out as several studies have been carried out in order to assess predominately if there is a nexus between dimension of farm, in terms of land capital, and technical, allocative and economic efficiency in different European countries (Galluzzo, 2013; Gorton and Davidova, 2004; Brummer, 2001). These authors have

highlighted as the efficiency is correlated to the farm dimension, ownership, altitude of farm and productive specialization.

Bojnect and Latruffe in 2011 have argued using the Farm Accountancy Data Network (FADN) dataset as the labour capital in family farm is the main constraint in order to implement the efficiency corroborating the hypothesis according to which the shift from a new open economy has strengthen as a consequence of its transition investments and farm specialization. Findings in other studies have pointed out as the level of technical inefficiency in small and family farms is significant (Brummer, 2001; Bojnect and Latruffe, 2008). FADN is an instrument established by the Council Regulation 79 in 1965 aimed at assessing the income of agricultural holdings and impacts of the Common Agricultural Policy actions towards farmers which has been set up to gather accounting data in a sample of European farms.
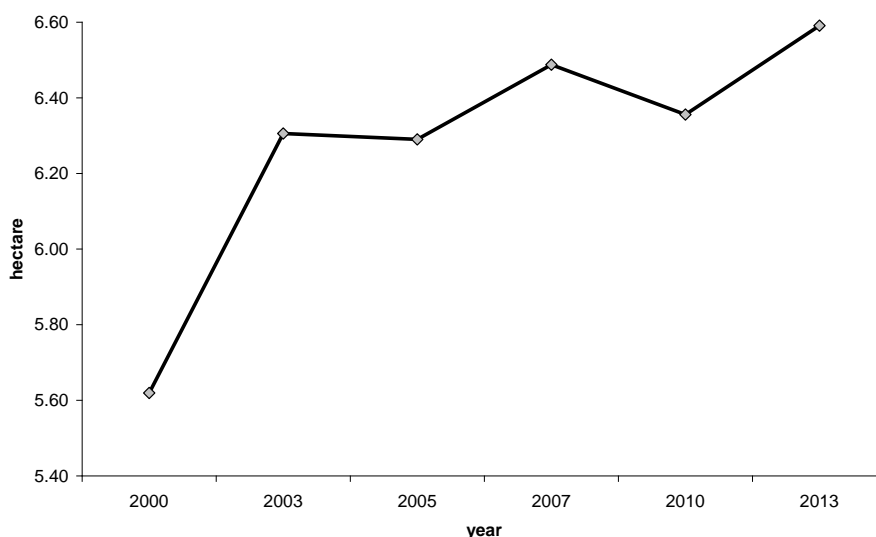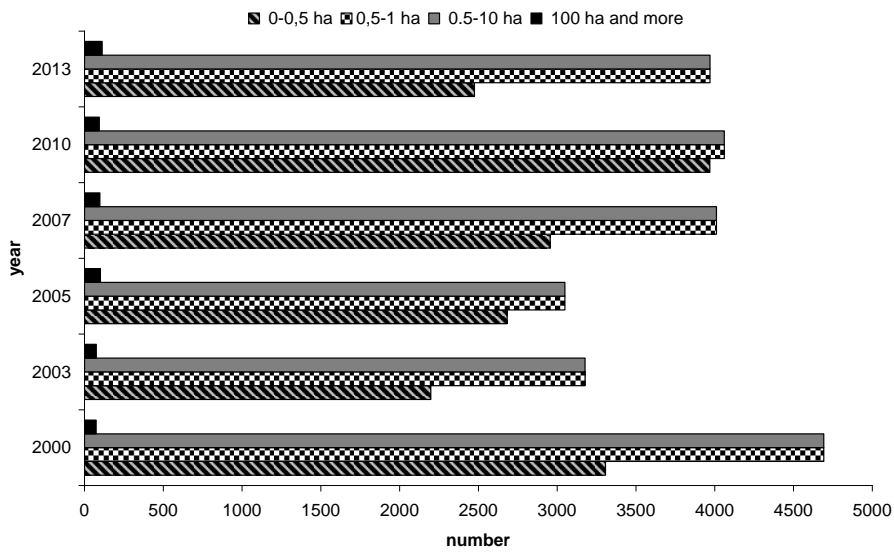

Source: our elaboration on data Statistical Office Republic of Slovenia 2013.
Fig. 1 Evolution of the UAA in Slovenia

Many authors assessing in depth relationships between productive specialization and efficiency have pointed out some direct and significant correlations in these two variables both in European countries and also in U.S (Latruffe et al., 2005; Latruffe et al., 2004; Mugera and Langemeier, 2011). Nevertheless, these authors have argued as the typology of farming (crop and or livestock specialization) is correlated to the level of efficiency, without taking into account, in a quantitative approach, the impact of financial subsidies allocated by public authorities towards farmers.

