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Assessment of the European Common Agricultural Policy and landscape changes: an example from Slovenia

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Abstract: The objective of this study was to determine whether and to what extent Common Agricultural Policy (CAP) measures actually succeed in preserving the diversity of agricultural landscapes. This paper assesses the effects of agricultural policy on changes in the diversity of agricultural landscapes in Slovenia. Diversity is measured by the Shannon index and the Simpson index, while the impacts were estimated using a spatial lag model. The results show that direct payments decrease landscape diversity by 2 index points per 1 000 EUR/ha, but agri-environmental payments for reducing negative impacts on the environment and those for nature conservation increase agricultural landscape diversity by 2.8 index points and 12.30 index points per 1 000 EUR/ha, respectively. Furthermore, we did not find any statistically significant effects of habitat protection payments on landscape diversity. Since direct payments are almost four times larger on average as agri-environmental payments, they preserve landscape diversity only to a limited extent.

Keywords: agricultural landscape diversity, agricultural payments, Shannon index, Simpson index, spatial lag model

The quality and diversity of European landscapes constitute a common resource, which represents a basic component of European natural and cultural heritage and which contributes to human well-being and European identity. The complexity of European landscapes has led to different landscape definitions highlighting different aspects. For example, Moran (2005) puts emphasis on physical aspects in defining landscape as “an assemblage of physical attributes that is viewed by people” including landform, geology, vegetation and water bodies, while in the European Landscape Convention (Council of Europe 2000) the emphasis is on the action and interaction of natural and/or human factors. Diverse historical European landscapes have evolved over centuries in interaction with humans to generate ecosystem services, provide habitats for a range of species and create natural and cultural heritage. For this very reason, European citizens prefer heterogeneous landscapes compared to homogenous ones. The more diverse or heterogeneous the landscape is, the more it can potentially contribute to amenity, cultural, recreational and knowledge values (Brady et al. 2012). As landscape preservation and its diversity is crucial for future generations, ensuring proper management is of high priority.

This paper focuses on changes in the diversity of agricultural landscapes. In Europe, agriculture is the main land user and agricultural land use accounts for 47% of the total land area (Eurostat 2016). As such, agriculture has a large impact on landscape diversity, and thereby on the services it provides to society. However, agricultural use of land has been slowly decreasing over time, e.g. cropland and pastures in Europe decreased by 0.7 and 0.35%, respectively, between 2009 and 2012 (Eurostat 2016). Moreover, in recent decades we can observe a trend of the phasing out of agricultural production in areas with low productivity of land and an increase in the use of land in more productive areas (Brady et al. 2003). In this way, traditional agricultural landscapes are disappearing and agricultural production is intensifying. The

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first phenomenon has a greater impact in Southern Europe, the second in Northern Europe, while a mix of these phenomena characterises many Eastern European countries (Kristensen 2016). Consequently, the contemporary European agricultural landscape is losing its diversity.

In response, the Common Agriculture Policy (CAP) of the European Union has instituted measures including agri-environmental payments to farmers, like payments for the establishment and maintenance of habitats, management of pastures, traditional hay meadows and traditional orchards. These payments represent a second pillar of the CAP and are aimed at improving competitiveness and promoting diversification of economic activity, delivering environmental public goods and improving quality of life in rural areas (EC 2011). On the other hand, the first CAP pillar is aimed at providing basic income support to European Union (EU) farmers. Within the first pillar, farmers receive direct payments, the main part of which is decoupled from production (implemented in 2005). In order to be eligible to receive this support, farmers must keep land in good agricultural and environmental conditions and meet legislative standards covering the environment, public health, plant health and animal health (cross-compliance conditions) (Erjavec and Lovec 2017). Here, it should also be pointed out that the CAP receives the largest share of the EU budget. For example, in the period from 2007 to 2009, direct payments represented on average 29% of agricultural income in the EU (EC 2011). Moreover, agri-environmental payments represent 30% of rural development expenditures from the European Agricultural Guarantee and Guidance Fund (EAGG fund) (Eurostat 2012). It follows from the above that the CAP is a sufficiently complex and well-financed policy that could potentially facilitate land use changes which conserve landscape patterns and rural viability. However, it is challenging to quantify the complex potential impacts of CAP on agricultural landscape diversity. Consequently, studies examining these issues are rare (Lefebvre et al. 2012; Lefebvre et al. 2015; Kristensen 2016).

