7 EXPLORING THE RELATIONSHIP BETWEEN FARM PRODUCTIVITY AND THE CAP SUBSIDIES FOR THE NMS[1]

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Abstract

The paper studies the impact of the Common Agricultural Policy (CAP) subsidies on farm productivity using the Farm Accountancy Data Network (FADN) samples for the New Member States (NMS). We employ multilevel mixed-effects models, with fixed and random effects included to represent heterogeneity in the data and the the importance of the group effects (country and region). We estimate models for different sizes of farms (small, medium and large) in the case of some New Member States (NMS). We find that size matters mainly in terms of effect size and less in terms of its sign for subsidies, assets, land and liabilities in most countries.

We found that subsidies have a negative impact on agricultural productivity in almost all countries (in Bulgaria it turned positive for small and medium-sized farms). The effect of other variables on productivity is more nuanced (for land is positive in most countries).

Our findings could be of use in the evaluation of EU policies on subsidies and in a better design of future policies towards an improvement of the food productive capacity of the EU agricultural sector.

Keywords: CAP subsidies, investment, productivity, farm size.

JEL Code: D22, Q12, Q14, Q18

1. Introduction

The paper investigates the impact of the Common Agricultural Policies (CAP) on farm productivity in the case of the New Member States (NMS). Under the Common Agricultural Policies farms can access different type of subsidies. The most important in terms of size are direct subsidies which are linked to the acreage of the farm. In our paper, we are

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interested to investigate the impact of subsidies on productivity for different countries, and farm sizes. In the literature there is disagreement with regard to the effect of subsidies, which some argue that create large distortions on the market therefore have a negative impact including on the productivity. Other researchers argue that due to the volatility of the agricultural market (both in terms of prices and production) and the necessity to achieve food security farmers should be supported and encourage to invest in new technology, hence the need for subsidies.

We use data from Farm Accountancy Data Network (FADN) for NMS (new member states) but our analysis is restricted to farms which declared filed crops as their main activity. The data is available starting from 2004 for most countries, but only from 2007 for Romania and Bulgaria which joined the EU at a later date, till 2016. The countries for which we performed the analysis are: Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia. The series contain information at a regional level and on a farm size level about the aggregated statistics of all farms in that size level and region. It includes information on production, costs, inputs, labour force, assets, liabilities, etc.

As we have a hierarchical data structures with three nested levels (country, region and time) we employ multilevel mixed-effects models, with random effects included to capture the heterogeneity in the data. We estimate the effects on productivity, measured by output divided by input, of different variables: the size of the farm (a measure which includes both economic and land size), subsidies, investment, and labour force. We are interested to see also if the effect subsidies have on productivity varies according to the size of the farms.

Our analysis documents the link between CAP subsidies and aggregate farm productivity across the New Member States. In order to incorporate the complexity of the hierarchical data we estimate the multilevel mixed effects which make use of the importance of the group effects, considering a combination of fixed and random coefficients. In these models the effect of subsidies on productivity is more nuanced and could vary across countries both in sign and magnitude. Our findings could be of use in the evaluation of EU policies on subsidies and in helping the design of future policies aim towards the improvement of the food productive capacity of the EU agricultural sector.

2. Literature review

In the context of recent developments of world markets for agricultural products leading to higher volatility of food prices and renewed interest of private investors in agriculture FAO made recommendations for policies aimed at increasing agricultural productivity (FAO, 2013). In line with this CAP can support farm investment and technological progress as means of productivity-enhancing. Furthermore, there was an important change of regime with decoupling of subsidies by the 2003 CAP reform that continues with the most recent reform in 2013.

Many studies either theoretical (Henessy, 1998; Ciaian and Swinnen, 2009) or empirical (Rizov, Pokrivcak and Ciaian, 2013; Bojnec and Latruffe, 2013; Zu and Lansink, 2010; Kazukauskas, Newman and Sauer, 2014; Kumbhakar and Lien, 2010, Galuzzo, 2016) analyse the impact of subsidies on productivity. Henessy (1998) explained a negative relation between subsidies and productivity by wealth effect and changes in risk attitude toward expanding production. Ciaian and Swinnen (2009) talk about the productivity gain induced by credit investments, affirming a positive relationship between subsidies and productivity. Rizov, Pokrivcak and Ciaian (2013) found negative correlation between subsidies and farm total factor productivity for EU-15 before decoupling reform and positive

correlation after the reform for some of the countries. Zu and Lansink (2010) show that the share of total subsidies in total farm revenues has negative impacts on technical efficiency in Germany, the Netherlands and Sweden. Kumbhakar and Lien (2010) found on a micropanel dataset of Norwegian grain farms that subsidies have a negative influence on farm productivity but had a positive effect on technical efficiency.

N. Galuzzo (2017) analyses the importance of subsidies allocated under CAP (Pillar 1 and Pillar 2), in the period 2004-2013, on the level of net income from the Slovenian farms included in the FADN data set. The influence of other factors is also investigated, like utilized agricultural area, total inputs, total assets, CAP payments for less-favoured areas (LFA). The study uses a multivariate regression model, where the farm net income is the dependent variable, while the independent variables are total subsidies allocated by the CAP, LFA payments, total assets, total inputs, and the utilized agricultural area. The same author also has contributions on the analysis of farm situation on the basis of FADN data from Romania (N. Galuzzo, 2016). This paper assesses, through a quantitative method, the impact of funds allocated under CAP Pillar 2 on the specialization of crop farms, with the intention to provide solutions to reduce labour migration from the countryside. The findings show that the payments made under the CAP to farms in the less-favoured areas have not had any significant role in reducing marginalization and depopulation of rural areas, but that there is a direct link between direct payments and farm income (FNI).

