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The capitalisation of decoupled payments in farmland rents among EU regions

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Abstract. We study the capitalisation of subsidies in the European Union (EU) regions in the years 2006-2008, the first years after the introduction of the Common Agricultural Policy (CAP) 2003 reform that decoupled subsidies from production and attached them to land. For this purpose, we use regional aggregated data and estimate the capitalisation rate upon the entire sample and, in a second stage, splitting the sample according to the implementation regime applied by the different EU Member States (MSs), following the three options introduced by the CAP regulations (historical, regional and hybrid model). We find that between 28 and 52 cents per Euro of additional subsidy capitalise into land prices in MSs that adopted the hybrid and the regional model, respectively. We find as well that subsidies do not capitalise in farmland prices in MSs that adopted the historical model.

Keywords: European Union, capitalisation of EU payments, land rental prices, spatial panel econometrics.
JEL codes: Q12, Q18.

1. INTRODUCTION

Farmland is by far the most valuable input in agricultural production. In the European Union (EU), land, alongside permanent crops and quotas, accounts for about 65% of total fixed assets of farms in 2012 and the figure rises to 80% when only farms specialised in field cropping are considered (European Commission - EU FADN, 2015). Accordingly, the theoretical and empirical literature paid much attention to the determinants of farmland prices.

Following the implementation of the 2003 Common Agricultural Policy (CAP) reform, EU subsidies have been decoupled from production and linked to land, increasing the likelihood that these payments get capitalised, in full or in part, in land prices and land rents (Ifft, Kuethe, & Morehart, 2015). The capitalisation of subsidies transfers the money intended to support EU agriculture out of the agricultural sector and, for this reason, the consequences of decoupling and payment harmonisation have recently become

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the focus of academic and policy studies (Gocht, Britz, Ciaian, & Paloma, 2013; Graubner, 2018; Kilian, Antón, Salhofer, & Röder, 2012; Klaiber, Salhofer, & Thompson, 2017; Michalek, Ciaian, & Kancs, 2014).

With the recent 2013 reform, the CAP moved in the direction of equalising payment across farms, which translated into the reduction of the level of subsidies for most countries and an increase for the few remaining Member States (MSs) (European Commission, 2013). In implementing the 2003 reform, MSs could choose between three different implementation schemes, with only two of them guaranteeing a harmonisation of the payments. The first option (historical model) was to assign a farm-specific level of payment reflecting the historical amount of support to that farm during a reference period. In this way, the reform kept unchanged the differences in the levels of payments across farms. The second option (regional model) was to assign a flat payment per hectare to each farm allowing the payment to vary across regions but not among farms in the same region. This second implementation option resulted in the harmonisation of payments at the regional level. The third option (hybrid model) was a combination of both, with a level of payment resulting from the sum of the historical and the regional components, weighing initially more and then progressively less the historical component. Although the hybrid model, unlike the regional model, did not realise the harmonisation of payment immediately, it put forward the design of a smooth transition toward this objective. MSs that adopted the historical model or the hybrid model without completing the harmonisation of payments are now requested to make a further step in this direction. Thus, understanding the consequences of this transition for the capitalisation of the payments in land prices and rents appears of crucial importance.

The econometric literature concerned with the capitalisation of coupled and decoupled payments is interested in estimating the capitalisation rate, that is, how much the farmland prices and rents increase following a rise in the payment received. A large part of the literature refers to the US and is relatively less recent, probably because the US introduced decoupled payments earlier than the EU (Goodwin, Mishra, & Ortalo-Magné, 2012; Kirwan, 2009; Lence & Mishra, 2003; Patton, Kostov, McErlean, & Moss, 2008; Roberts, Kirwan, & Hopkins, 2003). With the only exception of Lence & Mishra (2003), which use county-level data, all studies use farm-level data. Farm-level data are also used at the EU level to investigate the capitalisation of subsidies (Breustedt & Habermann, 2011; Ciaian & Kancs, 2012; Guastella, Moro, Sckokai, & Veneziani, 2018; Klaiber et al., 2017; Michalek et al., 2014; O'Neill & Hanrahan, 2016). The farm-level evidence in the EU is heterogeneous. At the root of such heterogeneity, there is the geographical coverage of the study (the countries and regions analysed, new MSs vs old MSs), the period of the data (pre-reform vs post-reform), the methodological approach (cross-section analysis, panel data analysis, quasi-experimental approaches) and the type of agricultural support (coupled vs decoupled subsidies). Notwithstanding this heterogeneity, there is a broad consensus that payments capitalise in farmland prices. In addition to the farm-level empirical literature, there is evidence from studies using spatially aggregated data, either at a very aggregate scale, such as the country level (van Herck, Swinnen, & Vranken, 2013) or at a very disaggregated scale such as the municipality level (Kilian, Antón, Salhofer & Röder, 2012; Nilsson & Johansson, 2013).

The present work contributes to this empirical literature by exploring the relationship between farmland rental prices and decoupled subsidies in the entire EU. To get comparable results across the EU, we aggregate farm-level data at the regional level and estimate the capitalisation rate using spatial econometric models. In addition, we allow the estimated capitalisation parameter to vary among regions according to the implementation regime adopted by the reference MS. The work aims at contributing to the policy debate as well. In the most recent CAP reforms, regions appear to be the designed entities to implement the harmonisation of agricultural payments. Hence an investigation at this level is deemed appropriate to understand the potential consequences of this reform for land markets in relation to the harmonisation strategy adopted by each MS.