A review of the studies from the field reveals that scholars focus on a number of areas relating to landscapes that agricultural payments should influence, like provision of ecosystem services (Khatun 2012; Reed et al. 2014; Brunner and Grêt-Regamey 2016), biodiversity (Vickery et al. 2004; Chiron et al. 2013), crop diversity or space diversity in crops (Smale et al. 2003; Cortignani and Dono 2015; Capitanio et al. 2016) and abandonment of agricultural land (Benayas et al. 2007; Renwick et al. 2013). However, to our knowledge, there have been only a few studies characterising the impacts of agricultural payments on landscape diversity (Reger et al. 2009; Brady et al. 2012; Golobič and Lestan 2016).

Various methodological approaches to modelling the impacts of CAP policy on land use change have been applied. For instance, Brady et al. (2012) applied an agent-based approach to modelling farmer behaviour and landscape dynamics under three agricultural policy schemes. An agent-based model was also used by Piorr et al. (2009) in addition to linear programming in order to assess the impact of different policy scenarios: (i) idealised single farm payment; (ii) without direct payments + good agricultural and environmental conditions (GEAC) and (iii) without direct payments, environmental payments and no cross compliance. The authors analysed the effects of these three scenarios on structural change, land abandonment and cropping patterns of typical farms for two study areas. Renwick et al. (2013) combined the CAPRI model (CAPRI stands for Common Agricultural Policy Regionalised Impact) and the Dyna-CLUE model (a dynamic, spatially explicit, land use and land cover change model) to estimate the extent of change in land use across Europe under removal of direct payments and trade liberalisation. However, both applications are only focused on the impacts of direct payments. Similarly, Reger et al. (2009) investigated the impacts of direct payments on farmland habitat diversity in a marginal European landscape. They generated land-use patterns for the three scenarios using the ProLand agro-economic land-use model. One of the few studies focusing on the impacts of agri-environmental measures on landscape diversity is the one conducted by Golobič and Lestan (2016). Their evaluation of impact is based on the territorial impact assessment concept using expert opinion and an analysis of data on land-use change.

The scientific literature on factors influencing land use changes distinguishes between endogenous or local factors and exogenous or macro-level factors (Kristensen et al. 2016). Two major types of drivers of land use change are classified as local factors: (i) farmer characteristics, such as age, duration of farm ownership, owner occupation and education, and (ii) farm characteristics, e.g. size, arable land, labour stock and type of production. The third major type of drivers represents the physical, socio-economic and policy environments, i.e. exogenous factors. Following this logic, agricultural payments can be considered as one of the main exogenous drivers. Given the

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objective possibilities, it is appropriate to consider these drivers when the impacts of agricultural payments on land use are examined.

The research question posed in this paper is whether and to what extent the CAP measures actually succeed in preserving the diversity of agricultural landscapes. Most of the literature in the field is focused on the impacts of direct payments on landscape diversity (Piorr et al. 2009; Reger et al. 2009; Brady et al. 2012), and, to the best of our knowledge, investigations into the impacts of both direct payments and agri-environmental payments on landscape diversity have not been given sufficient attention by researchers in the past. Therefore, our motivation in the present study was to investigate the impacts of various agricultural payments on landscape diversity. More precisely, for the EU member state Slovenia, we assess the impacts of direct payments (Pillar I) and agri-environmental payments (Pillar II) in the period 2007–2013 on changes in the Shannon and Simpson landscape diversity indices.

We see the main scientific contribution of our study as filling a gap in assessing the effectiveness of recent CAP policy relating to maintenance of landscape diversity and consequently, also habitats favourable to biodiversity. The findings will provide policy decision-makers with new insights which might help them in achieving the goals of sustainable agriculture. As a result, communication concerning sustainable agriculture among stakeholders will be stimulated and policy-makers will be appropriately informed.

MATERIAL AND METHODS

In this study, we analysed data from Slovenia, which is an example of a new EU member state from South-eastern Europe. Slovenia is characterised by rich diversity in a rather small territory situated between the Alps, the Dinaric Mountains, the Pannonian plain and the Mediterranean. This variety is manifested in the geology of the area, its varied relief, climatic conditions, biodiversity as well as landscape and cultural diversity (MESP - EARS, 2001: ix) (MESP – EARS 2001). Moreover, more than three quarters of the surface belong to areas with less favoured conditions for agricultural production (e.g. Alpine region). Consequently, public spending on agri-environmental measures represents the largest share of the budget for rural development, and the same applies to Europe.

