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ENVIRONMENTAL SUSTAINABLE VALUE IN AGRICULTURE REVISITED: HOW INVESTMENT SUBSIDIES FOSTER ECO-EFFICIENCY[1]

Key words: sustainable agriculture, Environmental Sustainable Value, eco-efficiency, agricultural policy, CAP

ABSTRACT. Many researchers and policy makers argue that CAP should support small farms mainly through environmental subsidies contributing by this mean to sustainable agriculture. This study offers a methodological contribution to the value-based sustainability approach, consisting of a computing indicator of environmental sustainable value (ESV). In this study, the authors have attempted to combine the value-oriented approach with DEA frontier benchmarking. In the next step, the authors test how investment subsidies contribute to ESV using a long-term panel of FADN region-representative farms in 2004-2015 with regards to other policy measures and factor endowments. The seminal within-between specification was employed to the control time variant and time in-variant space heterogeneity of European regions. The articles main finding is that higher investment support is beneficial for ESV. Other payments exert a negative effect on ESV besides the cross-sectional impact of environmental subsidies. When it comes to factor endowment influence, there is a positive impact of the capital-labor ratio and negative impact of the capital-land ratio.

INTRODUCTION

A commonly used approach to sustainability at a farm level consists of testing whether environmental impacts decrease or increase as the value of economic output is maintained [Picazo-Tadeo et al. 2011, Bleischwitz, Hennicke, 2004]. The eco-efficiency approach is very well advocated in sustainable agriculture literature. In most cases, authors use the DEA method to measure eco-efficiency levels at a farm level. The most recent of these are Andrés Picazo-Tadeo et al. [2011], Yiorgos Gadanakis et al. [2015] and Andrea Bonfiglio et al. [2017]. In this study, the authors attempt to combine a value-oriented approach (i.e. the environmental sustainable value (ESV)) with frontier benchmarking. The core research problem of this study lies in the question of how investment subsidies impact eco-efficiency with regard to other policy measures and factor endowments. The

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aim of the paper is to attempt to answer the above question. There is a commonly known point of view that small, poor of capital and labor-intensive farms guarantee a higher ESV than capital-intensive ones [C. Burja, V. Burja, 2016, Czyżewski et al. 2018]. Under this assumption, many researchers and policy makers argue that CAP should support them mainly through environmental subsidies, thus contributing by this mean to sustainable agriculture. On the other hand, stimulating capital endowment under CAP fosters industrial farming and may lead to allocative inefficiency, i.e. over-investment [Rizov et al. 2013].

Usually researchers look for a method, by applying a synthetic indicator, which will provide an overview of the overall performance of agricultural holdings. There is vast literature body in this field in different scopes, at a farm and local level: Hayo Van der Werf and Jean Petitt [2002], Steven Van Passel et al. [2006], Camelia Burja and Vasil Burja [2016], Dan Rigby et al. [2001], Jan Klaas Van Calker et al. [2006], Fritz Hani et al. [2003], Nora Van Cauwenbergh et.al. [2007], at a regional level: David Niemeijer and Rudolf de Groot [2008] and at a national level Vesela Veleva and Michael Ellenbecker [2000], Frank Figge and Tobias Hahn [2005].

The construction of a composite measure of environmental pressure in agriculture is a problematic issue. Katie Reytar et al., [2014] identifies 25 various indicators related to environmental sustainability. The variables that are of key significance refer to water consumption, agricultural subsidies, climate change, agricultural production, ecosystem biodiversity, and land use. The OECD [2001], in turn, argues that environmental indicators for agriculture should include water and soil quality, biodiversity, greenhouse gas emissions, land conservation, wildlife habitats, and the landscape. Other approaches point to issues of pesticide, herbicide, and fungicide use in agricultural production, the use of organic fertilizers, the use of synthetic fertilizers and plant protection products or crop rotation [Saltiel et al. 1994, Hayati et al. 1996, Czyżewski et al. 2018].

