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The Role of Environmental and Land Transaction Regulations on Agricultural Land Price:

The example of Brittany

ABSTRACT

Using data from individual transactions for the period 1994-2010 in the French NUTS2 region Brittany, the authors investigated how environmental regulations and transaction land regulations influence the price of sold plots. Regressions on three sub-samples of buyers were performed in order to assess whether different buyers have different attitudes or plans regarding the farmland purchased: a sub-sample including only farmer-buyers, a sub-sample including non-farmer individual buyers, and a sub-sample including non-farmer non-individual buyers. Estimations were performed ignoring and accounting for spatial interactions (model SARAR).

Results indicate that the price of land decreases when buyers are farmers, that the nitrate surplus area zoning increases the price of land, even more so for farmer-buyers. Regarding land transaction regulations, there is a negative effect, on land price, of the purchaser being the current tenant or being the land regulating public body SAFER. Estimating the model on different sub-samples depending on the buyers' type shed light on the factors that are more important for each buyer.

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1. Introduction

The observation of time and space variations in prices of agricultural land has triggered a large body of literature on farmland price formation. Most of the research is based on the Ricardo capitalisation formula, where land price is given by the discounted value of expected agricultural revenues. However, the discrepancy between the development of agricultural revenues and the development of land prices has questioned the validity of the simple Ricardo capitalisation formula (Weersink et al., 1999). In particular it is now well acknowledged that pressure from non-agricultural activities, such as urban development, transport infrastructures, and tourism, plays an important role on farmland price. It is also now well known that agricultural policies affect land price. In particular, agricultural subsidies are capitalised into land prices (for a review, see Latruffe and Le Mouël, 2009). Environmental regulations such as zonings may also be capitalised in land prices (Henneberry and Barrow, 1990; Vaillancourt and Monty, 1985; Le Goffe and Salanié, 2005). Institutional regulations may also affect the market for agricultural land. For example, land regulations are an important feature of developed countries, and may exist in the form of prohibited land ownership for specific entities, pre-emptive rights for specific buyers, restrictions regarding the size of the plot exchanged (Ciaian et al., 2012). In France in particular, land regulations are relatively strong, among the strongest in Europe (Van Herck et al., 2012). How regulations of land transactions affect agricultural land price is nevertheless little known.

This paper contributes to this issue. The objective is to estimate the determinants of agricultural land price in a French region with individual transaction data during 1994-2010. In particular, we aim to assess the role of regulations that may affect farmland transactions price. We focus on the role of environmental and land transaction regulations on agricultural land price.

The paper is structured as follows. The next section presents the case study and background on regulations. Section 3 explains the conceptual framework and Section 4 presents the data and variables used. Section 5 describes the results and the last section concludes.

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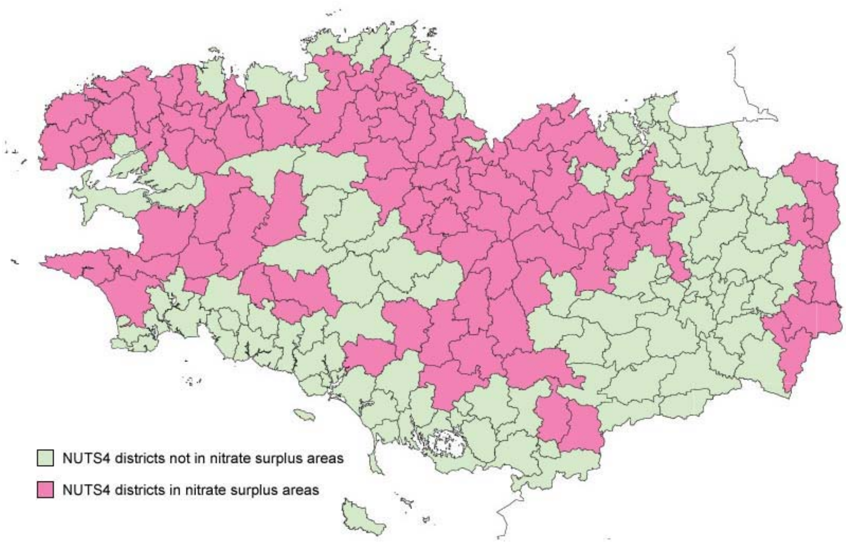
2. Background: case study and regulations

This section describes the region studied, and the regulations considered. The case study is Brittany, a French administrative region at the NUTS2[1] level located in Western France. It consists of four NUTS3 regions, 201 NUTS4 districts and 1,270 municipalities. The region has a strong agricultural character: it is among the first agricultural European regions. In particular it is the first region in the European (EU) in terms of milk production, with 3.7% of the EU production in 2010 (Eurostat, 2010). The region is also a big producer of pork, poultry products and vegetables. In 2010 it accounted for 20%, 54% and 22% respectively, of French farms specialised in milk, pork and poultry respectively (Agreste, 2011). In terms of farm structures, in 2010 the region accounted for 6%, 8% and 21% respectively, of the French utilised agricultural area (UAA), number of farms and number of livestock units respectively (DRAAF Bretagne, 2011).