Approaching the issue of payment capitalisation with spatially aggregated data has drawbacks and advantages. The gain of farm-level over spatially aggregated data is that with repeated observations over time it is possible to control for unobservable heterogeneity related to the quality of land, undoubtedly among the most important determinants of the farmland price. As a drawback, such heterogeneity likely disappears when data for different land parcels are aggregated at a larger spatial scale. The availability of microdata, however, comes at the price of the limited variation of the dependent variable, farmland rents, over time, when the observed price comes from long-term rental agreements that weakly react to changes in subsidies. Hence, an advantage of using spatially aggregated data is the possibility to capture regional trends in land prices that are not subject to price stickiness. Another advantage of using aggregated data is the coherence with the policy objective of the 2003 reform, the convergence of agricultural subsidies to a fixed per hectare amount at the regional level. As the agricultural subsidy is gradually converging to a fixed regional amount, the comparison across territories, rather than across farms, should be more suitable for understanding and analyse the capitalisation of the Single Farm Payment (SFP).

In the remainder of the paper, we briefly introduce in the next section the policy framework framed by the recent reforms and provide a description of the data and the empirical approach in section three. We present the estimation results of the spatial econometric model in section four. A discussion concludes the work.

2. THE CAP REFORM: DECOUPLING AND HARMONISATION

The CAP process of decoupling dates back to 1992, with the MacSharry reform that introduced area payments for arable crops, awarded to all farmers sowing cereals, oilseeds and protein crops, provided they were setting aside a fixed share of arable cropland. Area payments were based on regional historical yields, thus introducing heterogeneity across the EU, with the intent of keeping support at the pre-reform level. Being still linked to production and differentiated by crop, these payments were only partially decoupled. This setting was maintained under the next Agenda 2000 reform in 1999.

In 2003, under the so-called Fischler reform, a radical change of agricultural support was undertaken. Area payments converted into an SFP, whose rights were linked to land but progressively decoupled from production. The introduction of the SFP is the key element of the Fischler reform. Other important innovations are cross-compliance (i.e., payments made conditional to fulfilling a number of requirements concerning land maintenance and other agro-ecological provisions) and modulation (i.e., aiming at transferring support away from the largest farms and finance other voluntary measures of the CAP). The reform implementation followed three different schemes. In the historical scheme, the SFP simply reflected the amount of support historically received by the farm during a reference period (the three years 2000-2002), thus leaving unchanged the differences in the level of support among farms, with no redistribution within a certain area/region. Under the regional scheme, within a certain area/region the per-hectare payment was equalised, making it equal to the amount of historical support in that region divided by the eligible land. In other words, the regional scheme allowed to redistribute and harmonise support within each region but keeping differences across regions. Finally, the hybrid scheme was a combination of the previous two schemes; at the area/region level the per-hectare payment was made up by two components: the first computed on a historical basis, and the second computed according to the regional model. Thus, this option maintained some differences across farms, progressively reduced by transferring support from the historical to the regional component. However, a common feature of the three schemes was to preserve some payment differences across regions in the same MS. In figure 1, we report the distribution of the three implementation schemes of the 2003 CAP reform across the EU regions. The 2013 or Cioloş reform, while modifying the structure of the direct payments, aimed at a more equitable distribution of support among areas and farmers, to be achieved by mean of both a process of external convergence across MSs and a process of internal (full or partial) convergence, across farmers within the same MS or region. Through the external convergence process, by 2020 the MSs receiving less than 90% of the EU average payment in 2013 will increase such payment in order to close at least one-third of this gap and will not receive less than an agreed minimum payment level (196 euro/ha). Payments will thus become more homogenous, although not perfectly equal, across MSs. With the internal convergence process, payments are going to be harmonised within each MS, or specific regions inside each MS. Three options are available: full convergence, with a flat rate to be reached either by 2015 or by 2019 and partial convergence, in which some differences across farmers are still maintained.

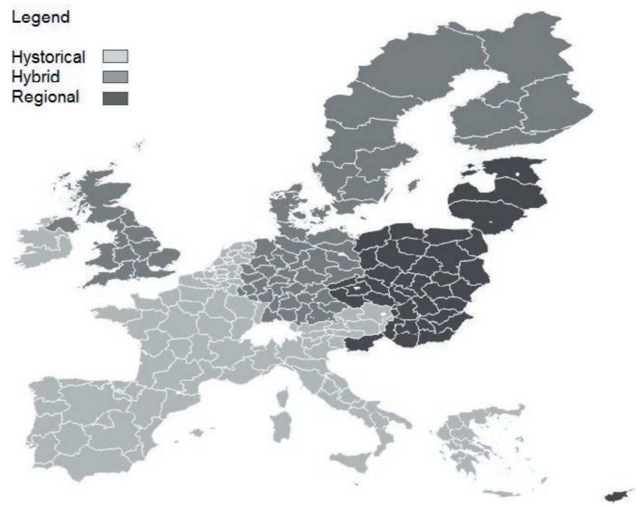

Figure 1. EU regions adopting different implementation schemes of the CAP 2003 reform.

3. EMPIRICAL STRATEGY AND DATA

For the empirical analysis, we borrow the theoretical framework from Lence & Mishra (2003) and use their equation 1 to estimate the capitalisation rate. The dependent variable r_{it} is the average price of land rents in region i at time t. The use of farmland rents instead of values is widespread in capitalisation studies and also brings the advantage that rents more than values can be directly related to market returns, being less sensitive to other location factors (Borchers, Ifft, & Kuethe, 2014). To explain the variation in farmland rents, we use the information on the average productivity including the X matrix, whose $j=1,2,\ldots,J$ columns represent the average productivity of the j^{th} sector weighted by the share of total area farmed in each sector. The set of variables captures the structural differences in agricultural production among European regions that can influence farmland rents. Mediterranean regions, for instance, characterised by a significant share of land employed in high-value agricultural production from permanent crops, olives, grapes, and related transformed products, are expected, other things being equal, to exhibit higher rental prices.