Our data set merges land use data of the Ministry of Agriculture, Forestry and Food (LUR) (2006, 2014) (Land Use Registry – LUR), SAAMRD (2015) data on agricultural payments (Slovenian Agency for Agricultural Markets and Rural Development), data on Natura 2000 sites (Institute of the Republic of Slovenia for Nature Conservation) (IRSNC 2013) and the Agricultural census of Slovenian Statistical Office (SORS – AC 2010).

LUR land use data contain artificial surfaces, agricultural areas, forests and semi-natural areas, wetlands and water bodies. However, for our purpose only agricultural areas were used in accordance with CORINE land cover nomenclature. Agricultural areas encompass the following land uses: arable land, permanent crops, pastures and heterogeneous agricultural areas (agricultural land with areas of natural vegetation, like trees and shrubs, hedgerows). In order to explain changes in land use, data on agricultural payments were used, which include direct payments and agri-environmental payments per ha of utilised agricultural area. Agri-environmental payments (*AEP*) are further classified into three groups: negative-impact-reducing payments (*AEP*1), conservation payments (*AEP*2) and habitat-protection payments (*AEP*3). Moreover, data on agricultural holdings and farmer characteristics were used. These were obtained from the 2010 Agricultural Census of the Slovenian Statistical Office (SORS – AC 2010). Finally, data on Natura 2000 areas as a measure of nature conservation policy were acquired from the IRSNC (2013).

Descriptions and the sources of the data variables included in the analysis are presented in Table 1, from which it is evident that the availability of data is limited. The financial perspective covered the period from 2007 to 2013, beginning with the first payment in 2008, while the land use data are available from 2006 onwards only for every third year. Moreover, the agricultural census was carried out in 2000 and 2010. Limitations in data availability restricted us from carrying out a panel data analysis. A cross-sectional analysis is thus focused on relative differences encompassing the financial perspective. The analysed area consists of 210 Slovenian municipalities (LAU 2)[1].

Descriptive statistics for used variables are presented in Table 2. Following Kristensen et al.'s (2016)

[1]LAU stands for Local Administrative Units. LAU 2 was previously called NUTS 5.

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Table 1. Description and source of data for used variables

Variable	Definition	Unit	Source	Availability	Taken
Diversity index	difference in diversity index	–	LUR (2006, 2014)	2006, 2009, 2012, 2015	2006, 2015
Agricultural payments	total agricultural payments per ha of utilised agricultural area	EUR	SAAMRD (2015)	2007–2013	2018–2013
*Natura*2000	share of Natura 2000 areas in total area	%	IRSNC (2013)	2013	2013
Size	economic size of an agricultural holding (the total standard output of the holding)	EUR	SORS – AC (2010)	2000, 2010	2010
Type	share of agricultural holdings practising mixed crop/livestock farming	%	SORS – AC (2010)	2000, 2010	2010
Fragmentation	relative difference in standard deviation of GULU* sizes	%	LUR (2006, 2014)	2006, 2009, 2012, 2015	2006, 2015
Age	share of young farmers (under 25 years old) in total	%	SORS – AC (2010)	2000, 2010	2010
Education	share of agricultural holdings using personal computers for farm management	%	SORS – AC (2010)	2000, 2010	2010

*GULU – graphical unit of land use for agricultural holding; for further explanation of variables see Materials and Methods

Source: authors' own elaboration

Table 2. Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Diversity				
Δ*Shannon index*	0.034	0.064	–0.245	0.200
Δ*Simpson index*	0.016	0.047	–0.179	0.264
Macro-level				
DP	1 986.644	731.503	148.586	6 059.322
AEP1	398.543	390.356	9.112	2 236.334
AEP2	148.874	130.523	0.000	715.663
AEP3	1.715	5.622	0.000	45.070
*Natura*2000 (%)	0.326	0.299	0.000	1.000
Farm-level				
Fragmentation (%)	1.050	0.066	0.803	1.412
Size (EUR)	12 758	7 039	3 350	46 795
Type (%)	0.149	0.088	0.000	0.403
Farmer-level				
Education (%)	0.113	0.078	0.010	0.440
Age (%)	0.204	0.051	0.009	0.388

DP and *AEP*1–3 are the total payments in the seven-years period/ha in 2008 constant prices (EUR); *AEP* – agri-environmental payments; *DP* – total direct payments in the period; for further explanation of variables see Materials and Methods

Source: authors' own calculations

evidence on drivers of land use change, the independent variables represent macro-level factors and local factors on the farm- and farmer-levels. Macro-level explanatory variables are agricultural payments and Natura 2000 areas. The economic size of agricultural holdings and the type of farming and fragmentation are used for control at the farm level, while farmer age and education are used for control at the farmer level.