Pollution from agriculture in Brittany is a crucial problem, in particular in terms of livestock dejections, resulting in high nitrogen rates in water and, more recently, in high concentration of green algae in some ocean bays. Following the 1991 EU Nitrate Directive (91/676/CEE) the whole region has been classified in nitrate vulnerable areas since 1994. This implies that all farmers in Brittany must comply with specific farming practices, such as keeping a yearly register with fertiliser quantities used on the farm, not using fertilisers outside specific periods and implementing grass buffer strips along rivers. In addition, some districts in the region are subject to more restrictive practices as they are classified in nitrate surplus areas ("zones d'excédent structurel"). This zoning is based on the quantity of livestock dejections in the district: if it would lead to a nitrogen quantity greater than the authorised ceiling of 170 kg per hectare, then the district is included in the zoning. There, farmers' practices are more constrained, in terms of livestock head numbers, quantity of nitrogen produced, and use of the manure. Figure 1 shows the districts in Brittany which are subject to such zoning since 2010. In 2010 about four among ten NUTS4 districts in the region were subject to such zoning, and the average nitrogen quantity in the region was 178 kg per hectare (DRAAF Bretagne, 2012).

Figure 1. Brittany's districts in the environmental zoning of nitrate surplus areas in 2010



Source: Observatoire de l'Eau en Bretagne.

[1] The Nomenclature of Territorial Units for Statistics (NUTS) provides a single uniform breakdown of territorial units for the production of regional statistics for the EU. In France, NUTS2 corresponds to the French administrative regions ("régions"), NUTS3 corresponds to the French administrative sub-regions ("départements") and NUTS4 corresponds to the French administrative districts ("cantons"). France (excluding overseas territories) consists of 22 NUTS2 regions and 96 NUTS3 regions. (source: http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction).

Adding to this is the fact that the region is densely populated and attractive in terms of population flows. In 2009, among the 22 NUTS2 regions in France, it was the seventh most densely populated region with 116 inhabitants per square kilometre, the fifth region in terms of incoming population flows, and it had the lowest unemployment rate (9.3%) (INSEE, 2009). All this results in conflicts over land use between agriculture and other land uses, such as urban development. During 1990-2000 Brittany was the fifth French NUTS2 region in terms of rate of urbanisation of agricultural land, a situation slightly attenuated during 2000-2006 (seventh region) (INSEE, 2009).

Despite the urban development pressure on agricultural land, the price of such land remains low in Brittany as in the rest of France. The average price of agricultural land (for plots larger than 0.7 hectare and excluding land with vineyards) in France in 2000 and 2010 was respectively 3,480 and 5,070 Euros per hectare, while the respective figures for Brittany were 3,120 and 4,980 Euros (Agreste, 2012). These figures are relatively lower than most of the EU countries, whose average price is in general above 9,000 Euros per hectare (Figure 1 in Ciaian et al., 2010). One reason for such low figures compared to other European countries may be the role of specific bodies regulating land transactions, the SAFERs ("Sociétés d'aménagement foncier et d'établissement rural") (Latruffe and Le Mouël, 2006). SAFERs are private bodies with public service missions to oversee land transactions in order to support the settlement of farmers, favour farm consolidation and limit farm enlargement, and avoid price speculation. For this, each plot transaction is notified by notaries to the local SAFER, which then has two months to approve or refuse the transaction. The transaction is accepted by the SAFER if it does not go against its above-mentioned missions. In the inverse situation, the transaction is rejected and the SAFER tries to reach a mutual agreement with the buyer and the seller. If this is not possible, SAFERs have a pre-emption right on the land exchanged: they can purchase land at a lower price than the original one, and re-sell it later at a lower price, or at the same price but to another buyer of their choice.

The situation described above is specific to France. In general there may exist additional regulations that may affect land transactions in terms of market participation, such as inheritance laws, pre-emptive rights, and restrictions on land ownership or land use (Latruffe and Le Mouël, 2006). In this paper we consider the case of pre-emptive rights from the current tenant farmer. A farmer renting in a parcel of land has a pre-emptive right for the purchase of the parcel if the landlord decides to sell. This means that the tenant farmer has priority in the purchase when the land is put up to sale, or can become the new owner even though another person has bought the land, and this, up to one month after the purchase by this person. This regulation ensures that the farm using the land to sale is not affected by the sale, and gives incentives to tenant farmers to become owners and therefore improve the use of land (Boinon, 2011). The farmer tenant must however satisfy several criteria: to have been a farmer for the past three years at least, to own less than a specific size of land and to commit to farm the purchased land during at least nine years.

While it is clear that SAFER's intervention may affect the price of sold agricultural land, it is less clear how tenants' pre-emptive rights would influence it. As explained by Latruffe and Le Mouël (2006), such rights restrict the number and type of potential buyers. But the effect on the price is not clear. As for the EU Nitrate Directive aiming at limiting the quantity, per hectare of land, of nitrogen released by livestock, it may increase the demand for agricultural land and as a consequence its price.

3. Conceptual framework and econometric strategy

3.1 Conceptual framework

The Present Value Model (PVM) is used here as the basic framework. The PVM model stipulates that land price is given by the capitalisation of expected revenues generated by the land. More precisely, assuming that the use of the land is on an infinite horizon, the value of land at a period t is given by the sum of discounted revenues from land. In mathematical terms (Weersink et al., 1999):

$$L_t = \sum_{i=1}^{\infty} \frac{E_t R_{t+i}}{(1+r_{t+1})(1+r_{t+2})..........(1+r_{t+i})} \quad (1)$$

or

$$L_t = \int_{i=1}^{\infty} E_t R_{t+i} e^{-r_{t+i}s} ds \quad (2)$$

where L_t is the value of land at period t; R_{t+i} is the agricultural revenue generated at period $t+i$; r is the time-varying discount rate; E_t represents the expectation of the revenue on the basis of information available in period t.