The variable of interest is the average per-hectare amount of subsidies (S) received by farms in region i at time t, and γ is the associated coefficient which expresses the capitalisation rate. The equation also includes region-specific effects β_i that account for structural differences among regions due to unobservable factors. Z is a matrix of control variables.

$$r_{it} = \beta_i + \sum_{k=1}^{K} \beta_k X_{k,it} + \gamma S_{it} + \delta Z_{it} + \varepsilon_{it} \tag{1}$$

Differently from Lence & Mishra (2003), who consider two agricultural outputs only, and from EU studies that consider aggregate measures of either productivity (Breustedt & Habermann, 2011) or market returns (Ciaian & Kancs, 2012), we consider multiple outputs to capture the considerable heterogeneity in the composition of aggregate agricultural production in the EU regions. More specifically, total production is divided into k=7 output categories, namely, arable crops (including cereals, proteins, potatoes, sugar beet, oilseed and industrial crops), vegetables and flowers, fruits, wines and grapes, olives, forage crops and other crops[1].

The decoupled payments are measured as the monetary amount disbursed as SFP under the Single Payment Scheme (SPS) for the old MSs (EU15) and under the Single Area Payment Scheme (SAPS) for the new MSs (EU10). Since the amount of the subsidy per hectare is perfectly known, we exclude any endogeneity caused by the problem of expectation errors discussed in Lence & Mishra (2003) and Patton, Kostov, McErlean, & Moss (2008).

The matrix Z includes a list of controls to account for characteristics expected to impact on farmland rent variation. In particular, we control for the average size of farms (*SIZE*); the average share of family labour (*FAMLAB*); the average capital per ha (*FIXASS*); the animal density (*ANIMALD*); the average share of rented to total Utilised Agricultural Area (UAA) (*RENTPROP*). We expect a negative coefficient related to farm size because larger farms have substantially more power to bargain in the land markets. At the same time, it is essential to acknowledge that large farms are more efficient and thus, willing to pay higher land rents. The outcome depends on which effect will prevail, on average. Besides farm size, family labour, and fixed assets control for the managerial approach to farming in the regions. In regions where farmers adopt a managerial approach to agricultural activity, the market for land is expected to be more dynamic. Consequently, farmland rents should be higher. The animals' density controls for the higher farmland rents generated by the demand for land for manure spreading, as a result of the nitrate directive. A higher animal density, related to more productive and profitable activities, implies an increase in the demand for land, thus driving up rents. Nonetheless, the high density of animals is also a characteristic of regions specialised in livestock production to the largest extent. The share of permanent grassland in these areas can be in fact very high, leading to a spurious negative relationship between farmland rents and animal density due to the unobserved quality of land, that may be lower in regions specialised in livestock production. Finally, the theoretical hypothesis that all land is the property of landowners and rented to farmers at the equilibrium rental price might appear simplistic, especially in some EU regions. On average, almost 50% of land used in agriculture is rented, but this figure masks considerable heterogeneity among territories in Europe (European Commission - EU FADN, 2015). The proportion of rented land controls for the increase in the average value of rents due to the limited supply of land for rent.

Following the discussion presented in the previous section, the likelihood of subsidy capitalisation is higher in case the regional model is adopted compared to the historical model. In the latter case, the extent of capitalisation is determined by the relative abundance of eligible hectares, required to activate the payment, com-

[1] The aggregation of agricultural activities in sectors is based on the classification scheme provided with the FADN data.

pared to the number of entitlements. To assess the structural differences in capitalisation rates among regions in MSs that adopted different implementation regimes, the model in equation 1 is modified allowing the capitalisation parameter γ to vary according to the implementation regime in equation 2, where *HIS*, *HYB* and *REG* are dummy variables indicating whether region *i* belong to a MS that adopted the historical, hybrid or regional model, respectively.

$$\gamma = \gamma_1 HIS_i + \gamma_2 HYB_i + \gamma_3 REG_i \tag{2}$$

Since the structural characteristics of the implementation regime may also condition the effect of the land market in general, not only of the capitalisation process, we extend the structural heterogeneity approach in equation 2 to all the parameters of the model.

Both the models in equation 1 and 2 are estimated using linear panel data models. Since the observations in the sample are related to spatial units, the standard linear model residuals independence assumptions may be violated. We thus correct the specification assuming a spatial autocorrelation structure of the residuals and estimate a spatial error model (SEM, equation 4).

$$\begin{cases} r_{it} = \beta_i + \sum_{k=1}^{K} \beta_k X_{k,it} + \gamma S_{it} + \delta Z_{it} + \varepsilon_{it} \\ \varepsilon_{it} = \lambda \sum_{j=1}^{J} w_{ij} \varepsilon_{it} \end{cases} \tag{3}$$

Alternative spatial econometric model specifications can account for unobserved spatial heterogeneity, omitted spatially correlated variables and spatial spillovers. LeSage & Pace (2009) provide an extensive review of the possible motivations leading to spatial correlation in data and an overview of testing procedures to select the correct specification based on observed data.