MATERIAL AND METHODS

In research, we use FADN data at a regional level for 25 EU member countries, excluding Cyprus and Malta as they were outliers. The time range of research applies to the years 2004-2015. In the first step, the environmental sustainable value (ESV) for the aforementioned scope was calculated. This method originates from the value-oriented approach to sustainability. Sustainable Value is calculated in five steps according to Andrea Liesen et al. [2009] and Camelia Burja and Vasil Burja [2016]: (1) defining resource efficiency, (2) determining benchmark resource efficiency, (3) calculating opportunity costs, (4) determining value contributions, and (5) computing SV . The following indicators of environmental pressure were engaged in our study [FADN database FADN codes in brackets]:

1) stock density per ha (SE120);
2) mineral fertilizer use (SE295);
3) plant protection products (SE300);
4) total use of energy (SE345);
5) UAA minus woodland area (SE075).

This set of variables fits in with the discussion on the environmental sustainability of agriculture and is well advocated in the literature [Latruffe et al. 2016]. The proposal was put forward to engage the DEA technique to identify a benchmark unit for ESV, which is an original contribution here. Hence, ESV calculated in this study extends the DEA analyses primarily used to identify the so-called benchmark units yb_{ij} *and* $rb_{ij.}$ The calculation formula for determining the ESV of farms in regions is as follows:

$$ESV_i = \frac{1}{m}\sum_{j=1}^{m} r_{ij}\left(\frac{y_{ij}}{r_{ij}} - \frac{yb_{ij}}{rb_{ij}}\right)$$

where: ESV_i is the sustainable value afferent to a farm from region i; r_{ij} and rb_{ij} respectively represent the polluting capital (input) used of type j and region/farm i, and of the farm considered as the reference (benchmark) system identified in the DEA analysis as an average of input in farms located on the frontier (with 1 score); y_{ij} and yb_{ij} are the return of resources (output) of the analyzed and benchmark farm identified in the DEA analysis as an average of output in farms located on the frontier (with 1 score); $i = 1 \ldots n$ is the region and $j = 1 \ldots m$ is the type of analyzed capital (resource).

If the ESV has a minus sign, it indicates a value of "clean production" (obtained without additional input of polluting capital) which ought to be provided by a farm to achieve the benchmark eco-efficiency level. If it has a plus sign, it indicates clean production exceeding the average eco-efficiency of farms on the frontier.

In the second step, a regression model, where ESV (in real prices 2004 = 100) is the dependent variable and CAP Subsidies on investments (SE406) stand for the explanatory variable, was estimated. Meanwhile, step-by-step, different types of CAP subsidies were introduced to the model as well as factor endowments as control variables to prove that the effect of investment subsidies is stable and robust despite modification in specification. Then, investment subsidy effects on the influence of other significant policy measures and factor endowments were compared.

Our specification refers to the production function in agriculture but the effect of resources on ESV is assumed. Having ESV computed for region-representative farms in the years 2004-2015, it is possible to employ one of the panel data methods. However, most panel data methods do not allow to separately model the consequences of changes to that phenomenon over time, or the effects of its heterogeneity in space. To account for this, there is quite a new approach called "the seminal within-between specification" recently advocated by Andrew Bell and Kelvyn Jones [2015] that solves this problem. This specification was employed and written in the following general form as follows:

$$y_{c,t} = \propto + \beta\left(x_{c,t} - \bar{x}_c\right) + \gamma\bar{x}_c + (\varepsilon_c + e_{c,t})$$

where $x_{c,t}$ is a set of time-variant variables, $\bar{x}_c$ consists of $x_{c,t}$ means calculated for each region j (which by definition are time-invariant). The error term presented in brackets consists of two parts: a time-invariant element ε_c that reflects the unobserved heterogeneity of regions and an idiosyncratic disturbance $e_{c,t}$ for each observation. The parameter β reflects the within effect, while Υ captures the between effect which can be interpreted as the impact of a unitary difference in $x_{c,t}$ among FADN regions on the dependent variable.

The within-between specification can be treated as a variant of a random effects model, but where explanatory variables are divided into time and varying cross-region parts. The seminal within-between model solves the endogeneity problems found in RE modelling.

RESULTS

Descriptive statistics of the dependent variable can be found in table 1. In the period under examination (2004-2015), ESV levels were characterized by considerable variability. It is worth stressing that the value of this variable is expressed in EURO, not in relative units of distance, which means that there are more possibilities of interpretation and in this way, the truncated data bias is avoided. At the same time, the moderate upward trend of this indicator was noted. This trend means that there was an improvement in the eco-efficiency of farms at a regional level. At the same time, the data presented in Table 1 indicate that ESV might potentially be improved.