An extension of the basic PVM model consists in accounting for the fact that agricultural land price is not solely determined by the revenue generated by agricultural activities, but is also affected by the possibility for land to be converted for other uses (e.g. urban development, transportation or tourism infrastructures). Hence, an opportunity cost component (i.e. rent from alternative uses) is added to the agricultural component of land price (Plantinga and Miller, 2001; Goodwin et al., 2003), as follows:

$$L_t = \int_{i=1}^{i*} \left(E_t R_{t+i} e^{-r_{t+i}s} \right) ds + \int_{i=i*}^{\infty} \left(E_t X_{t+i} e^{-r_{t+i}s} \right) ds \quad (3)$$

where X is the rent generated from alternative uses of the land; i^* is the period at which the conversion to non-agricultural use occurs.

According to model (3), the current value of agricultural land is a non-linear function of rents stemming from agricultural activities, of rents stemming from potential future conversion of land to alternative uses, and of the discount rate.

In this paper we account for regulations that affect the market of agricultural land, and that may therefore affect its price. For this, as proposed by Plantinga et al. (2002), a random parameter specification is used. The model used is a specific case of the random parameter model developed by Hildreth and Houck (1968), Swamy (1970), and Swamy and Tinsley (1980). As suggested by Hornbaker et al. (1989) and used by Plantinga et al. (2002) in the case of agricultural land price, the parameters to estimate are not fixed but are a function of specific explanatory variables, here in particular regulations. Such specification is appropriate for the assessment of the role of regulations on land price. Indeed, while some regulations affect land prices directly only (e.g. the intervention of SAFER), the environmental regulations in particular lay affect land prices directly but also indirectly, through the basic factors of the PVM model: the agricultural revenue R and the rent of alternative land uses X.

The random parameter model of land price is:

$$L_p = \alpha_{0p} + \alpha_{1p} R_p + \alpha_{2p} X_p + \mu_p \quad (4)$$

where subscript p denotes the observation level (plot transaction); μ_i is a white noise; and the parameters to estimate, α_{0p}, α_{1p} and α_{2p}, can be written as a function of specific explanatory variables Z including regulations, as follows:

$$\alpha_{jp} = \delta_{j0} + \sum_z \delta_{jpz} Z_{pz} + \upsilon_{jp} \quad (5)$$

where υ_{jp} is a white noise; δ_{j0} and δ_{jpz} are parameters.

The land regulations considered here (see below) are assumed to directly affect the land price, while the environmental regulation considered is assumed to affect land both directly and indirectly. In addition, other explanatory variables from R and X may also affect land price indirectly as well as directly. Therefore, the land price model can be written as follows:

$$L_p = \left(\delta_{00} + \sum_z \delta_{0pz} Z_{pz} + \upsilon_{0p}\right) + \left(\delta_{10} + \sum_z \delta_{1pz} Z_{pz} + \upsilon_{1p}\right) R_p + \left(\delta_{20} + \sum_z \delta_{2pz} Z_{pz} + \upsilon_{2p}\right) X_p \\ + \alpha_{Zland,p} Zland_p + \alpha_{Zenv,p} Zenv_p + \mu_p \tag{6}$$

where $Zland_p$ are the land regulations variables; Z_{pz} are explanatory variables excluding land regulations but including environmental regulation; δ_{00}, δ_{10}, δ_{20} and δ_{1pz}, δ_{2pz} δ_{3pz}, $\alpha_{Zland,p}$ and $\alpha_{Zenv,p}$ are parameters.

Model (6) can be estimated as an heteroscedastic model using Feasible Generalised Least Squares (FGLS), as the model can be rewritten as follows:

$$L_p = \left(\delta_{00} + \sum_z \delta_{jpz} Z_{pz}\right) + \left(\delta_{10} + \sum_z \delta_{jpz} Z_{pz}\right) R_p + \left(\delta_{20} + \sum_z \delta_{jpz} Z_{pz}\right) X_p + \alpha_{Zland,p} Zland_p \\ + \alpha_{Zenv,p} Zenv_p + \xi_p \tag{7}$$

with

$$\xi_p = \left(1 + R_p + X_p\right) \sum_{i=0}^{2} \upsilon_{ip} + \mu_p \tag{8}$$

Model (7) is the model to be estimated. However, the potential rents from agricultural activity (R) and the potential rents from alternative uses (X) for each plot considered are not observed. Instead we use proxies which we assume represent the rents as a linear function. The potential rents from agricultural activity are thus modelled by (9) and the potential rents from alternative uses by (10):

$$R_t = f\left(\sum_{h=1}^{H} RV_{ht}\right) = \sum_{h=1}^{H} RV_{ht} \tag{9}$$

$$X_t = g\left(\sum_{h=1}^{H} XV_{ht}\right) = \sum_{h=1}^{H} XV_{ht} \tag{10}$$

where *f* and *g* are linear functions; RV_{ht} are proxies for agricultural rent; XV_{ht} are proxies for other rent.

We estimate the model with FGLS on the pooled sample (i.e. all years together), including control variables in an additive form: whether the buyer is farmer or not; and some year dummies.