In order to implement the level of farm net income it is important to assess if the typology of farming impacts directly to the level of efficiency because high specialized farms should have the highest level of output and farmer's income, corroborating the hypothesis according to which in some new comers member states of the European Union livestock farms have been more efficient than crop farms (Latruffe et al., 2004). Furthermore, another innovative purpose of this study was addressed to estimate the impact of financial subsidies allocated by the CAP in order to implement the level of efficiency in farms in function of their own level of crop specialization. Focusing the attention on the cost efficiency, comparing the target cost function to the real one, this research has been able to suggest to

74

Slovenian farmers which inputs have to be reduced or implemented with the aim to lessen cost inefficiency.

Source: our elaboration on data Statistical Office Republic of Slovenia 2013.
Fig. 2 Evolution of farms stratified in different class of utilized agricultural area
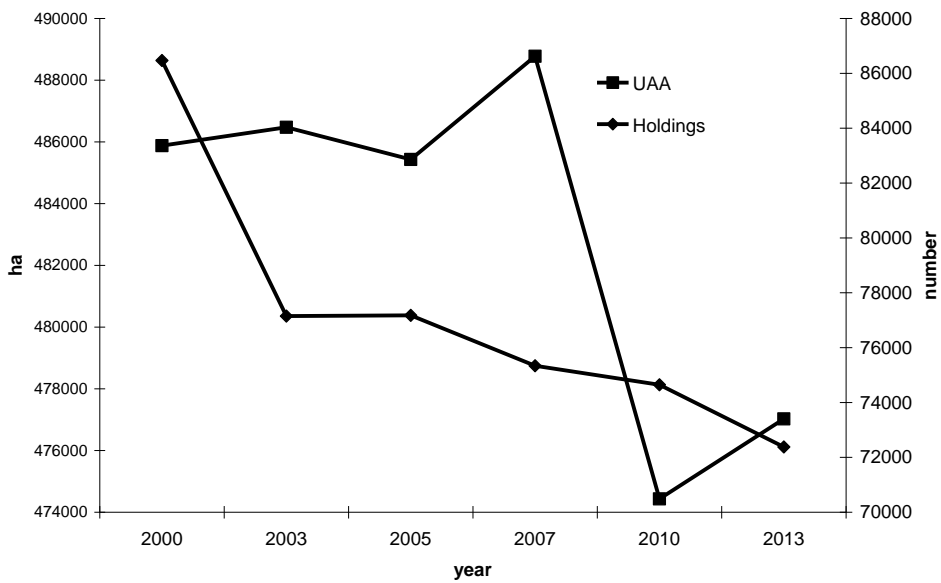
Source: our elaboration on data Statistical Office Republic of Slovenia 2013.
Fig. 3 Evolution of the utilized agricultural areas and holdings in Slovenia

After the enlargement of the European Union, Slovenian farms have increased their level of technical efficiency as a consequence of an expansion of investments in land capital and a growth in their own farm size even if financial subsidies in favour of small farms seem not

implementing their technical efficiency (Bojnect and Latruffe, 2013). Comparing small farms to the medium-size farms findings have highlighted as the medium-size farms have been less efficient than small farms mainly family owned (Bojnect and Latruffe, 2013).

Output oriented model in the DEA efficiency analysis has pointed out in the FADN dataset as there has been an increase of efficiency in many European farms which have reached the pick close to 100% even if few farms specialized have been fully efficient which has implied as high level of investments finalised in increasing the productive specialization are able to implement technical, allocative and economic efficiency (Bojnect and Latruffe, 2008).