In this paper, we take a different perspective. The choice to consider structural heterogeneity in the deterministic part of the model, that is to allow the capitalisation and other parameters to vary depending on the implementation regime, invites to leave the spatial autocorrelation issues in the error term and to exclude the other three prevalent specifications, the spatial autoregressive model (SAR), the spatial Durbin model (SDM) and the model with the spatial lag of the covariates (SXL). In principle, it is possible to account for structural heterogeneity also in these models. That would result, however, in very complex expressions for the marginal effect, among the others, of subsidies on farmland rents and, hence, of the capitalisation rate. The SEM model, differently from the SAR, the SDM and the SXL models, is the only one that does not consider spatial processes in the deterministic part of the model and allows a direct interpretation of the coefficients as the marginal effects. This characteristic appears very useful when dealing with structural instability. However, we test the robustness of this choice (and of the results) and estimate the most common alternative to the SEM model, the SAR model.

In both the spatial models without and with the structural heterogeneity, the spatial weight matrix *W* identifies neighbourhood relationships through its elements w_{ij} that express the inverse distance from region *i* to its neighbour *j* if the distance is lower than a threshold d^* and 0 otherwise[2].

The dataset used to estimate the capitalisation effect comprises 208 NUTS regions belonging to the EU25 countries. More precisely, NUTS II classification is the territorial reference for all countries but the UK and Denmark, where NUTS I and NUTS 0 is used instead, respectively. The choice is consistent with the design of the FADN survey data, which is stratified by regions, agricultural specialisation, and size, and hence returns reliable estimates of the values of interest by aggregating at the regional or higher level[3].

Regional data are available in the FADN database for the whole period 2003-2008 for the EU15 and starting from 2005 for the EU10. However, since some countries implemented decoupling after 2005 only, data for the SPS payments are available only from 2006 for the complete set of regions. Romania and Bulgaria are excluded from the analysis because data collection started in 2007. We compute the distance between each pair of regions based on geographical coordinates available in the reference files of the Geographical Information System of the EU Commission (GISCO). Since Atlantic islands are considered too far for any spatial relation with continental regions to exist, these regions are excluded from the sample. The threshold distance to define contiguity between regions (d^*) is 500 km and is appropriate to describe the spatial structure of connectivity links, although arbitrary. In particular, the 500

[2] As usual and required, the elements of the matrix are row standardised and the diagonal elements are set to zero to exclude self-contiguity. The choice of the distance-based approach is made to avoid cases of self-contiguity only.

[3] We exclude accordingly the Local Administrative Units (LAU, in the Eurostat Nomenclature) used in Kilian, Antón, Salhofer & Röder (2012) and Nilsson & Johansson (2013) because the FADN aggregates are not representative at this level. We also exclude the country level used in van Herck, Swinnen, & Vranken (2013) because land rents vary significantly across regions of the same country, especially in some Member States (MSs), and we want to preserve this heterogeneity in our empirical analysis.

Table 1. Description of the dataset.

Variable	Description
RENT	Average rent paid (euro/ha)
AC	Output value – Arable crops (euro/ha)
VF	Output value – Vegetables and Flowers (euro/ha)
FR	Output value – Fruits (euro/ha)
WG	Output value – Wines and grapes (euro/ha)
OO	Output value – Olives (euro/ha)
FC	Output value – Forage crops (euro/ha)
OC	Output value – Other crops (euro/ha)
SFP	Average payment received under SAPS or SPS (euro/ha)
SIZE	Average farm size (ha)
FAMLAB	Share of family to total labour (%)
FIXASS	Value of Fixed Assets (Machinery and Equipment) (euro/ha)
ANIMALD	Number of animal units per ha (count in livestock equivalent)
RENTPROP	Proportion of rented UAA (%)

km cut-off distance ensures that every region has at least one neighbour and that, in turn, each row of the weight matrix has at least a non-zero element.[4]

The 208 regions in our dataset are observed for three years. To build the dataset, we used 153,069 original farm-level observations, excluding the outliers showing unreasonable values of average productivity and payments[5]. Table 1 describes the main variables used for the land rental price model, and Table 2 provides some useful descriptive statistics. The average farmland rent, which is the total rent paid by the farmers in the region excluding rent paid for quotas and other things not attached to land over the total rented area, was about 171 euro per hectare in 2006 and increased to 176 in 2008. The largest value of production per ha in 2006 accrued to farms producing vegetables and flowers followed by fruits and wines and grapes and all values changed little during the three years. This substantial heterogeneity indicates that an empirical specification that considers the composition of agricultural production is appropriate in the case of EU regions. The average value of the SFP per ha was 256 euro in 2006 and increased to 298 in 2008. The figure related to the contribution of family labour is unsurprisingly high, since, on average, almost two over three hours are worked by family members. Also, two-thirds of the available UAA in the regions is rented, and the figure looks relatively stable over time. This high proportion of rented land suggests both that an analysis of SFP capitalisation at the EU level is appropriate and that rental prices, rather than sale prices, should be considered for this purpose.

4. RESULTS

We perform the empirical estimation of the land price model using different estimators and summarise all the results in Table 3. The first column of the table reports the estimation results using the Pooled OLS, from which we get an estimate of the capitalisation rate for subsidies of 26% (26 cents per additional Euro). The estimate substantially lowers when introducing in the specification individual effects, either as fixed (second column) or random (third column) effects. Assuming fixed effects also leads to an estimate of the capitalisation rate that is not statistically different from zero. This result looks reasonable because both the rental price and the subsidy variables show very limited within variation, partly because of structural rigidities and partly as a consequence of the short time dimension of the panel.