The model's adjustment to empirical data is quite good: $R^2 = 0.7$, within $R^2 = 0.08$, VIF for each variable lower than 5. First of all, it was observed that changes in investment subsidies have a positive and stable effect on ESV regardless of what kind of different subsidies or factor endowments are added to the model, cf. Table 2. On the other hand, no significant cross-sectional influence of investment subsidies ("between" variable) was noted. Other payments exert a negative effect on ESV besides the cross-sectional impact of environmental subsidies as might be expected. When it comes to factor endowment influ-

Table 1. Descriptive statistics for ESV (2004-2015) in regions of the EU

Variable	Year	n	Panel mean	Min.	Max.	SD
ESV [EUR] real prices 2004 = 100	2004	114	-9,570	-233,593	83,788	36,721
	2005	114	-13,084	-266,580	74,896	40,385
	2006	114	-10,920	-238,650	79,330	40,413
	2007	127	-3,246	-152,258	91,189	32,922
	2008	128	-8,776	-206,047	103,269	37,067
	2009	128	-17,770	-344,827	89,189	50,435
	2010	128	-8,880	-425,523	120,428	51,469
	2011	128	-8,052	-574,292	133,978	62,188
	2012	128	-2,003	-484,280	150,745	55,586
	2013	128	-3,394	-218,230	149,568	41,099
	2014	128	-6,101	-531,579	178,875	60,063
	2015	128	-4,695	-495,735	177,217	59,550

Note: the illustrative interpretation of ESV, says that e.g. -13,084 indicates a value of "clean production" (obtained without the additional input of polluting capital) which ought to be provided by an average farm in the region to achieve the benchmark eco-efficiency level, or, if it has a plus sign, indicates clean production exceeding the average eco-efficiency of farms on the frontier.
Source: own calculations based on FADN data

Table 2 Effect of investment subsidies on Environmental Sustainable Value with regard to other subsidies and factor endowments

Variables 2004-2015	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	**ROBUST**(9)
const	-5,078	-1,480	4,796	2,939	1,425	7,105	-1.018e+04*	-1,724	-1,724
	(3,981)	(4,278)	(4,501)	(4,620)	(4,592)	(5,509)	(5,260)	(6,408)	(1.436e+04)
Betw Investment	-3.098*	-1.737	-0.6746	1.581	1.676	2.016	0.1931	0.5703	0.5703
	(1.800)	(1.887)	(1.837)	(2.262)	(2.226)	(2.213)	(1.895)	(1.878)	(1.662)
With Investment	**1.893****	**1.582****	**2.264****	**2.269****	**1.980****	**2.199****	**2.060****	**2.059****	**2.059****
	(0.6741)	(0.6854)	(0.6841)	(0.6839)	(0.7177)	(0.7176)	(0.7118)	(0.7115)	(0.7783)
Betw Decoupled	CAP measures	-0.3245**	-0.08174	-0.1377	-0.4816**	-0.5754**	-0.5922**	-0.6253**	-0.6253
		(0.1530)	(0.1642)	(0.1671)	(0.2214)	(0.2257)	(0.1916)	(0.1897)	(0.4525)
With Decoupled		0.1800**	-0.7537**	-0.7260**	-0.7390**	-0.7072**	-0.6751**	-0.6722**	-0.6722
		(0.07517)	(0.1629)	(0.1662)	(0.1665)	(0.1656)	(0.1642)	(0.1642)	(0.4351)
Betw Production			-1.396**	-0.7666	-0.5825	-0.3702	-1.088**	-1.213**	-1.213
			(0.4228)	(0.5614)	(0.5580)	(0.5680)	(0.4923)	(0.4891)	(1.116)
With Production			**-0.9399****	**-0.9112****	**-0.9195****	**-0.8972****	**-0.7962****	**-0.7936****	**-0.7936****
			(0.1460)	(0.1501)	(0.1501)	(0.1494)	(0.1495)	(0.1495)	(0.3984)
Betw LFA				**-2.350***	**-4.697****	**-5.213****	**-4.130****	**-3.942****	**-3.942****
				(1.383)	(1.696)	(1.707)	(1.457)	(1.440)	(1.999)
With LFA				-0.6269	-0.8860	-0.9167	-1.216	-1.218	-1.218
				(0.7666)	(0.7910)	(0.7859)	(0.7814)	(0.7811)	(1.288)
Betw Environment					**3.808****	**4.000****	**2.687***	**2.828****	**2.828****
					(1.643)	(1.631)	(1.396)	(1.380)	(1.110)
With Environment					0.7677	0.7238	0.2719	0.2748	0.2748
					(0.5810)	(0.5775)	(0.5805)	(0.5803)	(0.5951)