To quantify landscape diversity, we used the most popular metrics, the Shannon index and the Simpson index (Forman 1995). While the Shannon index emphasises the richness component, which relates to the number of different land cover types encountered in a given landscape, the Simpson index emphasises the evenness component which relates to the distribution of area among land cover types (Nagendra 2002). In a high

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diversity landscape, one would expect to see different land cover types and also that one abundant land cover type does not dominate the landscape. For our purpose, we calculated the Shannon and the Simpson indices based on the following land uses: arable land, permanent crops, pastures and heterogeneous agricultural areas. The Shannon index is defined as follows:

$$\text{Shannon index} = -\sum_{i=1}^{N} p_i \times \ln p_i \quad (1)$$

where N is the number of land cover types and p_i is the proportion of the total landscape area allocated to land cover type i.

The Simpson index is a reciprocal summed value of squared proportions of the total landscape area allocated to land cover type i:

$$\text{Simpson index} = \frac{1}{\sum_{i=1}^{N} p_i^2} \quad (2)$$

Their analogous (standardized) evenness indices refer to the observed value of the Shannon/Simpson diversity divided by the maximum possible diversity for a landscape. The index approaches one when the landscape approaches a perfectly even distribution of land between cover types. Differences in standardized values of both indices in the period 2006–2015 are shown in Figure 1.

On average, diversity has increased in the studied period; the average increase in diversity emphasising the richness component measured by the Shannon index was 3.4-index points, while the average increase in diversity emphasising the evenness component measured by the Simpson index was 1.6-index points. The larger differences in the Shannon index compared to the differences in the Simpson index indicate that landscape is changing mostly due to the ocurrence of rare cover types rather than the dominant cover types. Major land use changes occurred in heterogeneous agricultural areas where they almost doubled in size (3.9–7.6%). On the other hand, arable land and permanent crops land use has decreased by 8% (from 32.1–29.6%) and 18% (from 5.5–4.5%), respectively. Land used for pastures (58.4%) has not changed in the observed period. Moreover, from these spatial patterns we can see that changes in agricultural landscape diversity are spatially unevenly distributed. In terms of richness, diversity in Western and Northern Slovenia increased; yet, in terms of evenness differences are less intense.

Returning to Table 2, in the studied period, total direct payments amounted to an average of 1 986 EUR/ha of utilised agricultural area (or 283 EUR yearly), which is almost four times as much as average agri-environmental payments (549 EUR). Within the *AEP*, negative impact-reducing payments (*AEP*1) were most important, while habitat protection payments (*AEP*3) received negligible funds. The average share of Natura areas in municipalities was 32.6%. On average, the standard output of agricultural holdings was around 13 000 EUR, 15% of agricultural holdings practised mixed crop/livestock farming, and the relative difference in the standard deviation of GULU sizes (graphical unit of land use for agricultural holding)