1. Aim of the research

The main research question was addressed to investigate, using a quantitative approach, whether the different level of technical and economic efficiency in all farms part of the FADN dataset after the enlargement of the European Union is correlated to the crop specialization in terms of different types of farming (TF) such as defined and grouped by the European Commission in the Regulation 1242/2008.

In general a poor level of land capital in terms of utilized agricultural area is considered an intrinsic feature able to influence negatively the level of enterprise's efficiency. This research used and elaborated time series of microeconomic datasets published by the European Union in its own FADN database for the period 2004-2013 (FADN, 2013).

The purpose of the FADN is to evaluate farmers' incomes and to assess the impact of the CAP on a representative sample of European farms. In this research the sample of Slovenian farms has been stratified in function of their predominant level of cultivation and/or livestock in farms.

Table 1 Evolution over the time of efficiency in all Slovenian farms part of the FADN dataset in function of their type of farming

Typology of farming	Year									
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fieldcrops	100	100	44.65	100	100	100	100	100	100	100
Wine	n.a.	100	100	100	100	100	100	100	100	100
Other permanent crops	n.a.	100	100	100	100	100	100	100	100	100
Milk	100	100	100	100	100	100	100	100	100	100
Other grazing livestock	100	100	100	100	100	100	100	100	100	100
Granivores	100	100	100	100	100	100	n.a.	100	100	100
Mixed	100	n.a.	100	100	100	81.47	100	92.43	100	100

n.a. means not available
Source: our elaboration on data FADN 2013

2. Methodology

In order to study the efficiency there are two ways: a parametric or deterministic approach, which needs a knowledge in depth of the specific production function and other parametric variables, and a non-parametric model or DEA (Data Envelopment Analysis) aimed at defining in function of the distance from the frontier of an hypothetical function of production an index of technical inefficiency (Bielik and Rajcaniova, 2004).

In the non-parametric model some deviations from the frontier of function are caused by inefficiencies and they are not connected to errors thus, the technical efficiency is described as capabilities of farmers to maximize the output minimizing used inputs or vice versa (Bojnec and Latruffe, 2008).

76

Following the hypothetical framework proposed by lots of authors (Farrell 1957; Battese 1992; Battese and Coelli, 1992; Coelli 1996) in this paper the efficiency has been estimated by a non-parametric model applied to a specific assumptions such as the constant return to scale (CRS) in an input oriented model using PIM-DEA software. The goal of DEA linear programming model is to minimize in a multiple-output model the multiple-input in each farms part of FADN dataset over the time 2004-2013, stratified by its own crop specialization in terms of different types of farming, that is a ratio of efficiency and in a mathematical model it can be written (Papadas and Dahl, 1991):

$$\max h = \Sigma r u r y r j o / \Sigma i v i x i j o \qquad (1)$$

$$\text{s.t. } \Sigma r u r y r j / \Sigma i v i x i j \leq 1 \qquad (2)$$

$$j = 0, 1, ...n \text{ (for all j)}$$

$$u r, v i \geq 0$$

The efficiency is a ratio between produced output and used inputs and it is a pivotal tool to define the capability of each Decision Making Units (DMU) to be efficient; in this case the farmer in order to produce a well-define quantity of output has to use a specific combination of input in different cross sections data over the time of investigation. In term of productivity if there are two DMUs such as A and B able to produce two levels of output such as y_a or y_b using a specific quantity of input x_a and x_b the productivity is a simple ratio y_a/x_a and y_b/x_b.

The non-parametric linear model throughout the Data Envelopment Analysis has been elaborated for the first time in 1978 (Charnes et al., 1978) and it has been useful to estimate the relative efficiency in each Decision Making Units based on different level of input and output (Hadad et al., 2007) with the purpose, in an input oriented strategy which has been used in this paper, to minimize the level of input (Doyle and Green, 1994) in different specialized farms part of the sample dataset FADN.