Table 2 Cont.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	**ROBUST**(9)
Bewt Asset per UAA	Factors endow-ments					-1.681*	-2.453**	-2.714**	-2.714
						(0.9764)	(0.8357)	(0.8330)	(2.730)
With Asset per UAA						**-3.693****	**-5.953****	**-5.953****	**-5.953****
						(0.7410)	(0.8790)	(0.8787)	(2.267)
Betw Asset per labor							**794.6****	**693.6****	**693.6****
							(110.3)	(117.8)	(182.4)
With Asset per labor							**457.7****	**457.7****	**457.7****
							(97.87)	(97.83)	(176.7)
New MS ref. Old MS								**-1.742e+04****	**-1.742e+04****
								(7,743)	(8,168)
n	1,492	1,492	1,492	1,492	1,492	1,485	1,485	1,485	1,485
lnL	-1.82e+004	-1.818e+004	-1.813e+004	-1.812e+004	-1.81e+004	-1.8e+004	-1.783e+004	-1.781e+004	-1.781e+004

* In grey – different groups of control variables

Source: own calculations based on FADN and Eurostat data

ence, there is a positive impact of the capital-labor ratio and negative impact of the capital-land ratio in terms of its time effect. When comparing the marginal effects of different subsidies on ESV, it is visible that investment payments have an almost three-fold stronger effect than decoupled ones and production subsidies slightly weaker than LFA and environmental schemes.

The results are, to some extent, in line with other studies of eco-efficiency. There is evidence that the participation of farms in agri-environmental schemes affects their pro-ecological orientation [Bonfiglio et al. 2017]. Research carried out by Y. Gadanakis et al., [2015] indicates that medium and small farms are more eco-efficient than large farms, and environmental payments have a positive and statistically significant impact on the improvement of eco-efficiency. However, some contradictory findings prove that direct payments can also be positively related to environmentally friendly production [Kleinhanß et al. 2007]. On the other hand, subsidies do not necessarily have a positive impact on the technical efficiency of farms, as demonstrated by the example of Hungary, the Czech Republic, Slovenia or Romania [Latruffe et al. 2008]. At the same time, it should be pointed out that there is a lack of research regarding the direct impact of investment subsidies on the ESV or ecological effectiveness of farms. This approach is, however, extremely important due to the upcoming challenges for agriculture in the area of increasing the productivity of agricultural land, in line with the growing demand for food and fiber [Keating et al. 2010].

CONCLUSIONS

In the context of the results of our research, investments that are ecofriendly should be supported in the future CAP perspective. Particular attention should also be paid to large differences between farms from different EU regions in terms of ESV creation, which should be a reason for greater diversification of CAP instruments between regions. This should concern both a greater diversification of payments between farms, as well as investment support due to size. Instruments supporting the internalization of costs and benefits related to externalities in agriculture, and thus a reduction of soil erosion and water and air pollution, while supporting biodiversity and techniques of better management of water resources should be further developed. In addition, the removal of some exemptions related to the application of compulsory practices to take account of different territorial contexts could increase the effectiveness of the CAP. In light of the above, it would be advisable to continue supporting investments in the next budget perspective of the CAP, especially those that are more environmentally friendly and of lower energy intensity. Thus, the pro-investment direction of the CAP would be correct from an ESV perspective, despite the fact that it is challenged by policy makers in Western Europe. However, environmental pressure should be considered at the level of regions, scale of production and production types of farms. This is a particularly important issue due to the threats resulting from climate change as well as the growing demand for food on the global market.

BIBLIOGRAPHY

Bell Andrew, Kelvyn Jones. 2015. Explaining fixed effects: Random effects modeling of time-series cross-sectional and panel data. *Political Science Research and Methods* 3 (1): 133-153. DOI: 10.1017/psrm.2014.7.