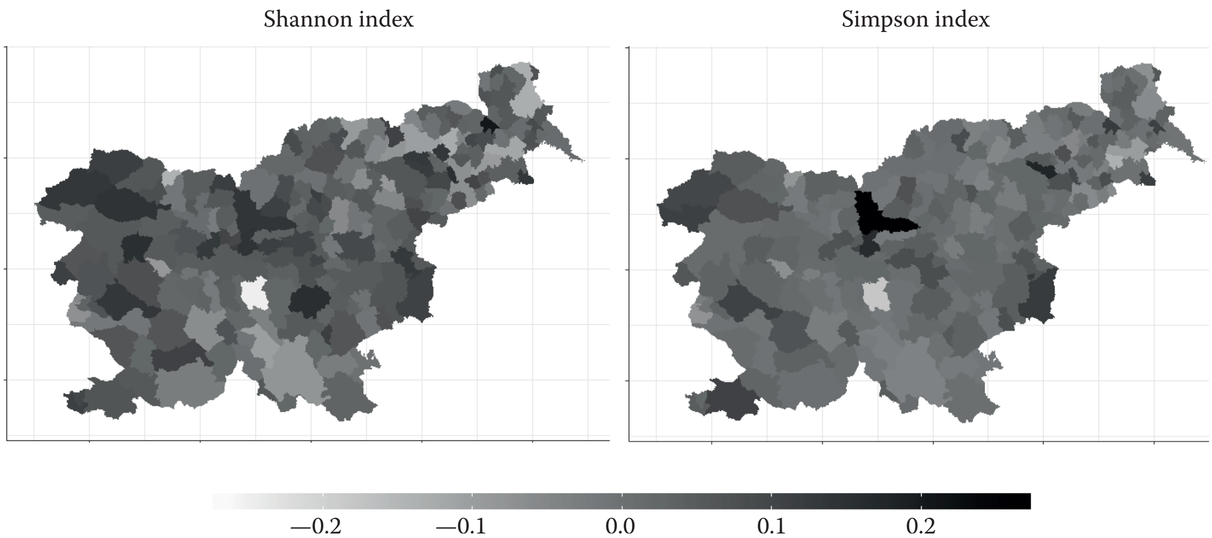

Figure 1. Differences in standardised values of the Shannon index and the Simpson index in the period 2006–2015

Source: authors' own calculations

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is more than 1. Moreover, on average 11% of agricultural holdings used personal computers for farm management and 20% of farmers were young.

A cross-sectional analysis was conducted in order to assess the impacts of agricultural payments on landscape diversity measured by the Shannon index and the Simpson index. To examine the impact of agricultural payments on landscape diversity, we estimate the following spatial lag model:

$$\Delta DI_i = W\Delta DI_i + DP_i + AEP1_i + AEP2_i + AEP3_i + \\ + Natura2000_i + Fragmentation_i + Size_i + \\ + Type_i + Education_i + Age_i + e_i \quad (3)$$

where i is a municipality index, ΔDI denotes the difference within the 2006–2015 period of the selected diversity index, W is the connectivity or spatial weights matrix and $W\Delta DI$ is a spatial lag of the dependent variable, e is the error term. Connectivity is defined by the queen contiguity (municipalities are neighbours if they share either a common border or vertex), while the W matrix is row-standardised. Moving on to individual independent variables, DP denotes total direct payments in the period. The impacts of agri-environmental payments are assessed separately for negative impact-reducing payments ($AEP1$), conservation payments ($AEP2$) and habitat protection payments ($AEP3$), because $AEP2$ and also $AEP3$ are targeted at preserving agricultural landscapes. All payments in the model are expressed in 1 000 EUR for interpretation purposes. In order to also take into account conservation policy measures, the Natura 2000 areas (*Natura*2000) are included in the model.

To consider all major types of drivers of land use change that have been already identified by scholars as relevant for assessing the impacts on landscape diversity and given the objective possibilities local factors are also included in the model. We assumed that landscape diversity is affected by farm size (*Size*), type of farming (*Type*), land fragmentation (*Fragmentation*), age of the farmer (*Age*) and use of computers as a proxy for farmer education (*Education*), as data on farmer education are not available.

The model was estimated with spatial two stages least squares (S2SLS) with heteroskedastic and autocorrelation consistent (HAC) standard errors (Kelejian and Prucha 2007) in R Core Team (2016), using the "sphet" package (Piras 2010; Bivand and Piras 2015). Figures are produced with "ggplot2" library (Wickham 2009). The test for heteroscedasticity was executed using the Breusch-Pagan test on the least squares fit of the spatial models, while Moran's I and Lagrange multiplier (LM) tests were used on the ordinary least squares (OLS) fit. All tests were performed using "spdep" library (Bivan and Piras 2015). Estimation of the spatial lag model comes with a simultaneous feedback feature, which makes interpretation of the parameter vector different from OLS. If we rewrite Equation 3 as:

$$Y = \rho WY + X\beta + u \quad (4)$$

and reorder it as:

$$(I_n - \rho W)Y = X\beta + u \quad (5)$$

$$S_r(W) = (I_n - \rho W)^{-1} (I_n\beta_r) \quad (6)$$

where Y is a vector of observations on the dependent variable, X is the matrix of independent variables, W is the connectivity matrix, β is the vector of regression coefficients, ρ is a spatial lag coefficient and I_n is the identity matrix of size n, the diagonal elements of $S_r(W)$ represent direct effects, while off-diagonal elements of the $S_r(W)$ matrix summarised as row sums represent average indirect effects (LeSage and Pace 2009). The sum of direct and indirect effects equals the total effects.