The goal of a non parametric input oriented model, such as in our research, or rather DEA linear programming, is to minimize in a multiple-output model the multiple-input in each farm that is a ratio of efficiency; hence, this model has many possible solutions and ur* and vi* are variables of the problem and the value of efficiency have to be greater to 0 or another small but positive quantity thus, any input and output can be ignored in estimating the efficiency (Bhagavath, 2006; Papadas and Dahl, 1991). If h is 100 there are not issues because this unit (DMUh1) is more efficient compared to other DMUhn, but whether h is above 100 there are lots of units more efficient than this unique unit (DMUh1) then, every units is tightly linked to the level of input and output making each unit efficient (Bhagavath, 2009). To solve this negative aspect is fundamental to transform the model in a linear one by a linear programming methodology called CCR used also in FADN dataset (Charnes and Cooper 1962; Bhagavath, 2009; Galluzzo, 2014) written in this way:

$$\max h = \Sigma r u r y r j o \qquad (3)$$

$$\text{s.t. dual variable } \Sigma i v i x i j o = 100\% \ Z o$$

$$\Sigma r u r y r j o - \Sigma i v i x i j o \leq 0 \text{ with } j = 0, 1, ...n \text{ (for all j) } \lambda j \qquad (4)$$

$$- v i \leq -\varepsilon i = 0, 1,....m \text{ and } \varepsilon \text{ is a positive value } s i +$$

$$u r \ \leq \ -\varepsilon r = 0, 1, ...t \text{ and } \varepsilon \text{ is a positive value } s r -$$

**Table 2 Cost efficiency in Slovenian farms over the time of investigation
in function of type of farming**

Type of farming	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fieldcrops	49.34	87.48	34.26	73.56	100	100	78.25	72.69	63.46	59.55
Wine	n.a.	100	69.07	100	92.49	100	100	97.79	79.36	51.95
Other permanent crops	n.a.	84.89	60.7	66.23	100	90.58	87.34	98.57	65.02	94.34
Milk	55.44	74.93	49.83	65.14	88.1	88.28	89.49	81.86	78.68	78.94
Other grazing livestock	24.72	34.91	20.57	34.02	28.47	36.65	37.87	36.15	36.28	37.99
Granivores	100	100	100	100	97.13	100	n.a.	100	100	100
Mixed	34.89	n.a.	38.39	48.08	61.17	62.29	56.31	58.39	54.66	47.33

Source: our elaboration on data FADN 2013

**Table 3 Allocative efficiency in Slovenian farms over the time
of investigation in function of type of farming**

Type of farming	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fieldcrops	49.34	87.48	76.75	73.56	100	100	78.25	72.69	63.46	59.55
Wine	n.a.	100	69.07	100	92.49	100	100	97.79	79.36	51.95
Other permanent crops	n.a.	84.89	60.7	66.23	100	90.58	87.34	98.57	65.02	94.34
Milk	55.44	74.93	49.83	65.14	88.1	88.28	89.49	81.86	78.68	78.94
Other grazing livestock	24.72	34.91	20.57	34.02	28.47	36.65	37.87	36.15	36.28	37.99
Granivores	100	100	100	100	97.13	100	n.a.	100	100	100
Mixed	34.89	n.a.	38.39	48.08	61.17	76.46	56.31	63.17	54.66	47.33

Source: our elaboration on data FADN 2013

3. Results and Discussions

Findings about the efficiency have pointed out over the time of investigation as high specialised farms such as wine and milk enterprises have level of efficiency close to 100% and stable during the time (Tab.1) instead mixed farms have highlighted significant fluctuations in their values of efficiency due to exogenous effects in terms of economic crises which have had impacts on the efficiency.

Addressing the attention towards the cost efficiency results have pinpointed as farmers specialised in granivores have had the best performances whose levels of efficiency have been close to 100% with the exception in the year 2008 (Tab. 2). The worst findings have been highlighted in clusters classified as other grazing livestock (specialist cattle, cattle and sheep) and in mixed farms such as various crops and livestock combined even if the wine farms have suffered in 2012 and in 2013 of a drop in terms of cost efficiency.

Allocative efficiency has also corroborated partially findings assessed by the cost efficiency with milk and granivores farms characterized by higher level of efficiency compared to mixed farms (Tab. 3).
Findings, focusing the attention on the impact of financial subsidies allocated by the European Union in term of efficiency, have pointed out a not stable effect even if during the seven year time of the rural development plan 2007-2013 there has been an impact of the second pillar or considering the total amount paid by the first and second pillar of the CAP due to a decline of direct payment towards crops (Tab. 4).