Bleischwitz Raimund, Peter Hennicke. 2004. *Eco-Efficiency, regulation and sustainable business. Towards a governance structure for sustainable development*. Cheltenham, Northampton: Edward Elgar.

Bonfiglio Andrea, Andrea Arzeni, Antonella Bodini. 2017. Assessing eco-efficiency of arable farms in rural areas. *Agricultural Systems* 151: 114-125. DOI: 10.1016/j.agsy.2016.11.008.

Burja Camelia, Vasile Burja. 2016. The economic farm size and sustainable value disparities between Romania and the EU states. *Annnals of „Constantin Brâncuşi" University of Târgu Jiu. Economy Series* 1: 50-57.

Czyżewski Bazyli, Anna Matuszczak, Andrea Muntean. 2018. Environmental sustainability in agriculture: different ways of quantification. *Economic Sciences for Agribusiness and Rural Economy* 1: 40-47. DOI: 10.22630/ESARE.2018.1.4.

FADN, http://ec.europa.eu/agriculture/rica/database/database_en.cfm.

Figge Frank, Tobias Hahn. 2005. The cost of sustainability capital and the creation of sustainable value by Companies. *Journal of industrial ecology* 9: 47-58. DOI: 10.1162/108819805775247936.

Gadanakis Yiorgos, Richard Bennett, Julian Park, Francisco Jose Areal. 2015. Evaluating the sustainable intensification of arable farms. *Journal of Environmental Management* 150: 288-298. DOI: 10.1016/j.jenvman.2014.10.005.

Hani Fritz, Francesco Braga, Andreas Steampfli, Thomas Keller, Matthew Fischer, Hans Porsche. 2003. RISE, a tool for holistic sustainability assessment at the farm level. *International Food and Agribusiness Management Review* 6: 78-90.

Hayati Dariush, Ezatollah Karami. 1996. *A proposed scale to measure sustainability at farm level in socio-economic studies*. [In] First agricultural economic conference of Iran. Zabol, Iran, 05-07.05.1996.

Keating Brian A., Peter S. Carberry, Prem S. Bindraban, Senthold Asseng, Holger Meinke, John Dixon. 2010. Eco-efficient agriculture: concepts, challenges, and opportunities. *Crop Science* 50 (1): 109-119.

Kleinhanß Werner, Carmen Murillo, Juan Carlos San, Stefan Sperlich. 2007. Efficiency, subsidies, and environmental adaptation of animal farming under CAP. *Agricultural Economics* 36 (1): 49-65. DOI: 10.1111/j.1574-0862.2007.00176.x.

Latruffe Laure, Zoltan Bakucs Lajos, Stefan Bojnec, Imre Ferto, Jozsef Fogarasi, Camelia Gavrilescu, Ladislav Jelinek, Lucian Luca, Tomas Medonos, Camelia Toma. 2008. *Impact of public subsidies on farms' technical efficiency in New Member States before and after EU accession.* [In] 12th Congress of the European Association of Agricultural Economists – EAAE. August 26-29, 2008, Ghent, Belgium.

Latruffe Laure, Ambre Diazabakana, Christian Bockstaller, Yann Desjeux, John Finn, Edel Kelly, Mary Ryan, Sandra Uthes. 2016. Measurement of sustainability in agriculture: a review of indicators. *Studies in Agricultural Economics* 118: 123-130.

Liesen Andrea, Frank Müller, Frank Figge, Tobias Hahn. 2009. *Sustainable value creation by chemical companies.* Belfast: Sustainable Value Research, https://www.sustainablevalue.com/downloads/sustainablevaluecreationbychemicalcompanies.pdf.

Niemeijer David, Rudolf S. de Groot. 2008. A conceptual framework for selecting environmental indicator sets. *Ecological Indicators* 8: 14-25. DOI: 10.1016/j.ecolind.2006.11.012.

OECD. 2001 National soil surface nitrogen balances – preliminary estimates 1985-1997. Paris, OECD, http://www.oecd.org/agr/env/indicators.htm.

Picazo-Tadeo Andrés J., José A. Gómez-Limón, Ernest Reig-Martínez. 2011. Assessing farming eco-efficiency: a data envelopment analysis approach. *Journal of Environmental Management* 92 (4): 1154-1164. DOI: 10.1016/j.jenvman.2010.11.025.