RESULTS AND DISCUSSION

The estimated coefficients of the models are presented in Table 3. In both cases, Moran's I statistic of the dependent variable indicates the presence of spatial autocorrelation, while Lagrange multiplier tests reject no spatial autocorrelation only in the case of the Shannon index. Consequently, the OLS remains unbiased in the case of the Simpson index, but it is no longer efficient and the classical estimators for standard errors will be biased. The Breusch-Pagan test (BP test) rejects homoscedasticity in both cases; hence, HAC standard errors were used in the estimation of spatial lag models.

Coefficients presented in Table 3 refer to direct effects on diversity indices. However, because of a spatial lag there are also indirect impacts, and consequently the total impacts are larger than the direct impacts shown with regression coefficients. Thus, for interpretation of results, it is more appropriate

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Table 3. Regression results of agricultural payments on landscape diversity

Variable	Shannon index	Simpson index
Intercept	–0.575*** (0.046)	–0.410*** (0.038)
DP	–0.017*** (0.005)	–0.014*** (0.004)
*AEP*1	0.024** (0.01)	0.014* (0.008)
*AEP*2	0.102*** (0.029)	0.075*** (0.017)
*AEP*3	–0.156 (0.370)	–0.032 (0.329)
Size	–0.001 (0.001)	0.001 (0.001)
*Natura*2000	0.018* (0.011)	0.011 (0.009)
Education	–0.001 (0.001)	–0.037 (0.031)
Age	0.003*** (0.001)	0.001 (0.001)
Type	0.033 (0.041)	–0.037 (0.031)
Fragmentation	0.006*** (0.001)	0.004*** (0.001)
Spatial lag	0.177** (0.071)	0.084 (0.065)
R^2	0.650	0.689
N	210	210
Se^2	0.038	0.027
BP test	42.319***	55.324***
Moran's I test	0.091**	0.104***
LM test	3.8741**	2.218

regression coefficients at significance levels: *,**,*** < 0.1, 0.05, 0.01, respectively; heteroskedastic and autocorrelation consistent (HAC) standard errors in brackets; *AEP* – agri-environmental payments; *DP* – total direct payments in the period; R^2 – coefficient of determination; *N* – number of observations ; Se^2 – error variance; *BP* – Breusch-Pagan test; *LM* – Lagrange multiplier test; for further explanation of variables see Materials and Methods

Source: authors' own calculations

to present all impacts – direct, indirect and total impacts (Table 4).

Combining the results from Table 3–4 leads us to the following interpretation. Direct payments are correlated with a negative impact on the Shannon index. The direct effect of the increase of direct payments by 1 000 EUR is associated with an on average 1.70-index point decrease of the Shannon index and a 1.40-index point decrease of the Simpson index. Total effects are slightly larger due to spill-over effects resulting in total effects of a 2.00-index point decrease in the Shannon index and a 1.5-index point decrease in the Simpson index. Spill-over effects or indirect effects occur because landscape diversity is also harmed by or benefits from payments in surrounding non-target municipalities.

Agri-environmental payments for negative impact-reducing measures (*AEP*1) have a positive and statistically significant effect on the Shannon index and the Simpson index. An increase of *AEP*1 by 1 000 EUR is associated with an on average 2.80-index point increase in the Shannon index and a 1.50-index point increase in the Simpson index.

The largest impact on diversity was observed in the case of agri-environmental payments for conservation (*AEP*2). *AEP*2 has a positive effect on both diversity measures. An increase of *AEP*2 by 1 000 EUR is associated with an on average 10.20-index point increase in the Shannon index directly and 2.10 indirectly, which comes to a 12.30-index point increase in total. Moreover, an increase of *AEP*2 by 1 000 EUR is also associated with an on average 7.50-index point increase in the Simpson index directly and 0.70 indirectly, which comes to an 8.10-index point increase in total.