In contrast, assuming random effects, we get a significant, although low, capitalisation rate, estimated at 4.3%. We get similar results in the case of spatial models. With both specifications (SAR and SEM), the use of fixed effects (columns 4 and 6) leads to lower in magnitude and insignificant capitalisation rates, opposite to the random effect specification (columns 5 and 7). The only noticeable difference with the non-spatial model is that the coefficient estimates for the capitalisation rate lower down to 3%.

In both spatial and non-spatial models we get positive and statistically significant coefficients for the "Arable crops" and "Vegetables and flowers" categories, but only in the spatial models, and independently of the specification, we also get positive and statistically significant coefficients for the "Fruits" and "Wines and Grapes" categories. Thus, spatial models seem more capable to capture the geographical concentration of specific productions in particular regions of Europe, typically the regions of the Mediterranean countries.

The use of spatial specifications leads to more significant results, also in the case of the control variables. For instance, it is the case of the coefficient of the FAMLAB variable, which is insignificant in the POLS model, significant in the FE model and always significant in the

[4] Alternative distances have been tested, and the estimate and significance of the capitalisation rate appears not affected. Only minor changes can be noticed in relation to the control variables.

[5] Outliers are not necessarily the result of reporting errors. Rather they are closely related to the accountancy nature of the database and appear because some monetary values may be reported in a different accounting year, for instance, in the case of subsidies, because of delayed payments.

Table 2. Summary statistics of the variables.

	2006			2007			2008		
	Mean	(SD)	[min; Max]	Mean	(SD)	[min; Max]	Mean	(SD)	[min; Max]
RENT	171.411	(124.353)	[8.25;583.57]	173.611	(123.860)	[9.82;609.81]	176.058	(124.688)	[12.03;656.35]
AC	1287.311	(1514.206)	[0;15428.92]	1499.436	(1583.810)	[0;15475.54]	1598.579	(2063.647)	[0;18560.53]
VF	10379.490	(11748.030)	[0;96182.79]	10705.340	(11094.790)	[0;70163.73]	11880.270	(13328.370)	[0;76807.57]
FR	5594.956	(6158.491)	[0;35745.33]	12143.420	(83190.780)	[0;1181033]	9896.156	(44404.570)	[0;621233.4]
WG	4142.775	(8783.751)	[0;63246.45]	5205.113	(13893.260)	[0;139150]	5161.718	(11601.920)	[0;82500]
OO	455.659	(1156.293)	[0;10062.25]	479.537	(1212.344)	[0;9379.722]	549.385	(1434.236)	[0;10297.3]
FC	181.831	(285.286)	[0;2074.19]	187.035	(245.419)	[0;1473.687]	212.475	(284.639)	[0;1359.38]
OC	29229.110	(111487.700)	[0;1249723]	34359.420	(209769.100)	[0;2865080]	16822.680	(36829.070)	[0;282031.3]
SFP	256.108	(128.571)	[31.45;626.06]	270.722	(131.702)	[36.46;610.11]	298.738	(178.626)	[47.711;1367.23]
SIZE	10.763	(28.564)	[0.05;236.99]	11.254	(30.441)	[0.08;210.84]	11.885	(34.100)	[0.07;298.81]
FAMLAB	0.677	(0.270)	[0.02;1.0]	0.672	(0.269)	[0.01;1]	0.668	(0.269)	[0.01;0.99]
FIXASS	4668.559	(6322.787)	[285.67;65261.51]	4976.150	(7887.282)	[363.92;80204.6]	5091.916	(8355.090)	[483.39;85890.15]
ANIMALD	1.129	(1.323)	[0;12.05]	1.128	(1.379)	[0;11.72]	1.152	(1.418)	[0;11.22]
RENTPROP	0.674	(0.175)	[0.26;0.99]	0.676	(0.177)	[0.23;0.98]	0.683	(0.175)	[0.17;0.97]

Table 3. Estimates of the rental price equation, EU regions, 2006-2008.

	POLS	FE	RE	SAR FE	SAR RE	SEM FE	SEM RE
X_{AC}	0.114***	0.037**	0.065***	0.036***	0.059***	0.043***	0.072***
	(0.008)	(0.017)	(0.011)	(0.007)	(0.008)	(0.008)	(0.009)
X_{VF}	0.014***	0.018***	0.014***	0.018***	0.014***	0.018***	0.013***
	(0.003)	(0.005)	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)
X_{FR}	0.014***	0.006	0.009	0.007*	0.008**	0.008**	0.009**
	(0.004)	(0.012)	(0.01)	(0.004)	(0.004)	(0.004)	(0.004)
X_{WG}	0.016	0.039	0.042	0.039***	0.038***	0.033***	0.026**
	(0.014)	(0.045)	(0.035)	(0.012)	(0.012)	(0.011)	(0.012)
X_{OO}	-0.085***	0.009	0.001	0.012	0.006	0.011	0.000
	(0.027)	(0.016)	(0.01)	(0.009)	(0.011)	(0.009)	(0.011)
X_{FC}	-0.007	-0.020	-0.024	-0.020	-0.007	-0.031	-0.016
	(0.028)	(0.044)	(0.031)	(0.019)	(0.021)	(0.019)	(0.023)
X_{OC}	-0.038*	-0.068**	-0.065**	-0.068***	-0.063***	-0.069***	-0.063***
	(0.019)	(0.027)	(0.026)	(0.006)	(0.007)	(0.006)	(0.007)
SFP	0.261***	0.007	0.043**	0.007	0.030**	0.004	0.032**
	(0.025)	(0.022)	(0.019)	(0.009)	(0.012)	(0.01)	(0.015)
SIZE	-1.910	-3.707	-9.024*	-5.299	-11.100***	-7.806*	-16.020***
	(3.222)	(9.246)	(5.178)	(4.229)	(3.362)	(4.437)	(4.148)
FAMLAB	-16.960	-124.900**	-44.367	-120.345***	-72.557***	-126.988***	-98.005***
	(18.733)	(55.197)	(31.01)	(21.981)	(18.662)	(21.854)	(20.803)
FIXASS	12.470**	14.328	26.844***	12.928***	18.333***	12.644**	21.791***
	(5.718)	(11.32)	(6.689)	(4.766)	(4.862)	(4.883)	(5.637)
ANIMALD	28.176***	1.439	14.130***	1.830	10.995***	2.194	11.304***
	(2.804)	(5.859)	(4.266)	(2.437)	(2.505)	(2.415)	(2.629)
RENTPROP	-155.691***	-124.286*	-134.619***	-121.159***	-127.441***	-126.147	-138.694***
	(21.964)	(69.663)	(37.023)	(22.724)	(21.196)	(22.422)	(22.535)
				0.206***	0.557***		
				(0.062)	(0.044)		
						0.346***	0.950***
						(0.068)	(0.018)