3.2 Accounting for spatial heterogeneity and autocorrelation

Besides the effect of fundamental explanatory variables which can be derived from the theory, land prices may also be influenced by spatial interactions among sold plots. Data on land prices may indeed by spatially associated or spatially heterogeneous (Paez and al., 2001). Two issues may arise that have to be considered when estimating model (7): the spatial heterogeneity and the spatial autocorrelation. As explained by Patton and McErlean (2003), spatial heterogeneity would indicate that there exist spatially distinct land sub-markets, while spatial autocorrelation would reveal spatial lag dependence. The authors also stress that not accounting for these spatial issues during the estimations may result in parameter estimates that are biased.

The literature on spatial economics often relies on the use of the SARAR model in econometric estimations (Anselin and Florax, 1995; Kelejian and Prucha, 1998, 2010). The SARAR model is a generalisation of the spatial autoregressive model (SAR) proposed by Cliff and Ord (1973, 1981) with spatial autoregressive disturbance terms. The SARAR model, that is to say the spatial autoregressive model with autoregressive disturbances, can account for spatial lags in the dependent variable, in the exogenous variables, and also in the disturbance terms (Kelejian and Prucha, 2010).

We use the SARAR model here, and assume that the spatially weighted average of land prices neighbouring plot p (i.e. the spatial lag) affects the price of this plot p (through indirect effects), in addition to the effect of standard explanatory variables. We also assume that there is one or more omitted variables in our model and that the omitted variables vary spatially. Due to the unobserved heterogeneity or dependence, the error term tends to be spatially autocorrelated.

Model (7) can thus be written in a compact form including spatial effects, as in equation (11):

$$L = \lambda WL + \beta B + \mu \tag{11}$$

with

$$\mu = \rho W \mu + \varepsilon \tag{12}$$

where λ and ρ are parameters indicating the extent of spatial effects; W is a weight matrix indicating the spatial structure of the data; ε is a random term normally distributed such as $\varepsilon \sim iid\left(0, \sigma_\varepsilon^2 I\right)$; and B are the explanatory variables of model (7) and β their associated coefficients.

In our data set the plot observations are geo-coded according to their location in one of Brittany's municipalities. We assume that all observations within the same municipality are uniformly distributed, and their locations are approximated by the municipality centroid. Thus, we compute a $n \times n$ (with n the number of observations) spatial weight matrix W in which a neighbour set is specified for each observation based on Euclidean distance criterion. Considering an inverse-distance function we assume that all units (i,j observations) are neighbours[2], because the spatial weights decrease with the distance. Self-neighbours are excluded, such that the diagonal elements of W are zero. In addition, the weight matrix is row-standardized, such that the sum of the elements of each row is unitary. Finally, given the size of our sample, the inverse-distance matrix is truncated and stored in a banded form.

Spatial autocorrelation and heterogeneity have to be treated together (Anselin, 1988). Therefore, we estimate the model with the generalized spatial two-stage least squares estimator (GS2SLS) (Kelejian and Prucha (1998, 1999). The estimation procedure is performed in three stages. In the first stage equation (11) is estimated with two-stage least squares (2SLS) and an instrumental variable matrix H defined as follows:

$$H = \left(B, WB, W^2 B\right) \tag{13}$$

In the second stage the first-stage residuals are used to estimate, with the generalised method of moments (GMM), the autoregressive parameter ρ of equation (12) (Kelejian and Prucha, 2010). The last stage consists in using ρ to apply a Cochrane-Orcutt transformation to equation (11) before estimating it with 2SLS (Kelejian and Prucha, 2010).

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[2] An alternative way is to consider that the elements $W_{i,j}$ of W are non-zero when observations i and j are neighbours within a specific distance, and zero otherwise.

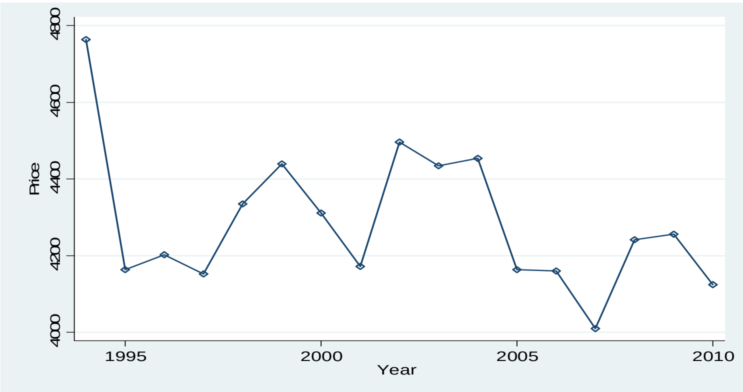
4. Data and variables used

4.1 Data

Our data are extracted from the database of all individual transactions of arable and pasture land that occurred in Brittany between 1994 and 2010, collected by notaries (the database "PERVAL"). We excluded built land, and we excluded very small plots, namely less than 0.15 hectares. Such plots are very expensive and reflect the possibilities to convert to development use. We also removed outliers. In the end, the database that we use consists in 14,991 sale transactions over the whole period for the region. The dependent variable, plot price, is the price per hectare of the plot exchanged. All variables in values were deflated by the yearly French price consumer index with base 2005.