The evidence about the relationship between size and productivity/efficiency is mixed. In Czech Republic size is positively related to productivity (Davidova and Latruffe, 2007; Latruffe *et al*., 2008), in Slovakia there is an inverse relationship between size and productivity (Ladvenicová and Miklovičová, 2015), in ten Central and East European countries (CEECs): large farms performs better than small-size farms (Tonini and Jongeneel, 2006). Alexandri, Pauna and Saman (2020) showed that subsidies are not conducing to productivity in the case of the Romanian farms, in the period 2007-2017, irrespective of the size and the type of the farm with the notable exception is medium-sized dairy farms.

Comparative studies conducted in different countries reveal that in many situations the total factor productivity (TFP) is higher for the small farms than for the large farms. The TFP increase can be attributed to several variables such as farm size, technological progress, managerial performance, environmental variables (temperature, rainfall), public policies and human capital (Jacques C. Julien et al., 2019). Access to input market improves small farm productivity, while the expenditures with transport infrastructure and extension services improve the productivity of large-sized farms. The study highlights that inverse relationship (IR), which reveals that small farms are more productive than large farms.

An issue that would emerge from here for policy makers refers to whether this could serve as a basis for an eventual decision to divide the large-sized farms, in order to improve the economic performance and the agricultural supply. The functional relationship used in the above-mentioned study is of Cobb Douglas type, where the dependent variable y is the agricultural output value, while the independent variables are the conventional inputs represented by land, labour and capital, plus environmental factors, public policies, etc.

TFP decomposition brings arguments that different factors, like public policies for instance, can generate a productivity growth effect for each class of farms. As growth strategies, the programs for increasing access to inputs, public investments in roads, extension, and development of financial instruments are mentioned.

Another study that investigates the link between farm size, subsidies and farm performance for Slovenia was published by Bojnec and Latruffe (2013).

Although Slovenia is one of the best performing ex-communist countries, the farming sector performance is low. Productivity in agriculture is low, and farms have been heavily subsidized, even in the pre-accession period.

In the analysis, several indicators have been used to measure the farm size, namely: land, herds of animals, total assets, and economic farm size expressed by the standard output, total output value.

One of the conclusions of the study is that small-sized farms although have a lower technical efficiency they have higher allocative efficiency and are more profitable.

However, the large-sized farms, with marketing activities, have better technical efficiency. L.Latruffe (2004) brings methodological contributions to the assessment of farm profitability, productivity and efficiency. Profitability exists when a firm generates enough earnings to cover its operating expenses and survive.

For output evaluation, in the investigated Poland's case, three indicators have been used, namely crop production, animal production and other farm productions. For inputs, the following variables have been used in the DEA model: area (hectares), labour expressed in annual work units (AWU), total value of assets (thousand euros) and intermediate consumptions (euros). Furthermore, the following are used as additional variables: % of leased land in total utilized agricultural area, % of hired labour in total labour force, % of debt to assets.

3. Backgrounds

Farm structure in the analysed countries

The agriculture systems in the investigated Central and Eastern European countries are quite different both in terms of agricultural structure, production profile, endowment with production factors, productivity, etc. Yet the CAP integrates the agricultures of these countries, through a relatively unitary system of interventions and implicitly subsidizing forms, under Pillar 1 and Pillar 2.

Table 1.

Number of farms in the year 2016

	Total	< 2 ha	2-20 ha	20-100 ha	> 100 ha
Bulgaria	202,720	147,200	37,430	12,010	6,060
Czech Rep.	26,530	3,070	11,540	7,200	4,710
Hungary	430,000	308,010	89,730	23,490	8,760
Poland	1,410,700	304,880	970,170	123,650	12,010
Romania	3,422,030	2,480,770	904,410	24,530	12,310
Slovenia	69,900	17,520	48,340	3,930	120
Slovakia	25,660	7,410	12,990	2,860	2,400

Source: Eurostat, ef_m_farmleg.xls

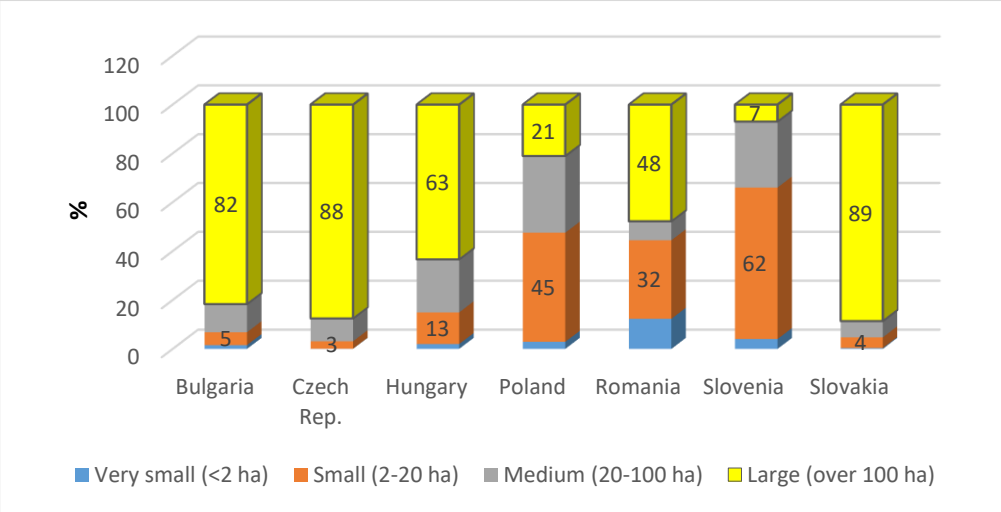
The agricultural structure is quite different in the investigated countries, if we take into consideration the share of small, medium and large-sized farms in the utilized agricultural area. There is a group of countries, namely Bulgaria, Czech Republic, Hungary and Slovakia, where the large and very large-sized farms prevail, and three countries, namely Poland, Romania and Slovenia, where the very small, small and medium-sized farms operate half and even more than half of the country's utilized agricultural area (Figure 1). The high share of large farms in certain countries from Central and Eastern Europe is a

continuation of the agrarian structure of the communist period, when agriculture was based on large-sized units, i.e. state farms and cooperative farms. In Romania, which also had the same pattern in the communist period, things have changed after 1990, with the successive agricultural land restitutions to former owners. In Poland, there was no cooperatization of agriculture in the communist period, agriculture was mainly based on small and medium-sized farms, and the same pattern continued after the 1990s as well. Yet this agrarian structure pattern is different from the pattern in the Old Member States of the EU.