Notes to table: SE in parenthesis. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels respectively. ρ and λ are the spatial parameters in thee equations 2 and 3.

spatial FE and RE models. For the FIXASS and RENTPROP variables, the coefficients are weakly significant, or altogether insignificant, when estimated with FE and turn highly significant in all the spatial models. At least for the FIXASS variable, the FE estimation in both spatial and non-spatial models underestimates the coefficient compared to the RE specification. The same happens with the ANIMALD and SIZE variables, which are significant in RE models only.

The more significant results obtained with the use of RE specifications in spatial and non-spatial models find justification in the very short time dimension of our panel, which causes structurally low within variation in all variables. Building on this evidence, we prefer to resort to RE effect specification. Moreover, we note from the results in Table 3 that all the coefficients have the correct signs and similar magnitude across all specifications. Considering the spatial models only, we get positive estimates of the coefficients associated with all the weighted outputs but "Other crops" which makes sense, since it is our residual category. We also get a positive estimate of the coefficient related to the SFP variable. The negative coefficient related to SIZE means that larger farms pay, on average, lower rents; the negative coefficient for FAMLAB and the positive one for FIXASS indicate that more managerial farms pay lower than expected rents, other things equal; the negative coefficient for RENTPROP is consistent with the hypothesis on the functioning of land markets. This evidence allows concluding against the hypothesis of a severe unobserved heterogeneity bias caused using random effects.

Confronting the spatial models, both the SAR and the SEM produce equivalent results, at least regarding estimated coefficients[6]. In addition, the spatial parameters are always positive and statistically significant. It is possible to notice that the estimated spatial parameter is higher in the RE model, and that provides an indication that the spatial component in the RE models also accounts for the spatial heterogeneity otherwise accounted for by the FE.

One significant advantage of the SEM specification over the SAR is that it allows easy manipulations of the model in the case of sample splitting, representing the most convenient way to manage the structural instability of the parameters[7]. We benefit of this property of the SEM specification to investigate the extent to which the estimated capitalisation rate varies across groups of regions defined according to the choice made by each MS on the implementation scheme of the SFP.

In Table 4, we report the estimation results that consider the structural heterogeneity of the parameters across the three groups of regions in figure 1, adopting the regional, hybrid and historical schemes, respectively. In other words, we allow the coefficients β, γ, and δ in equation 3 to vary across schemes (equation 4).

We find out less significant results related to the sectoral productivities of regions. The fact that we allow for time-invariant effects across regimes with regime-specific intercepts may explain this evidence, assuming that the differences in productivities among regions in

Table 4. Estimation results by implementation regime, EU regions, 2006-2008.

	regional	hybrid	historical
Intercept	-32.130	125.905	63.993
	(113.334)	(117.884)	(54.181)
X_{AC}	0.028	0.095***	0.079***
	(0.034)	(0.023)	(0.009)
X_{VF}	0.075	0.027**	0.010***
	(0.091)	(0.012)	(0.003)
X_{FR}	0.044	0.001	0.022***
	(0.18)	(0.007)	(0.007)
X_{WG}	0.048	-0.001	-0.002
	(0.158)	(0.044)	(0.013)
X_{OO}	1.971	0.002	-0.010
	(1.986)	(0.035)	(0.011)
X_{FC}	-0.165		-0.057**
	(0.12)		(0.028)
X_{OC}	-0.014	0.031	-0.080***
	(0.334)	(0.071)	(0.01)
SFP	0.519*	0.284***	0.017
	(0.306)	(0.105)	(0.013)
SIZE	-1.383	-16.664	-11.249**
	(9.614)	(10.513)	(4.718)
FAMLAB	-16.619	-49.949	-148.380***
	(75.689)	(44.21)	(29.749)
FIXASS	3.701	5.525	40.090***
	(11.315)	(13.319)	(6.284)
ANIMALD	-7.626	50.313***	10.022***
	(22.161)	(15.219)	(2.559)
RENTPROP	15.194	-147.330**	-168.624***
	(96.804)	(62.922)	(24.307)
λ	0.430***		
	(0.084)		

Notes to table: SE in parenthesis. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels respectively. λ is the spatial parameters in the equation 3.

[6] For the SAR model the coefficients are not directly interpretable. Instead the computation of partial derivatives is necessary, differently from the SEM case. However, for the purpose of model comparison, it is sufficient to look at the actual estimates. The estimates of the direct, indirect, and total effects are available upon request.