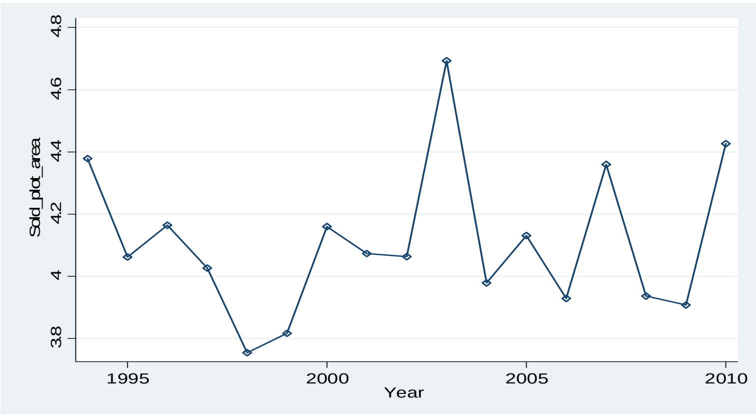
Figure 2 presents the evolution of the average agricultural land prices in Brittany between 1994 and 2010 in the sample used here. The average price during the period is 4,275 Euros per hectare (with a minimum of 1,018 and a maximum of 24,558 Euros), which is in the range of average agricultural land prices in France (SAFER-Agreste, 2012). The yearly average prices have slightly fluctuated during the period but remained between 4,000 and 4,800 Euros per hectare. Figure 3 shows the evolution of the average area of the sold plots over the period considered. The yearly average plot area fluctuates around 4 hectares; the average for the whole period is 4.1 hectares (with a minimum of 0.15 and a maximum of 74 hectares).

Figure 2. Evolution of the average deflated agricultural land prices (Euros per hectare) in Brittany between 1994 and 2010



Source: authors' calculations based on notaries' data.

Figure 3. Evolution of the average plots' area (hectares) in Brittany between 1994 and 2010



Source: authors' calculations based on notaries' data.

4.2 Variables used in the econometric model

Table 1 defines the variables used. The dependent variable (L) is the price per hectare for the exchanged plot, that is to say the price of the transaction divided by the area of the plot sold. The discount rate (r) is the yearly interest rate observed at the country level. The proxies related to agricultural rents (R) are: the average agricultural gross margin per hectare of UAA for the municipality where the plot is located; the sold plot's area; the number of agricultural family working units per hectare of UAA in the municipality where the plot is located; weather variables observed in the municipality where the plot is located (namely quantity of rain and atmospheric radiation); and soil characteristic observed in the NUTS4 district where the plot is located (namely cation exchange capacity). The proxies related to other rents (X) are all measured at the municipality level and include: the population density; the number of second homes per hectare of municipality's area; the growth rate of urbanisation of land; the attractiveness measured by the employment concentration rate; and whether the plot's municipality is located in an urban area[3].

As for regulations, they consist in environmental ($Zenv$) and land transaction regulations ($Zland$). The environmental regulation includes one proxy, namely whether the plot is located in a zoning nitrate surplus area. The land regulations include two dummy variables: whether the buyer is SAFER; and whether the plot is currently farmed by the buyer. In addition, a control variable representing whether the buyer is a farmer is included in the regression, as well as some year dummies.

It should be noted that variables are not observed at the same geographical level (plot or municipality or NUTS4 district level) and are observed for different periods: for example, transaction's characteristics are available for each year during 1994-2010, variables extracted from the Agricultural Census are for municipalities and for the years 2000 and 2010, variables extracted from the Population Census are for municipalities and for the years 1990, 1999 and 2009, weather variables are for municipalities and for each year between 2000 and 2008, and the soil variable is the average at the NUTS4 district level for the sub-periods 1995-1999, 2000-2004 and 2005-2009. Regarding nitrate surplus area zoning, the regulation has been implemented in 1994 and revised in 2005 and 2010. Throughout the revisions, some NUTS4 districts have changed status (within or without the zoning).

For some variables there is no information for some observations. The final sample used reduces to 13,743 observations. Table 2 presents descriptive statistics of the variables used in the estimation.

Following model (6), we assume that the environmental regulation ($Zenv$) affects the agricultural land price directly as it may be less easy to convert land to non-agricultural uses in this area. We also assume that it affects land price indirectly through the random parameters, as it may in fact affect the revenue generated by agricultural or non-agricultural uses of land. It is also expected that some specific variables affect land prices through the revenues R and X. More precisely, it is assumed that the following variables influence the R revenue proxy of gross margin per hectare: the interest rate, the plot's area, the number of family working units per hectare of UAA, the location in an urban area or not, all weather and soil variables, and the environmental regulation. And it is assumed that the following variables influence the X revenue proxy of population density: the atmospheric radiation, the number of second homes per hectare, the rate of urbanisation, the employment concentration rate, the location in an urban area, and the environmental regulation.

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[3] The employment concentration rate is the ratio between the number of jobs available in a municipality divided by the number of persons living in this municipality and holding a job inside or outside the municipality. Is considered as an urban area an area where housing constructions are close to each other (less than 200 meters away), with more than 2,000 inhabitants, where at least 10,000 jobs are available, and which is not located in the suburbs of another urban area (INSEE, 2009).