Figure 1 presents the situation of the agricultural structure in the investigated countries. We can notice that Romania has the highest share of agricultural land operated by very small-sized subsistence farms, under 2 ha. At the same time, Poland has the highest share of agricultural land operated by small and medium-sized farms, with an area of 2-20 ha and 20-100 ha, i.e. 76% of the Utilized Agricultural Area (UAA), followed by Romania, with 40% of UAA. Bulgaria, Czech Republic, Hungary and Slovakia have the highest share of large-sized farms in the Utilized Agricultural Area, i.e. 82%, 88%, 63% and 89% respectively of the Utilized Agricultural Area (Figure 1).

Figure 1.

Structure of Utilized Agricultural Area, by the size of farms, in the year 2016



Source: Eurostat

The agricultural structure based on large-sized farms can be one of the causes of high factor productivity (labour force for instance) in certain countries, this being mostly the case in the Czech Republic, Hungary and Slovakia (Figure 1). At the same time, in the less developed countries (i.e. Romania), the presence or large-size farms might generate rural poverty, as large farm units use a lower number of employees per hectare in comparison to small and medium size farms. Large farms are specialized in cereals and oil crops, in general, they are highly capital intensive and the production technology is based on the use of agricultural machinery in all the production stages. In this case, a large part of the rural population lives in poverty, only from social aids and subsistence provided by the small family household farms.

Another aspect to be noted is that beyond these statistical data, based on censuses and farm structure surveys, there are important differences regarding the size of certain agricultural holdings, which are not captured by statistics. For instance, although in Romania "only" 48% of the agricultural land is operated by farms over 100 ha, there is a significant number of extremely large farms, maybe the largest farms in the European Union. Thus, according to (APIA)[5] data, in the year 2017, there were 22 farms with 5000-10000 ha, 3 farms with 10000-20000 ha and 2 farms with more than 20000 ha. This agrarian structure is far from the European model, based on medium-sized farms, which pays particular attention to farmer incomes and rural poverty alleviation, considered as a priority CAP objective.

Table 2 presents the differences between the farms in the Central and Eastern European countries under discussion, in terms of farm's production factors, the importance of subsidies in the farm incomes, as well as certain structural indicators. The differences in average farm size stand out in this table as well, both in terms of physical size (hectares) and economic size (standard output). There is a high gap, as in Romania and Slovenia the average farm size is about 10 ha, while in the Czech Republic the average farm size is 200 ha and in Slovakia 500 ha. This accordingly influences labour productivity, which is 2-3 times higher in the countries with large-sized farms (Czech Republic, Slovakia) than in the countries with small farms, like Romania and Slovenia (Table 2). At the same time, total factor efficiency seems to be higher in the countries with smaller farms, i.e. in Romania (1.43), Poland (1.16) and Hungary (1.08). The number of hectares on the farm influences the way in which work is organized on the farm, in the sense that in the countries with small-sized farms (Romania, Slovenia), the share of wage labour is insignificant, while in the countries with large-sized farms from the Czech Republic or Slovakia, the wage labour prevails.

Table 2:

Descriptive statistics for FADN variables at farm level in the year 2017

	UM	BGR	CZE	HUN	POL	ROU	SVK	SVN
Total output crops & crop production	Euro	49590	159478	44920	15437	7571	336809	10836
Total output livestock & livestock products	Euro	17435	125427	20720	13162	5512	183536	9027
Other output	Euro	1068	38240	13497	494	5	105489	4724
Total output/Total input			0.86	1.08	1.16	1.43	0.81	0.96
Utilized agricultural area	Ha	66.0	205.8	47.0	19.0	9.7	500.7	9.84
Total labour input	AWU	2.9	5.4	1.6	1.6	1.1	12.1	1.18
Farm net value added/AWU	Euro	13604	23144	22828	7388	6437	16772	5957
Total crop output/ha	Euro	786	782	982	812	780	687	1102
Total assets	euro	139832	748762	206526	178166	38333	1206970	226789
Intermediate consumptions	Euro	38066	245632	52521	17746	6596	470942	16964
Total subsidies	Euro	18376	91141	16923	5902	2256	152748	7706
% subsidies /output value	%	27.0	28.2	21.4	20.3	17.2	24.4	31.3

[5] *Romanian Agency for Payments and Interventions in Agriculture*

	UM	BGR	CZE	HUN	POL	ROU	SVK	SVN
Economic size	ESU	56.3	253.0	52.3	28.3	9.8	493.8	20.6
Total livestock units	LU	19.3	93.7	18.2	12.3	4.7	141.4	10.4
% crop output/total output	%	72.8	49.4	56.8	53.1	57.8	53.8	44.0
% livestock output/total output	%	25.6	38.8	26.2	45.2	42.1	29.3	36,7
% rented UAA/total UAA	%	87.0	75.8	60.4	27.1	57.0	89.7	30.6
% paid labour input/ total labour input	%	57.8	75.9	57.9	11.2	9.1	93.8	2.5
% liabilities/total assets	%	23.8	31.0	14.9	5.3	2.7	40.0	3.6
Capital/AWU	%	2980336	109864	96720	55579	26490	88002	105781
Hectares/AWU	%	22.8	38.1	29.4	11.9	8.8	41.4	8.3

Source: FADN database, DG-Agriculture

As regards land productivity, we can notice from Table 2 that the productivity of this factor is higher in Slovenia (1102 euro/ha), country where the average farm size is around 10 ha and the small-sized farms prevail, as against Slovakia, for instance (687 euro/ha), where the average farm size exceeds 500 ha. This is also valid for the wheat and maize average yields per hectare, in which the farms from Slovenia have higher values, above those from Slovakia and other countries in the area. This observation is in line with the idea that size does not necessarily generate increased productivity. In this context, the theory of economies of scale in the case of large size farms needs further investigation.