[7] Again, primarily because the SEM model is the only one allowing the direct interpretation of the estimated parameters.

the same regime are limited. In general, the estimated coefficients related to productivities are more significant in the *historical* regime compared to the *regional* regime.

We get similar results estimating the coefficients for the control variables, with overall evidence of a better fit in the case of the *historical* and *hybrid* models compared to the *regional* model. All the coefficients show the expected sign and, with few exceptions, these are also consistent across regimes, although they vary in magnitude, as expected.

The most interesting result concerns the capitalisation rates, estimated at 52%, 28% and 2% in case the MSs adopted the regional, the hybrid, or the historical model, respectively. The estimated value in the case of MSs adopting the historical model is, however, not statistically different from zero. In the case of the hybrid model, we get a very significant result, and in the case of the regional model, the null hypothesis is rejected at the 10% significance level in a standard two-tail test. Considering that the capitalisation rate can only be larger than zero, a one-tail test may also be appropriate, and this would reject the null hypothesis at a lower significance level (5%).

5. DISCUSSION AND CONCLUSION

In 2013, the CAP reform marked an important step toward the convergence in the level of farm support across the different territories of the EU. The last reform, like the previous ones, has generated a vigorous debate about the possible impact of farm payments on input prices, and in particular on farmland rents. Payments decoupled from production and attached to land increase, in fact, the possibility of capitalisation, a side effect which should be taken into account when planning the redistribution of farm support.

The existing empirical literature on the capitalisation of agricultural subsidies in farmland rents in Europe consistently reports evidence of capitalisation, but the estimated rate varies widely across studies. The geographical coverage of the studies, usually narrow (one region), is among the reasons of such heterogeneity, together with the regime adopted by the reference MS for the 2003 reform for introducing the SFP. This type of payments is, in fact, intrinsically related to land, and this condition is expected to increase the rate of capitalisation compared to coupled subsidies. The extent of the phenomenon is however related to contextual factors such as land market imperfections (Ciaian and Swinnen, 2006) and the availability of entitlements compared to eligible hectares (Ciaian, Kancs, and Swinnen, 2008). Most importantly, the implementation regime could have influenced the rate of capitalisation (Kilian and Salhofer, 2008; Kilian et al., 2012) in the context of the 2003 reform. The three schemes available to implement the 2003 reform differ from each other regarding the perspective harmonisation. Almost all the MSs applying the regional model are NMS and, due to their recent admission to the EU, the regional scheme with harmonised payments was for them the first and unique scheme of payment adopted. Only a few MSs experienced a direct transition from the coupled payments to a decoupled payment scheme with harmonised payments across farms, while many MS preferred to link the level of decoupled payments to the historical coupled payments. Following the 2013 reform, these Ms are experiencing a process of gradual harmonisation of payments. Some other MS chose the hybrid model that implemented some partial harmonisation of payments during the years preceding the 2013 reform. The regional regime, which foresees an equal payment per hectare among farmers, may have facilitated the capitalisation and the leakage of subsidies out of the agricultural sector. Now that the 2013 reform is being implemented a further step in the direction of payment harmonisation is made (Ciaian, Kancs, & Swinnen, 2014). Thus, understanding the extent to which the harmonisation is responsible for higher capitalisation becomes even more relevant.

This work frames into this stream of theoretical and empirical debate about the influence of the implementation regime on agricultural payment capitalisation. We estimate the capitalisation rate using regional aggregate data from countries that adopted different implementation regimes and show how the estimated capitalisation varies across regimes. Consistently with the previous theoretical analysis, we find cross-sectional evidence of structural heterogeneity in the capitalisation rate among regions from member states that implemented the historical, hybrid, and regional regimes. When estimation is conducted on the full sample of European regions, results suggest that 3 cents per additional Euro of payment get capitalised into the land price, which is quite a modest result compared to existing evidence: in Europe, the capitalisation rate of decoupled subsidies has been previously estimated at between 18 and 20 cents in NMS (Ciaian and Kancs, 2012); between 25 and 77 cents in Germany (Kilian et al., 2012); between 8 and 76 cents in Sweden (Nilsson and Johansson, 2013). When considering the implementation regimes separately, it is found that as much as 52 cents per Euro get capitalised into the land price in MS that adopted the regional regime. Only 28 cents per Euro are capitalised in MSs that adopted the hybrid regime, and there is no evidence of capitalisation in MSs that adopted the historical regime.

These results add substantial evidence to the hypothesis that an equal payment for all farms in the same region is the scheme producing the highest capitalisation rate. The result is robust to the inclusion of other variables that drive farmland rents and to the use of econometric techniques that explicitly take the geographical position of the region and its neighbouring relationship into account. Unfortunately, the data source does not provide additional information about how the scheme has been implemented in each MS, and among regions in each MS. Thus, from the evidence in the study, it is not possible to infer any causal effect of the implementation scheme adoption on the capitalisation rate.

Based on our results, we conclude that in MSs that applied the historical model, the decoupled SFP did not capitalise into land prices, but, since these MSs are now experiencing the transition toward the full harmonisation of payments, the likelihood that this transition will bring the capitalisation of subsidies is very high. MSs that applied the hybrid scheme, in fact, already started the process of harmonisation and the payments have been capitalised since the very first years after the introduction of the SFP, although to a lower extent as compared to MSs that implemented the regional scheme.