Expectations regarding the total (indirect and direct) influence of explanatory variables on land price are as follows. We expect a positive effect, on land price, from revenue proxies that are positively correlated with revenues and a negative effect from revenue proxies that are negatively correlated with revenues (whether revenues from agriculture R or revenues from alternative uses X). Regarding environmental regulations ($Zenv$), the zoning, that is to say the nitrogen constraint imposed by the Nitrate Directive, is expected to have a positive effect on land price. As mentioned above, the nitrogen limit imposed by the regulation implies that farmers need to spread manure on an increasing land surface. The resulting increasing demand for agricultural land would result in an increase in price. As for land regulations ($Zland$), we expect the dummy variable whether the buyer is SAFER to have a negative effect on land price due to its possibility to pre-empt plots for which the price is too high and to sell them back at a lower price. As explained above, we have no expectation on the sign of the effect of the dummy variable whether the buyer is the current farmer tenant. As for the control variable of whether the buyer is a farmer, we expect a negative price. The reason behind is that a non-farmer buyer may be willing to pay a higher price than a farmer, as the planned use of land may not be agricultural and therefore the future land revenue is expected to be higher.

4.3 Econometric models

The model is estimated firstly ignoring, and secondly accounting for, spatial interactions.

The model is estimated for the full sample of all buyers, but also for three sub-samples depending on the characteristic of the buyer. The first sub-sample includes farmer buyers only. The second and third sub-samples include non-farmer buyers only. The difference between these two non-farmer sub-samples is that the second sub-sample includes individual non-farmer buyers, while the third sub-sample includes the other non-farmer buyers, and in particular SAFER and public buyers such as town councils. The objective of estimating the model for different sub-samples is to assess whether different buyers have different behaviour or plans for the plot purchased.

Therefore, in total eight models are estimated.

Table 1. Description of the variables used in the regression

Variables	*Year of observation*	*Observation level*	*Source*
Dependent variable *L*			
Land price per hectare of plot area	1994-2010	Plot	Notaries
Interest rate *r*			
Interest rate	1994-2010	Country	Statistical Office INSEE
***R* variables**			
Agricultural gross margin per hectare of UAA	2000, 2010	Municipality	Agricultural Census
Sold plot's area	1994-2010	Plot	Notaries
Number of family working units per hectare of UAA	2000, 2010	Municipality	Agricultural Census
Quantity of rain	2000-2008	Municipality	Météo France
Atmospheric radiation			
Soil cation exchange capacity	Averages for subperiods 1995-1999, 2000-2004, 2005-2009	NUTS4 district	Réseau de Mesures de la Qualité des Sols (RMQS), GIS Sol
***X* variables**			
Population density	1990, 1999 and 2009	Municipality	Statistical Office INSEE

Number of second homes per hectare of municipality's area	1990, 1999 and 2009	Municipality	Statistical Office INSEE
Growth rate of urbanisation	1990-2000 and 2000-2006	Municipality	Corine Land Cover
Attractiveness measured by the employment concentration rate	1990, 1999 and 2009	Municipality	Statistical Office INSEE
Urban area location or not [a]	2000, 2010	Municipality	Statistical Office INSEE
***Zenv* variable**			
In nitrate surplus area or not [a]	2005, 2010	NUTS4 district	Regional office of the Ministry of Environment
***Zland* variables**			
The buyer is SAFER or not [a]	1994-2010	Plot	Notaries
The plot is currently farmed by the buyer or not [a]	1994-2010	Plot	Notaries
Control variable			
The buyer is a farmer or not [a]	1994-2010	Plot	Notaries

[a] Dummy variables (1 if yes; 0 if no)

Table 2. Descriptive statistics of the variables used in the regression: full sample of 13,743 observations

Variables	*Unit*	*Average for the period*
Dependent variable *L*		
Land price per hectare	Euros per ha	4,303
Interest rate *r*		
Interest rate	%	4.6
***R* variables**		
Agricultural gross margin per hectare of UAA	Euros per ha	5,336
Sold plot's area	ha	4.1
Number of family working units per hectare of UAA	Number per ha	0.04
Quantity of rain	mm	855
Atmospheric radiation	J^{-5}/square cm	9.24
Soil cation exchange capacity	cmol+/kg	9.6
***X* variables**		
Population density	Inhabitants per square km	83.7
Growth rate of urbanisation	%	1.6
Number of second homes per hectare of municipality's area	Number per ha	0.05
Attractiveness measured by the employment concentration rate	%	66.4
Urban area location or not [a]		0.37
***Zenv* variable**		
In nitrate surplus area or not [a]		0.63
***Zland* variables**		
The buyer is SAFER or not [a]		0.03
The plot is currently farmed by the buyer or not [a]		0.41
Control variable		
The buyer is a farmer or not [a]		0.62

[a] Dummy variables (1 if yes; 0 if no)

5. Results

Table 3 presents the explanatory variables' marginal effects obtained from the econometric estimation ignoring spatial interactions. The second column of the table relate to the estimation for the whole sample. Most of the explanatory variables have an expected sign. Regarding the agricultural revenue proxies, as expected, the gross margin per hectare and the number of family working units per hectare positively influence the land price. The quantity of rain and atmospheric radiation decrease the price. However, the plot size has a negative effect while a positive effect was expected. All variables proxying the revenue from non-agricultural uses have the expected sign, namely a positive sign (i.e. the land price increases with an increased urbanisation pressure).