4, Methodology

Our data is hierarchical: individual farms (observations) are nested within regions, which are nested within countries. Farms within a particular region or country are more similar to each other than farms randomly sampled from the NMS or EU. They are more homogeneous in terms of socio-economic, environmental or geographic factors. So, it is more appropriate to model all groups simultaneously by taking into consideration the cross-level nature of the data.

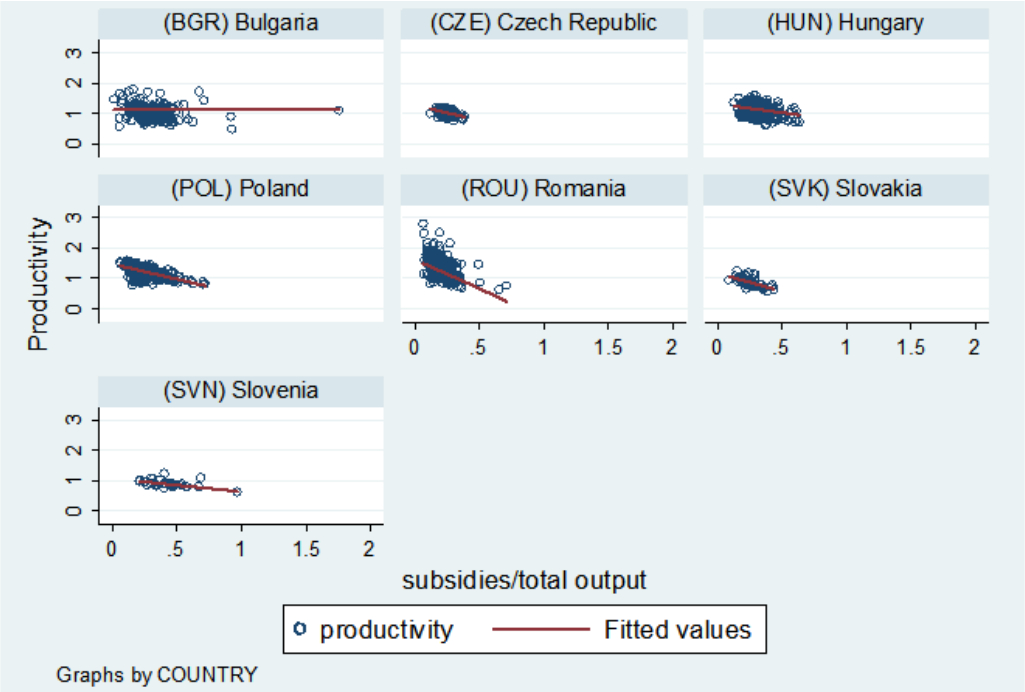
We decided to apply a multilevel analysis and find that this hierarchy (farms - regions-countries) is non-trivial. This means that the dependent variable (productivity) show variation associated with these units (countries or regions) and we cannot completely account this effect to the independent variables.

We use mixed-effects modelling two allow for two kinds of effects: fixed effects, meaning coefficients that are assumed to be the constant over the whole sample (the average effect in the entire population of units) just as in ordinary regression; and random effects, meaning coefficients that account for the differences between subsamples.

We are allowing intercepts to vary across countries and regions. But what if the slope of the productivity-subsidies relationship also varies across countries? A quick look at scatterplots for each country (Figure 2) gives us grounds to suspect that it does.

Figure 2.

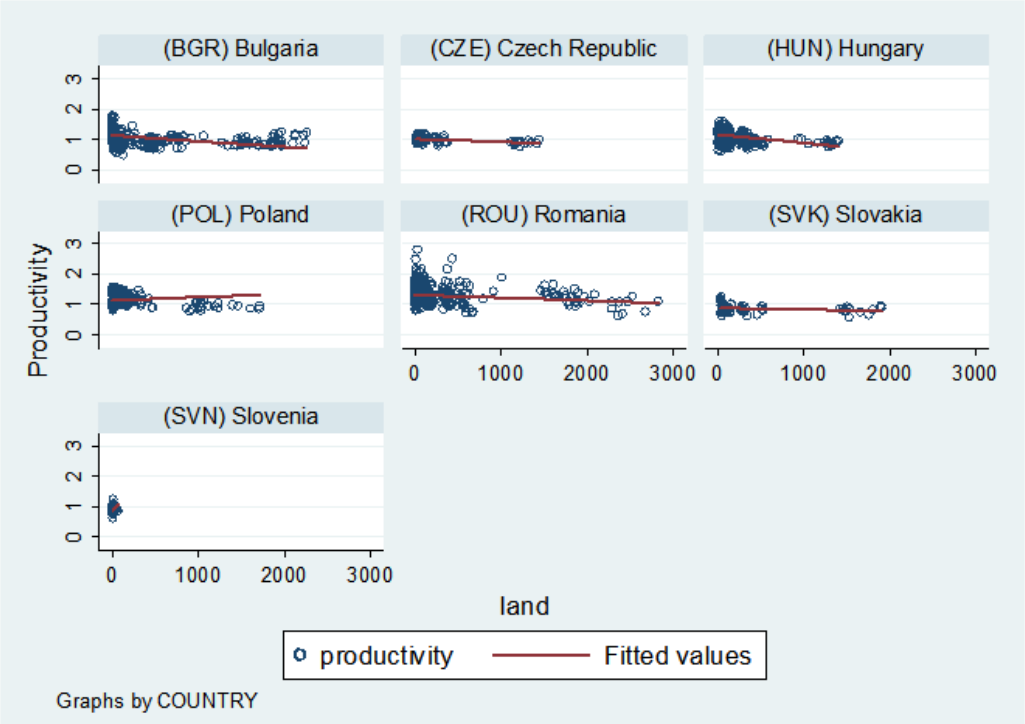
Productivity versus subsidies. *Source: FADN data*