Table 4. Direct, indirect and total impacts

Variables*	Shannon index			Simpson index		
	direct	indirect	total	direct	indirect	total
DP	–0.017	–0.003	–0.020	–0.014	–0.001	–0.015
*AEP*1	0.023	0.005	0.028	0.014	0.001	0.015
*AEP*2	0.102	0.021	0.123	0.075	0.007	0.081
*AEP*3	0.000	0.000	0.000	0.000	0.000	0.000
Size	0.000	0.000	0.000	0.000	0.000	0.000
*Natura*2000	0.018	0.004	0.022	0.000	0.000	0.000
Education	0.000	0.000	0.000	0.000	0.000	0.000
Age	0.003	0.001	0.004	0.000	0.000	0.001
Type	0.000	0.000	0.000	0.000	0.000	0.000
Fragmentation	0.006	0.001	0.007	0.004	0.000	0.004

**AEP* – agri-environmental payments; *DP* – total direct payments in the period; for further explanation of variables see Materials and Methods

Source: authors' own calculations

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A positive impact is also found in the case of Natura 2000. Areas under Natura 2000 are more likely to increase their diversity. A one percentage point increase in area covered under Natura 2000 is associated with a 1.80-index points increase in the Shannon index directly and 0.40 indirectly, which together give a 2.20-index point increase in total. However, we did not find any statistically significant effects of Natura areas on the Simpson index.

With respect to farmer characteristics, younger farmers below 25 years of age are found to be positively correlated with diversity (the Shannon index). And lastly, an increase in fragmentation increases diversity.

Our study indicates that direct payments have a statistically significant negative impact on landscape diversity in terms of richness and evenness. Similarly, Reger (2009) showed that direct payments support grassland as the most profitable farming system, which leads to low values of all habitat diversity indices. In addition, Brady et al. (2012) demonstrated a negative impact of direct payments on landscape mosaics, which become more homogenous in one marginal agricultural region in Sweden and have a relatively small effect in the second marginal agricultural region. However, they concluded that direct payments are potentially important for maintaining landscape values as their reduction results in land abandonment in one of the regions. This is supported also by Reger et al. (2009) who showed that direct payments may prevent land abandonment but may not counteract homogenisation in marginal landscapes. Conserving high farmland habitat diversity in such landscapes may require agri-environmental support schemes. In contrast, the study by Piorr et al. (2009) applied to the Italian case study region Mugello indicated that the phasing out of direct payments leads to a more homogenous landscape.

Moreover, our results show that agri-environmental payments are important for landscape diversity. Agri-environmental payments for reducing negative impacts on environment (*AEP*1) and those for conservation (*AEP*2) increase landscape diversity in terms of richness and evenness. However, we cannot claim that habitat protection payments (*AEP*3) have any statistically significant impact on landscape diversity at municipality level. The result concerning habitat-protection payments is expected as these measures receive only negligible funds. Although very few studies have examined the impacts of agri-environmental payments on landscape diversity, we can say that our findings are consistent with the findings of a recent study by Golobič and Lestan (2016). They positively assessed the majority of agri-environmental measures in Slovenian coastal regions.

In our study, we considered not only CAP measures but also a measure of nature conservation policy called Natura 2000. The latter represents a network of sites under environmental protection, where measures are undertaken to preserve traditional landscapes. Our results show that the pure nature conservation policy has a positive effect on landscape diversity, although the effect is not as strong as the effects of the CAP. In addition, as Piorr et al. (2009) concluded in their study, in marginal areas, particularly in Natura 2000 areas, a high share is turned into set-aside land, and without direct payments arable farming in these areas could not be maintained at all. Land abandonment and consequently a loss of landscape and habitat diversity would run contrary to the objectives of Natura 2000.

CONCLUSION

The current study contributes to the literature in the field by empirically confirming the positive correlation of agri-environmental payments with landscape diversity and the negative correlation of direct payments with landscape diversity in terms of richness and evenness. Since direct payments are almost four times as high on average as agri-environmental payments, they preserve landscape diversity only to a limited extent. A problem stemming from the low level of low agri-environmental payments compared to direct payments relates in particular to agri-environmental payments aimed at habitat protection, such as preserving grassland habitats and autochthonous and traditional plants. Also, pure nature conservation policy has a positive effect on landscape diversity, although the effect is not as strong as the effects of the agri-environmental payments.

We believe that policy decision-makers are interested in the question of the impact of high agricultural spending on agricultural landscapes and the sustainability of the countryside. New insights would help them to be successful in achieving the goals of sustainable agriculture. Also, we believe that this paper demonstrates the potential of spatial econometrics and its suitability for application in the field of sustainable agriculture.

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