Reytar Katie, Craig Hanson, Norbert Henninger. 2014. Indicators of sustainable agriculture: a scoping analysis. Working Paper, Installment 6 of Creating a Sustainable Food Future. Washington, DC: World Resources Institute. Available online at http://www.worldresourcesreport.org.

Rigby Dan, Phil Woodhouse, Trevor Young, Michael Burton. 2001. Constructing a farm level indicator of sustainable agricultural practice. *Ecological Economics* 39: 463-478. DOI: DOI: 10.1016/S0921-8009(01)00245-2.

Rizov Marian, Jan Pokrivcak, Pavel Ciaian. 2013. CAP subsidies and productivity of the EU farms. *Journal of Agricultural Economics* 64 (3): 537-557. DOI: 10.1111/1477-9552.12030.

Saltiel John, James W. Baunder, Sandy Palakovich. 1994. Adoption of sustainable agricultural practices: diffusion, farm structure and profitability. *Rural Sociology* 59 (2): 333–347.

Van Calker Klaas Jan, Paul B.M. Berentsen, Carlos Romero, Gerard W.J. Giesen, Rudd B.M. Huirne. 2006. Development and application of a multi-attribute sustainability function for Dutch dairy farming systems. *Ecological Economics* 57 (4): 640-658. DOI: 10.1016/j.ecolecon.2005.05.016.

Van Cauwenbergh Nora, Biala Katarzyna, Charles Bielders, et al. 2007. SAFE –ahierarchical framework for assessing the sustainability of agricultural systems. *Agriculture, Ecosystems & Environment* 120: 229-242. DOI: 10.1016/j.agee.2006.09.006.

Van der Werf Hayo M., Jean Petit. 2002. Evaluation of the environmental impact of agriculture at the farm level: a comparison and analysis of 12 indicator-based methods. *Agriculture, Ecosystems & Environment* 93: 131-145. DOI: 1016/S0167-8809(01)00354-1.

Van Passel Steven, Erik Mathijs, Guido Van Huylenbroeck. 2006. *Explaining differences in farm sustainability: evidence from flemish dairy farms*. [In] International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, https://ageconsearch.umn.edu/bitstream/25262/1/cp060302.pdf.

Veleva Vesela, Michael Ellenbecker. 2000. A proposal for measuring business sustainability. *Greener Management International* 31: 101-120. DOI: 10.9774/GLEAF.3062.2009.au.00010.

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ZRÓWNOWAŻENIE ŚRODOWISKOWE W ROLNICTWIE: W JAKI SPOSÓB SUBSYDIA INWESTYCYJNE SPRZYJAJĄ EKOEFEKTYWNOŚCI

Słowa kluczowe: rolnictwo zrównoważone, wartość zrównoważenie środowiskowego, ekoefektywność, polityka rolna, WPR

ABSTRAKT

Wielu badaczy i polityków Unii Europejskiej stoi na stanowisku, że Wspólna Polityka Rolna (WPR) powinna wspierać małe gospodarstwa, głównie przez subsydia środowiskowe jako swoistych strażników krajobrazu, przyczyniając się w ten sposób do większego zrównoważenia rolnictwa. W badaniach zastosowano podejście wartościowe (tzw. *value-base approach* – VBA) do określenia poziomu ekoefektywności gospodarstw w regionach FADN, obliczając wartość zrównoważenia środowiskowego. Podjęto próbę zintegrowania wartościowego ujęcia zrównoważenia ze wzorcem ustalonym metodą DEA. Następnie oszacowano wpływ subsydiów inwestycyjnych na tak podejmowaną ekoefektywność w kontekście oddziaływania innych instrumentów WPR oraz relacji zasobowych, w latach 2004-2015, w gospodarstwach reprezentatywnych dla regionów FADN. Zastosowano specyfikację *within-between* dla danych panelowych, aby uwzględnić heterogeniczność czasową i przestrzenną gospodarstw rolnych w regionach FADN. Jednym z głównych wniosków jest pokazanie pozytywnego oddziaływania subsydiów inwestycyjnych na ESV. Pozostałe płatności WPR wywierają negatywny wpływ na ESV, z wyjątkiem przekrojowego oddziaływania dopłat środowiskowych. W odniesieniu do wpływu relacji zasobowych zidentyfikowano dodatnie oddziaływanie technicznego uzbrojenia pracy.

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