In Figure 3 we see that the slope of the productivity-land relationship also varies across countries.

Figure 3.

Productivity versus land (total Utilised Agricultural Area). Source: FADN data



Our model fits a hierarchical or multilevel mixed-effects model predicting productivity of farms (rtpe: crops) as a function of:

(1) fixed or whole-sample effects of all independent variables:
- year (y) [6],
- r_land = Rented U.A.A. / Total Utilised Agricultural Area,
- the ratio of total subsidies to output (r_subsidies),
- total Utilised Agricultural Area (land),
- the ratio of paid labour input to total labour (r_labour),
- total assets (asset),
- the ratio of total liabilities to total assets (r_liab),
- the ratio of specific cost to total inputs (r_scost),
- the ratio of contract work to total inputs (r_cwork).

(2) a random intercepts representing the effect of the country and the region in which they operates;

(3) a random slope for the effect of farm's specific variable which could be different from one country to the next:
- the ratio of total subsidies to output (r_subsidies),

[6] *y_i is a dummy variable that takes value 1 for the year i and 0 otherwise.*

- total Utilised Agricultural Area (land),
- the ratio of paid labour input to total labour (r_labour),
- total assets (asset),
- the ratio of long term liabilities to total assets (r_liab),
- the ratio of specific cost to total inputs (r_scost),
- the ratio of contract work to total inputs (r_cwork).

The model expresses farms productivity (p_{ijr}) over year *i,* country *j* and region *r* on fixed-effect predictors (y_i, r_land_{ijr}) and also on random-effects predictors x_k ($r\_subsidies_{ijr}$, $land_{ijr}$, r_labour_{ijr}, $asset_{ijr}$, r_liab_{ijr}, r_scost_{ijr}, r_cwork_{ijr}) for each value of country *j*. It includes fixed slopes ($\alpha_{1i}$and α_2) on fixed-effect predictors, fixed slopes (β_k) and random slopes (u_{kj}) on predictor x_k for each country *j* and random intercepts (v_{0r} for each region and and v_{1j} for each country):

$$p_{ijr} = \alpha_0 + \alpha_{1i} y_i + \alpha_2 r_{land_{ijr}} + \beta_1 r_{subsidies_{ijr}} + \beta_2 land_{ijr} + \beta_4 r_{labour_{ijr}} + \beta_5 asset_{ijr} + \beta_6 r_{liab_{ijr}} + \beta_7 r_{scost_{ijr}} + \beta_8 r_c work_{ijr} + u_{1j} r_{subsidies_{ijr}} + u_{2j} land_{ijr} + u_{4j} r_{labour_{ijr}} + u_{5j} asset_{ijr} + u_{6j} r_{liab_{ijr}} + u_{7j} r_{scost_{ijr}} + u_{8j} r_c work_{ijr} + v_{0r} + v_{1j} + \varepsilon_{ijr}$$

We are introducing specific intercepts for countries and regions to capture differences in environmental conditions insofar as these conditions are the same in a specific region or country.

5. Empirical results

We have used two measures of productivity, first one as output per input to capture the effect of technical efficiency of total factor productivity and the second one as output per hectare to capture land productivity. The results are presented in the following subsections (5.1 and 5.2).

5.1 The role of farm size and agricultural subsidies on technical efficiency

After controlling for country, region and year specific effects, we find a negative or positive relationship between farm size and farm productivity depending on country.

We estimated the regression separately on farms of similar size, which allowed us to investigate if the productivity is influenced differently depending on the farm's size. We have constructed three classes, small farms in which we included farms under 20 ha[7], medium farms with land between 20 and 100 ha, and large farms above 100 ha.

As an observation, all countries except the Czech Republic and Slovakia have small farms.

We present the results for the regression on productivity including the UAA in hectares (land) as the size variable among the explanatory variables (Table 3 for country fixed effects and tables 4, 5, 6 and 7 for random effects different in each country).

It is interesting to notice first the incidence of bad years on the productivity of farms depending on their size. 2007 was not a good year in terms of agricultural production. Countries like Bulgaria, Romania and Hungary had experienced over 30% drops in the cereal production. Due to the increase in prices brought on by shortages the profit of successful farms might not be affected, and could in fact increase. As Table 3 shows large

[7] *Unfortunately, there is only a very limited number of small farms in the sample.*

and medium size farms fare better in 2007, while small size farms fared worse. A different picture is emerging for 2017 which was a year with record productions for Romania and Bulgaria, good production for Poland, and average for the rest. Under these circumstances, the medium farms were fairing the best, followed by small farms.

The coefficient on the share of rented land in total utilized land is positive for medium farms, and negative for small and large farms. Therefore, the more rented land the medium farm has, the better the performance. Greater dependence on rented land can increase farm performance due to increased financial stress. However, this variable can have a negative impact on technical efficiency in the case of non-aligned incentives between the contracting parties (Giannakas et al., 2001; Karagiannis et al., 2003).

Table 3.