Thus, in general, our results emphasise the role of policy design in determining a crucial outcome such as the capitalisation of agricultural subsidies in farmland prices. The application of a general policy objective, such as decoupling subsidies from production and attaching them to land, may lead to very different outcomes depending upon the implementation details. In the case of the CAP 2003 reform, the crucial elements of the policy design have been the rules governing the distribution of the payment entitlements and their linkage to the eligible hectares of agricultural land. This is of course extremely relevant for policymakers, in view of any further reform of the policy.

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REFERENCES

Borchers, A., Ifft, J., & Kuethe, T. (2014). Linking the Price of Agricultural Land to Use Values and Amenities. *American Journal of Agricultural Economics*, *96*(5), 1307–1320. https://doi.org/10.1093/ajae/aau041

Breustedt, G., & Habermann, H. (2011). The Incidence of EU Per-Hectare Payments on Farmland Rental Rates: A Spatial Econometric Analysis of German Farm-Level Data. *Journal of Agricultural Economics*, *62*(1), 225–243. https://doi.org/10.1111/j.1477-9552.2010.00286.x

Ciaian, P., & Kancs, d'Artis. (2012). The Capitalisation of Area Payments into Farmland Rents: Micro Evidence from the New EU Member States. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie*, *60*(4), 517–540. https://doi.org/10.1111/j.1744-7976.2012.01256.x

Ciaian, P., Kancs, D. & Swinnen, J. (2014) The Impact of the 2013 Reform of the Common Agricultural Policy on Land Capitalization in the European Union, *Applied Economic Perspectives and Policy*, 36(4), 643–673, https://doi.org/10.1093/aepp/ppu016

European Commission - EU FADN. (2015). *EU Farm Economics Overview based on 2012 FADN data*. Brussels, Belgium: European Commission.

Gocht, A., Britz, W., Ciaian, P., & Paloma, S. G. y. (2013). Farm Type Effects of an EU-wide Direct Payment Harmonisation. *Journal of Agricultural Economics*, *64*(1), 1–32. https://doi.org/10.1111/1477-9552.12005

Goodwin, B. K., Mishra, A. K., & Ortalo-Magné, F. (2012). The buck stops where? The distribution of agricultural subsidies. In J. S. Graff Zivin & J. M. Perloff, *The Intended and Unintended Effects of USS Agricultural and Biotechnology Policies*. University of Chicago Press.

Graubner, M. (2018). Lost in space? The effect of direct payments on land rental prices. *European Review of Agricultural Economics*, *45*(2), 143–171. https://doi.org/10.1093/erae/jbx027

Guastella, G., Moro, D., Sckokai, P., & Veneziani, M. (2018). The Capitalisation of CAP Payments into Land Rental Prices: A Panel Sample Selection Approach. *Journal of Agricultural Economics*, *69*(3), 688-704 . https://doi.org/10.1111/1477-9552.12258

Ifft, J., Kuethe, T., & Morehart, M. (2015). The impact of decoupled payments on USS cropland values. *Agricultural Economics*, *46*(5), 643–652. https://doi.org/10.1111/agec.12160

Kilian, S., Antón, J., Salhofer, K., & Röder, N. (2012). Impacts of 2003 CAP reform on land rental prices and capitalisation. *Land Use Policy*, *29*(4), 789–797. https://doi.org/10.1016/j.landusepol.2011.12.004

Kirwan, B. E. (2009). The Incidence of USS Agricultural Subsidies on Farmland Rental Rates. *Journal of Political Economy*, *117*(1), 138–164. https://doi.org/10.1086/598688

Klaiber, H. A., Salhofer, K., & Thompson, S. R. (2017). Capitalisation of the SPS into Agricultural Land Rental Prices under Harmonisation of Payments. *Journal of Agricultural Economics*, n/a-n/a. https://doi.org/10.1111/1477-9552.12207

Lence, S. H., & Mishra, A. K. (2003). The Impacts of Different Farm Programs on Cash Rents. *American Journal of Agricultural Economics*, *85*(3), 753–761. https://doi.org/10.1111/1467-8276.00480

LeSage, J., & Pace, R. K. (2009). *Introduction to Spatial Econometrics*. (C. R. C. Press, Ed.).

Michalek, J., Ciaian, P., & Kancs, d'Artis. (2014). Capitalisation of the Single Payment Scheme into Land Value: Generalised Propensity Score Evidence from the European Union. *Land Economics*, *90*(2), 260–289. https://doi.org/10.3368/le.90.2.260

Nilsson, P., & Johansson, S. (2013). Location determinants of agricultural land prices. *Jahrbuch Für Regionalwissenschaft*, *33*(1), 1–21. https://doi.org/10.1007/s10037-012-0071-4

O'Neill, S., & Hanrahan, K. (2016). The capitalisation of coupled and decoupled CAP payments into land rental rates. *Agricultural Economics*, *47*(3), 285–294. https://doi.org/10.1111/agec.12229

Patton, M., Kostov, P., McErlean, S., & Moss, J. (2008). Assessing the influence of direct payments on the rental value of agricultural land. *Food Policy*, *33*(5), 397–405. https://doi.org/10.1016/j.foodpol.2008.01.001

Roberts, M. J., Kirwan, B., & Hopkins, J. (2003). The Incidence of Government Program Payments on Agricultural Land Rents: The Challenges of Identification. *American Journal of Agricultural Economics*, *85*(3), 762–769. https://doi.org/10.1111/1467-8276.00481

van Herck, K., Swinnen, J., & Vranken, L. (2013). Capitalisation of direct payments in land rents: evidence from New EU Member States. *Eurasian Geography and Economics*, *54*(4), 423–443. https://doi.org/10.1080/15387216.2013.878230