The environmental regulation variable has a positive effect on the land price, suggesting, as expected that land prices increase with such regulations due to land competition. Regarding the land transaction variables, it is interesting to note that the SAFER intervention does not have a significant effect on the sale price. The variable indicating whether the land is currently tenanted by the farmer buyer has a negative effect. This may suggest that those buyers, knowing that they have priority in purchasing the land, may succeed in reducing the land price in the absence of other buyers' competition. As for the control variable which is whether the buyer is a farmer, it has a negative price, confirming that farmers pay less for the land that they purchase than non-farmer buyers.

The estimation was then performed on three sub-samples as explained above. The third column of Table 3 reports the marginal effects for the estimation on the sub-sample of farmer buyers, while the fourth and fifth columns report the marginal effects for the estimation on the sub-samples of, respectively, individual non-farmer buyers and non-individual non-farmer buyers. The gross margin plays a significant positive role for farmer buyers and for individual non-farmer buyers, but the effect is stronger for farmer buyers. As for the quantity of rain, it positively influences the price of land purchased by farmers, suggesting a climatic effect on harvests, but negatively influences the price of land purchased by individual non-farmers, suggesting a disinterest for areas with too much rain. The variables influencing the revenue from non-agricultural uses play similarly on the price of land purchased by farmer buyers and by non-farmer buyers, except for the attractiveness measured by the employment concentration rate. As expected this variable has a positive influence on the price of land purchased by non-farmer buyers, showing the effect of population pressure. However it has a negative influence on the price of land purchased by farmers. Except for the number of second homes which has a non significant effect on the price paid by non-farmer non-individual buyers, for this sub-sample the effects of the X variables are the strongest among all sub-samples.

Regarding the environmental regulation variable, it positively influences the price paid by all types of buyers. However, the effect is stronger for the sub-sample of farmer buyers suggesting strong competition for agricultural land among farmers. The non-significant effect of the SAFER found in the estimation for the whole sample is not confirmed. In fact, the variable has a significant negative effect on the price paid by non-farmer non-individual buyers, as expected.

Table 4 similarly presents the results from estimations accounting for spatial interactions (model SARAR). All signs of significant coefficients are confirmed. Only two coefficients become non significant: the coefficient of the quantity of rain and the coefficient of the atmospheric radiation for the estimation on the sub-sample of farmer buyers.

*Table 3. Results of the regression ignoring spatial interactions: marginal effects **

	Whole sample (sub-samples 1+2+3) 13,743 observations	Farmer buyers (sub-sample 1) 8,485 observations	Non farmer individual buyers (sub-sample 2) 3,564 observations	Non farmer other buyers (sub-sample 3) 1,457 observations
Interest rate *r*				
Interest rate	-0.1259	-0.1352	n.s.	n.s.
R variables				
Agricultural gross margin per hectare of UAA	7.51 E-05	1.45 E-04	7.9175 E-05	n.s.
Sold plot's area	-2.11 E-02	-8.39 E-03	-0.0280	-0.0303
Number of family working units per hectare of UAA	11.1567	16.5946	n.i.	n.i.
Quantity of rain	-2.75 E-04	0.0004	-0.0020	n.s.
Atmospheric radiation	-0.0197	-0.0207	n.s.	0.1909
Soil cation exchange capacity	-0.1444	-0.0869	-0.1490	-0.2957
X variables				
Population density	0.0068	0.0057	0.0025	0.0103
Number of second homes per hectare of municipality's area	1.4334	n.s.	4.2324	n.s.
Growth rate of urbanisation	n.s.	n.s.	n.s.	n.s.
Attractiveness measured by the employment concentration rate	0.0009	-0.0011	0.0021	0.0025
Urban area location or not	0.3668	0.3913	0.2581	0.4405
Zenv variable				
In nitrate surplus area or not	0.5800	0.6090	0.4587	0.3372
Zland variables				
The buyer is SAFER or not	n.s.	n.i.	n.i.	-0.5283
The plot is currently farmed by the buyer or not	-0.6676	-0.5604	n.i.	n.i.
Control variable				
The buyer is a farmer or not	-0.2868	n.i.	n.i.	n.i.
R-squares				
R-squares	0.23	0.34	0.10	0.17

* except for R-squares.
n.s.: marginal effect not available (parameters in the regression not significant).
n.i.: variable not included in the regression.

*Table 4. Results of the regression accounting for spatial interactions (model SARAR): marginal effects **

	Whole sample (sub-samples 1+2+3) 13,743 obs.	Farmer buyers (sub-sample 1) 8,485 obs.	Non farmer individual buyers (sub-sample 2) 3,564 obs.	Non farmer other buyers (sub-sample 3) 1,457 obs.
Interest rate *r*				
Interest rate	-0.1524	-0.1493	n.s.	n.s.
R variables				
Agricultural gross margin per hectare of UAA	9.2445 E-05	5.8051 E-05	7.1433 E-05	n.s.
Sold plot's area	-0.0187	-0.0138	-0.0582	-0.0327
Number of family working units per hectare of UAA	11.6267	16.8338	n.i.	n.i.
Quantity of rain	-0.0007	n.s.	-0.0024	n.s.
Atmospheric radiation	-0.0276	n.s.	n.s.	0.0989
Soil cation exchange capacity	-0.0956	-0.1015	-0.1545	-0.3328
X variables				
Population density	0.0067	0.0023	0.0015	0.0101
Number of second homes per hectare of municipality's area	1.4338	n.s.	4.3915	n.s.
Growth rate of urbanisation	n.s.	n.s.	n.s.	-0.0178
Attractiveness measured by the employment concentration rate	0.0010	-0.0010	0.0022	0.0029
Urban area location or not	0.2499	0.3299	0.2579	0.4488
Zenv variables				
In nitrate surplus area or not	0.6000	0.6100	0.2476	0.4092
Zland variables				
The buyer is SAFER or not	n.s.	n.i.	n.i.	-0.5957
The plot is currently farmed by the buyer or not	-0.8395	-0.6645	n.i.	n.i.
Control variable				
The buyer is a farmer or not	-0.3767	n.i.	n.i.	n.i.
Spatial parameters				
Lambda (λ)	0.2376	0.1997	0.2048	0.1531
Rho (ρ)	-0.1732	-0.0401	-0.1022	-0.1134