Fixed effects

			Small Farms		Mediu Farms		Large Farms	
	Coeff	t_stat	Coeff	t_stat	Coeff	t_stat	Coeff	t_stat
2005	-0.07732	0.00279	-0.05283	-12.3	-0.09143	-33.13	-0.03945	0.0071
2006	0.04324	0.0028	0.03931	9.19	0.03201	11.56	-0.00394	0.0073
2007	0.09727	0.0026	0.03174	7.19	0.14110	47.84	0.12671	0.0065
2009	0.02904	0.0030	0.02975	6.53	-0.06538	-17.3	-0.03157	0.0079
2010	0.11281	0.0029	0.13331	28.5	0.11265	30.91	0.08493	0.0079
2011	0.12901	0.0029			-0.11366	0.003	0.12681	0.0078
2012	0.12778	0.0029	-0.05419	0.0044	0.0149	0.003	0.12232	0.0079
2013	0.04758	0.0029	0.02374	0.0043	0.11677	0.0031	0.07224	0.0081
2014	-0.03706	0.0029	0.06458	0.0043	-0.07667	0.0043	0.05643	0.0081
2015	-0.12894	0.0028	0.03578	0.0048	0.10204	0.0041	-0.02698	0.0083
2016	-0.05674	0.0029	0.09833	0.0048	0.11628	0.0041	0.00777	0.0082
2017	-0.01892	0.0029	0.09285	0.0049	0.13414	0.0041	0.04938	0.0084
land			0.01173	0.0068				
r_land	0.09316	0.0038	-0.39345	0.0065	-0.13379	0.0106	-0.3559	0.0195
r_subsidies	-0.88734	0.2071	-0.97617	0.3424	-1.06852	0.3432	-1.04617	0.1491
asset							-5.76E-10	2.87E-10
r_liab							-0.27345	0.1082
r_scost	0.77637	0.2338	0.79360	0.4584			0.97147	0.2996
r_cwork	0.59304	0.2044					0.53045	0.3260
_cons	0.97368	0.0952	1.05740	0.1605	1.30359	0.1449	1.30702	0.2059

Source: own calculations.

Note: the missing coefficients correspond to variables that are dropped from the model due to insignificance.

Tables no. 4, 5, 6 and 7 present the result for the total effect coefficients (fixed effect plus random effect) for small, medium and large farms. In terms of subsidies, the result is consistent in almost all cases.

The rate of subsidies to output, which is seen like an indicator of subsidies' inefficiency (as the larger is the rate the smaller is the efficiency of using the subsidies) do not favourably affect farms productivity. This shows that receiving more subsidies without increasing production fails to promote greater efficiency of farm, an image which is intuitive and consistent with some of previous findings. The only exceptions are small and medium farms from Bulgaria. Still it can be noticed that small farms everywhere are more adversely affected by the inefficiency of subsidies, in comparison to large farms. The same is true for medium farms which are more adversely affected by the inefficient utilization of subsidies than large

farms. These results show that receiving more subsidies without increasing production but as a source of income tends to make farms less efficient showing that CAP measures should not always be considered as a way to increase farmers' competitiveness by improving their efficiency.

According to previous findings (Iraizoz et al. (2005) for Spanish beef production, Kleinhanß et al. (2007) for German and Spanish livestock farms, and Zhu and Oude Lansink (2010) for German, Dutch and Swedish crop farms), it is questionable whether farm income support of CAP is achieving its goal to increase farmers' competitiveness by improving their technical and managerial efficiency.

The variable land is a measure of farm size capturing the scale effect that land has depending on countries, and farm size. It has been shown to impact productivity both negatively and positively. Farms are in general positively affected by the size of the agricultural area as the marginal effect of land is positive for each country (with the exception of Hungary and Slovenia). The largest magnitude of the effect is for small farms in Romania.

The variable paid labour to total labour has different impact on productivity depending on size and country. In Bulgaria and Hungary, the effect is negative for all farms, the more paid labour in total labour, the less productive the farm is, and the magnitude of the decrease is larger for small farms in Hungary and large farms in Bulgaria. The same is true for large farms in all countries but the Czech Republic. This findings show that paid labour is less economic efficient than family labour. However, the share of paid labour for medium size farms (with the exception of the two already mentioned and Slovenia) have a positive impact on productivity.

The variable share of specific cost in total inputs showed that there is scope to increase the productivity by using more specialized materials. The farms in the Czech Republic and Romania does especially good in this area, and also small farms in Bulgaria, medium size farms in Hungary and large farms in Slovakia. It appears that large farms' productivity is the most responsive to increases in specific costs, with the exception of Bulgaria and Slovenia, their magnitude is in the vicinity of unity or above.

The variable liabilities to total assets, which express the indebtedness of farms has a negative impact on total factor productivity for most medium and large size farms. It seems that the negative drain on the income in order to pay back the loan is not offset by the productivity gain brought about by the investment financed with the loan. The exception is Bulgaria, Hungary and Romania for small farms, the Czech Republic, Hungary and Slovakia for medium size farms and Bulgaria for large farms.

Table 4.

Total effects for the whole sample of farms

	r_subsidies	land	r_labour	r_scost	r_liability	asset	r_cwork	country
Bulgaria	-0.0387	0.00014	-0.64473	0.72708	0.11993	6.83E-11	0.68360	0.05205
Czech Republic	-1.09845	2.61E-06	-0.49744	0.81050	0.97360	9.39E-11	0.70093	-0.03176
Hungary	-0.66926	-0.00029	0.01244	0.92199	-0.0149	3.91E-10	1.04457	-0.15999
Poland	-1.01057	-0.00017	0.01607	0.17851	-0.21434	-5.71E-10	-0.34176	0.38987
Romania	-1.67197	-8.8E-05	0.09318	1.99054	-0.20419	8.39E-10	1.08677	-0.21594
Slovakia	-1.27425	1.55E-06	-0.2061	0.63953	0.11139	3.46E-11	0.74681	-0.04025
Slovenia	-0.44818	-0.00016	-0.24709	0.16646	-0.35399	4.37E-10	0.23039	0.00602

Source: own calculations

The asset variable is a more difficult to interpret. With the exception of all farms in Hungary and Slovenia and medium size farms in Romania farms' assets are decreasing the productivity.