Table 4 Impact of payments allocated by the CAP on the efficiency in Slovenian farms

Year	II pillar CAP	I and II pillar CAP
2004	87,92	100
2005	71,36	77,52
2006	78,02	59,76
2007	100	100
2008	78,48	78,36
2009	100	100
2010	93,46	93,20
2011	100	100
2012	78,67	78,67
2013	85,54	85,53

Source: our elaboration on data FADN 2013

Table 5 Impact of payments allocated by the Common Agricultural Policy on the efficiency in Slovenian farms located in stayed behind rural areas

year	II pillar CAP	I and II pillar CAP	Increase (%)
2004	85.50	85.50	0.00
2005	78.70	78.70	0.00
2006	100	100	0.00
2007	93.50	93.20	-0.32
2008	100	100	0.00
2009	78.50	78.40	-0.13
2010	100	100	0.00
2011	78.00	59.80	-30.43
2012	71.40	77.50	7.87
2013	87.90	100	12.10

Source: our elaboration on data FADN 2013

Addressing the attention towards Slovenian rural areas located in less favored areas, results have highlighted as payments allocated by the first and second pillar of the Common Agricultural Policy have impacted and increased significantly the level of efficiency in Slovenian farms; hence, for the future it is important to strengthen these two pillars of development and economic growth in Slovenian countryside more than in other European countries due to a poor level of capital land in Slovenian farms (Tab. 5) by the virtue of the highest level of work capital in terms of working labor unit for utilized agricultural surface which is predominately concentrated in small farms with a level of capital land lower than 2 hectares (Tab. 6).

Economic size and the variable utilized agricultural areas are increased over the time and correlated directly (Tab. 7). The main concentration of livestock units is typical of large size farms, instead significant fluctuations over the time between the variable annual working units and economic size of Slovenian farms have pointed out as there has been an exodus from the countryside due to a different level of labor specialization and labor capital investments.

Table 6 Annual working units per hectares of UAA in Slovenian farms

Size class of UAA	2000	2003	2005	2007	2010	2013
Total	0.22	0.2	0.2	0.17	0.16	0.17
Less than 2 ha	0.64	0.59	0.63	0.61	0.54	0.59
2-3 ha	0.41	0.37	0.39	0.35	0.31	0.38
Size class of UAA – 3 to less than 5 ha	0.31	0.29	0.29	0.26	0.24	0.28
Size class of UAA – 5 to less than 10 ha	0.21	0.2	0.2	0.18	0.17	0.19
Size class of UAA – 10 to less than 15 ha	0.15	0.15	0.15	0.13	0.13	0.13
Size class of UAA – 15 to less than 20 ha	0.12	0.12	0.11	0.11	0.11	0.11
Size class of UAA – 20 to less than 30 ha	0.10	0.10	0.10	0.09	0.09	0.08
Size class of UAA – 30 ha and more	0.08	0.07	0.06	0.05	0.06	0.05

Source: our elaboration on data Statistical Office Republic of Slovenia 2013.

Table 7 Correlations between economic size and agricultural variables in Slovenian farms

Variable	2007	2010	2013
Economic size versus UAA	0.269 *	0.486 **	0.660 **
Economic size versus Livestock units	0.796 ***	0.899 ***	0.932 ***
Economic size versus Annual Working Units	-0.383 ***	0.373 ***	0.271 ***

* significance at 10%, ** significance at 5% ; significance at 1%
Source: our elaboration on data Statistical Office Republic of Slovenia 2013.

Conclusions

Efficiency is correlated predominately to the level of crop specialization and type of farming rather than the farm dimension because more specialized are the farmers higher have been levels of technical and allocative efficiency because of a significant grade of investment and capital land. This latter aspect is fundamental in order to strengthen the efficiency as proposed by other scholars and above mentioned discussed; hence, local and national authorities in order to face the out emigration and rural marginalization in Slovenian countryside have to face with these new challenges addressing their efforts in

allocating more financial resources towards a growth of land capital and an high specialization in agricultural enterprises by technical intensive investments.

In general, exogenous variables with a nexus to the conjunctural aspects such as economic crises can acted on the level of efficiency corroborating the hypothesis according to which financial subsidies allocated both by the first and also by the second pillar of the CAP correlated directly to the level technical and allocative efficiency.

It is important to address enterprise's attempts towards a diversification rather than the productive diversification in a perspective of multifunctional farms able to get the most by the environment and peculiarities Slovenian farms.

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