* except for lambda and rho.
n.s.: marginal effect not available (parameters in the regression not significant).
n.i.: variable not included in the regression.

6. Conclusion

In this paper, using data from individual transactions for the period 1994-2010 in the French NUTS2 region Brittany, we investigated how environmental regulations and transaction land regulations influence the price of sold plots. Regressions on three sub-samples of buyers were performed in order to assess whether different buyers have different attitude or plans regarding the farmland purchased: a sub-sample including only farmer buyers, a sub-sample including non-farmer individual buyers, and a sub-sample including non-farmer non-individual buyers. Estimations were performed ignoring and accounting for spatial interactions (model SARAR).

Results indicate that the price of land decreases when buyers are farmers. This may come from the fact that, in such cases, the land will be used for agricultural uses and not for alternative uses for which the price may be higher. The environmental zoning regulation considered (namely the nitrate surplus area zoning) increases the price of land. The effect of this zoning regulation is stronger for farmer buyers than other buyers, due to the increased competition for land in order to spread manure. Regarding land transaction regulations, while we had no a priori expectation on the effect, on land price, of the purchaser being the current tenant, we found a significant negative impact. This may reveal the absence of strong competition on the land market for plots currently farmed by a tenant, which has a priority over other buyers. Contrary to the expectation, we found no significant effect of the SAFER pre-emption right in the model estimated for the whole sample. However, when estimating the model on less heterogeneous sub-sample of non-farmer non-individual buyers, we found a significant negative effect of the SAFER being the buyer.

While this latter effect was expected, it should also be kept in mind that among the transactions pre-empted by SAFER, not all of them are effectively subjected to a reduced price. SAFER may intervene on the land market by buying land and selling it back at a lower price, but it can also sell it back at the same price but to another buyer. While the first type of intervention is to limit price increases, the second is to limit enlargement of farms that are already large and to favour the settlement of young farmers. In addition, SAFER's role is not confined to pre-empting land that is being exchanged. Before resorting to this extreme case, SAFER firstly tries to solve the issue by mutual agreement. Therefore, a part of SAFER's intervention on the land market is France is not captured in our data (this explains why only 3% of the transactions considered here were subjected to SAFER's pre-emption right).

Estimating the model on different sub-samples depending on the buyers' type enabled to give evidence of effect which would be blurred within the full sample, for example the effect of the SAFER being the buyer. Separating into the sub-samples also shed light on the factors that are more important for each type of buyer. The results reveal that the price paid by farmer buyers is strongly influenced by the gross margin (which proxies the potential agricultural revenue that can be generated by the land purchased), and by the location in environmental zoning. By contrast, the price paid by non-farmer buyers is more influenced by variables proxying the potential revenue that can be generated by non-agricultural use of the land. This effect is even more pronounced for the sub-sample of non-farmer non-individual buyers, which include SAFER and other public bodies such as administrative councils. This suggests that those buyers are more interested in plots which are located near densely populated and urbanised areas. This is where conflicts may occur and necessitate SAFER's intervention to avoid land speculation, and this is where agricultural land is more often urbanised.

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FACTOR MARKETS

Comparative Analysis of Factor Markets for Agriculture across the Member States

245123-FP7-KBBE-2009-3

The Factor Markets project in a nutshell

Title	Comparative Analysis of Factor Markets for Agriculture across the Member States
Funding scheme	Collaborative Project (CP) / Small or medium scale focused research project
Coordinator	CEPS, Prof. Johan F.M. Swinnen
Duration	01/09/2010 – 31/08/2013 (36 months)
Short description	Well functioning factor markets are a crucial condition for the competitiveness and growth of agriculture and for rural development. At the same time, the functioning of the factor markets themselves are influenced by changes in agriculture and the rural economy, and in EU policies. Member state regulations and institutions affecting land, labour, and capital markets may cause important heterogeneity in the factor markets, which may have important effects on the functioning of the factor markets and on the interactions between factor markets and EU policies. The general objective of the FACTOR MARKETS project is to analyse the functioning of factor markets for agriculture in the EU-27, including the Candidate Countries. The FACTOR MARKETS project will compare the different markets, their institutional framework and their impact on agricultural development and structural change, as well as their impact on rural economies, for the Member States, Candidate Countries and the EU as a whole. The FACTOR MARKETS project will focus on capital, labour and land markets. The results of this study will contribute to a better understanding of the fundamental economic factors affecting EU agriculture, thus allowing better targeting of policies to improve the competitiveness of the sector.
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Partners	17 (13 countries)
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SEVENTH FRAMEWORK PROGRAMME