The coefficient for the share of contract work is mostly positive especially for small size farms, supporting the theory that contracting might be a viable alternative to technology and is negative for medium and large farms in Romania, medium size farms in Bulgaria and small farms in Poland.

Table 5.

Total effects coefficients for small farms

	r_subsidies	land	r_labour	r_scost	r_liability	asset	r_cwork	country
Bulgaria	0.13929	0.01686	-0.25496	2.22268	1.05933	-1.22E-07	0.83267	-0.22536
Czech Republic								
Hungary	-1.16986	-0.0031	-0.39158	-0.3249	0.90397	2.17E-08	3.24215	0.00284
Poland	-1.18167	0.01603	-0.49831	0.32552	-1.61566	-2.11E-08	-2.05045	0.53352
Romania	-1.95053	0.03230	0.07702	1.43773	0.43222	-1.61E-08	1.70987	-0.21868
Slovakia								
Slovenia	-0.71809	-0.00345	3.40816	0.30699	-0.93893	1.34E-08	1.81007	-0.09232

Source: own calculations

Note: the missing coefficients correspond to the Czech Republic and Slovakia that doesn't have small farms into the database.

Table 6.

Total effects coefficients for medium farms

	r_subsidies	land	r_labour	r_scost	r_liability	asset	r_cwork	country
Bulgaria	0.02000	0.00050	-0.43178	-0.58789	-0.07217	-5.78E-09	-0.41377	0.23761
Czech Republic	-0.97062	0.00215	0.27029	0.9984	0.18317	-1.43E-08	1.56809	-0.2659
Hungary	-0.79898	-0.00152	-0.2489	0.98117	0.04319	1.64E-08	2.17164	-0.58247
Poland	-0.77193	0.00204	0.114152	-0.11566	-0.03795	-3.05E-09	0.24953	0.18551
Romania	-2.5874	0.00040	0.11510	0.84658	-0.17853	4.23E-09	-0.46812	0.30892
Slovakia	-1.96095	0.00104	0.00935	-0.04251	0.91943	-3.66E-08	0.14737	0.30475
Slovenia	-0.40977	-0.00331	-0.32638	-0.01248	-0.12305	3.38E-09	0.52430	-0.18842

Source: own calculations

Table 7.

Total effect coefficients for large farms

	r_subsidies	land	r_labour	r_scost	r_liability	asset	r_cwork	country
Bulgaria	-0.84127	0.00016	-0.55043	-0.00876	0.04789	-8.40E-10	0.10158	0.57101
Czech Republic	-1.04628	3.89E-05	0.11474	1.95039	-0.48301	-5.04E-10	0.09461	-0.44196
Hungary	-1.30106	-0.00014	-0.03486	0.46342	-0.44121	2.89E-10	0.51614	0.28248
Poland	-0.98884	0.00031	-0.1244	1.01854	-0.53406	-1.75E-09	0.80058	-0.03108
Romania	-1.56268	5.22E-05	-0.04668	0.83635	-0.17759	-2.40E-10	-0.19887	0.31995
Slovakia	-0.53685	7.86E-05	-0.00814	1.56884	-0.05269	-4.16E-10	1.86867	-0.7004
Slovenia								

Source: own calculations

5.2. The role of farm size and agricultural subsidies on land efficiency

The following results present the marginal impact of independent variables on land productivity.

Table 8.

Fixed effects

	Small Farms		Mediu Farms		Large Farms	
	Coeff	t_stat	Coeff	t_stat	Coeff	t_stat
2005	0.241933	0.03751	0.085763	0.02261	0.123117	0.04175
2006	0.997563	0.03715	0.986737	0.02283	0.584927	0.04373
2007	0.971428	0.03628	1.977725	0.02422	1.7804	0.03849
2008	0.506332	0.03658	1.100533	0.02899	1.494527	0.04341
2009	0.314926	0.03909	0.248812	0.0316	0.806899	0.04731
2010	1.106311	0.03911	1.668992	0.03021	1.899836	0.04400
2011	0.650656	0.03941	1.984973	0.03080	2.641598	0.04537
2012	0.766292	0.03818	2.075403	0.03156	2.748442	0.04744
2013	0.478698	0.03827	1.32411	0.03308	2.232416	0.04950
2014	-0.58772	0.03854	0.922942	0.03291	2.039968	0.04940
2015	-1.33995	0.03828	0.832067	0.03190	1.435396	0.05043
2016	-0.25134	0.03905	0.538577	0.03332	1.65796	0.04967
2017	0.066645	0.03949	1.01557	0.03262	1.983316	0.05029
land	-0.28609	0.08777	-0.06614	0.02236	-0.00071	0.0004
r_land	1.164981	0.05513	0.293852	0.08568	-0.44431	0.11920
r_scost	1.588593	0.46250	1.266118	0.30131	1.221082	0.12996
r_labour	7.966813	4.93131	4.970248	2.54152	0.172383	0.37862
asset	0.005728	0.00305	0.000548	0.00035	4.68E-05	1.69E-05
r_liab	-1.44961	4.48084	8.861641	4.25460	0.151248	0.79634
r_subsidies	-9.81355	4.03921	-10.0078	4.131635	-9.42996	1.27941
contr_work	1.652815	1.35111	1.530003	0.54654	0.341948	0.25915
_cons	6.204329	2.27546	5.523756	1.86575	5.755388	0.67680

Source: own calculations.

The total effect on productivity of land are presented in Tables 9, 10 and 11. They show that marginal effects of the other factors (i.e. total subsidies, special costs, the share of paid labour) have a similar pattern for both measures of productivity. The share of total subsidies in total farm output affects negatively land productivity in each country except for small and medium size farms in Bulgaria. This marginal effect is the same as the impact on total factor productivity. The impact of the share of paid labour is positive with some few exceptions (small farms in Hungary and large farms in Bulgaria and Poland) and the marginal effect of special costs is positive.

However, different results are obtained with respect to other factors (i.e. land, the contract work, the share of debts and total assets) for crops farms. The effect of utilized land on land productivity is negative for all types of farms in all countries. This finding means that in each category of farms (small, medium and large) farms can't achieve economies of scale by increasing production and lowering costs. According to Alvarez and Arias (2003), increasing the size of the farm with constant managerial capacity can lead to diseconomies of size. So this finding could mean that farms have not the necessary managerial capabilities to benefit from scale effect for output per hectare. The long-term liabilities have, in general, a positive effect on land productivity, which could reflect the efficient use of capital investments to

produce efficiently (as in Barnes, 2008 or Zhengfei and Oude Lansink, 2006). Also contract work, which reflect work carried out by contractors and to the hire of machinery has a positive effect on land productivity in almost all cases.

Table 9.

Total effects coefficients for small farms

	r_subsidies	land	r_labour	r_scost	c_work	r_liability	asset
Bulgaria	4.501911	-0.59579	5.112402	2.616727	3.551502	5.217652	0.017486
Czech Republic							
Hungary	-14.6465	-0.30071	-0.87671	0.301408	2.675227	11.20645	0.004248
Poland	-9.01921	-0.247	4.425812	2.683842	-3.314803	-14.2388	-0.00012
Romania	-19.6571	-0.05732	4.190591	1.114931	1.099123	-3.92892	0.004482
Slovakia							
Slovenia	-10.2469	-0.22964	26.98197	1.226057	4.253027	-5.50447	0.002546

Source: own calculations

Table 10.

Total effects coefficients for medium farms

	r_subsidies	land	r_labour	r_scost	c_work	r_liability	asset
Bulgaria	0.486210	-0.04644	1.2129	0.808255	2.17637	5.768074	0.000391
Czech Republic	-8.18043	-0.05403	0.278632	1.52051	0.829045	8.711627	0.001204
Hungary	-8.91661	-0.02916	0.104398	1.08738	1.831656	1.112151	0.001513
Poland	-6.71694	-0.05835	5.592369	1.25271	4.290486	5.986994	0.000475
Romania	-13.2592	-0.03333	2.483289	1.29927	-0.04252	0.190698	0.001475
Slovakia	-32.3131	-0.04583	6.037159	0.14458	1.019318	7.864172	-0.00085
Slovenia	-1.15463	-0.19586	19.08299	2.75013	0.605709	32.39777	-0.00038

Source: own calculations

Table 11.

Total effect coefficients for large farms

	r_subsidies	land	r_labour	r_scost	c_work	r_liability	asset
Bulgaria	-4.70518	-0.00011	-1.51395	1.723236	0.210787	0.262871	2.58E-05
Czech Republic	-13.3767	-0.00024	0.379894	1.466012	-0.23045	-2.28693	2.89E-05
Hungary	-12.0955	-0.00257	0.907694	1.107203	1.331777	2.143084	0.000124
Poland	-9.88933	-0.00054	-0.03506	0.984473	0.220436	-1.85707	0.000026
Romania	-8.22415	-0.00062	0.525789	1.138893	-0.22312	1.444979	5.33E-05
Slovakia	-8.289	-0.00018	0.76992	0.906673	0.742255	1.200555	2.25E-05
Slovenia							

Source: own calculations

6. Conclusions

Our results contribute to the literature about farm performance in post-accession NMS. We found that subsides are negatively related to efficiency of farms for all countries (with the exception of Bulgaria small and medium size farms) - it is significantly higher for Romania, Hungary and Poland. Size (express by land total Utilised Agricultural Area) is positively

related to productivity, except for Hungary and Slovenia (all sizes) and for small and medium farms in Bulgaria and small2 farms in Poland. For almost all countries the effect on productivity of the ratio of paid labour to total labour is positive for medium and large farms – with the exception of Bulgaria, Hungary and Slovenia. The opposite results found for small farms except for Slovenia. The special cost has a positive influence on productivity for small and large farms, while depends on country for medium size farms.

As an observation we can notice that it is rather the range of the coefficient that changes depending on the farm size than the coefficient sign. This is the case for Hungary for almost all variables. The impact is negative (-) for subsidies, land, and labour and positive (+) for contract work and asset. For Slovenia the effect is negative for subsidies, debt and land and positive for asset and contract work. For Bulgaria the effect of labour and asset is negative (-) for all farms and positive for land. For Romania the effect is independent of the farms' size for almost all variables: subsidies (-), land (+), specific costs (+), and liability (-). For Poland the effect of subsidies, liability and asset is negative (-) and positive (+) for land for all farms. For the Czech Republic the effect on productivity of subsidies and asset is negative and positive for land, labour, specific costs and contract costs.

Farms in the Czech Republic and Slovakia presented the same type (sign) of productivity response to the variation of the variables considered in the model (except for specific costs). This could be explained by the same structure of the farms in the two countries: they do not have small farms. Also, the medium and large farms in Romania and Poland are responding in the same direction (sign) for the rate of subsidies, land and labour.

In this study we do not intend to find the causes of different results in different countries but to highlight the variation of the impact on productivity on the variables specified in the model. These observations may be useful in the current context in which states propose strategic plans and may outline specific interventions.

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