AESTIMUM
CENTRO STUDI DI ESTIMO E DI ECONOMIA TERRITORIALE - Ce.S.E.T.

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OPEN ACCESS

**Citation:** Giuffrida, L., De Salvo, M., Manarin, A., Vettoretto, D., & Tempesta, T. (2023). Exploring farmland price determinants in Northern Italy using a spatial regression analysis. *Aestimum* 83: 3-20. doi: 10.36253/aestim-14986

**Received:** July 27, 2023

**Accepted:** December 7, 2023

**Published:** April 22, 2024



**Data Availability Statement:** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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# Exploring farmland price determinants in Northern Italy using a spatial regression analysis

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**Abstract.** Using spatial regression models, we detect determinants of farmland's prices in a rural area located in the upper Treviso plain (Veneto region, Italy). Econometric analysis is based on a Spatial linear regression model able to account for spatial lags in the data. Estimates show which intrinsic and extrinsic characteristics have the greatest influence on price, and how buyers and sellers' profiles also matter on the price determination. Our application fosters spatial regression models in rural real estate market analysis and appraisal, and highlights that in the area under study the farmland's prices are significantly affected by factors that are rarely considered in the literature, such as sellers and buyers' profiles, the land use in the context where the sold plot is located matters, the hydraulic risk of the area and the presence of large infrastructures.

**Keywords**: rural real estate market analysis, farmland value, spatial lag of X (SLX) model, Treviso (Italy).
**JEL codes**: C21, Q15, R32.

## 1. INTRODUCTION

Theory and empirical analysis show that the price of farmland depends on numerous factors. Literature identifies at least three main group of drivers: 1) intrinsic land characteristics; 2) locational characteristics; 3) land planning and presence of easements (Devadoss and Manchu, 2007; De Noni et al., 2019; Tempesta et al., 2021). Soil fertility and, more in general, soil productivity, have a positive effect on prices (Bastian et al., 2002; Drescher et al., 2001; Faux and Perry, 1999; Kostov, 2009; Maddison, 2009; Perry and Robinson, 2001; Sardaro et al., 2018b; Sardaro et al., 2021; Troncoso et al., 2010; Tsoodle et al., 2006; Uematsu et al., 2013; Xu et al., 1993). Prices also increases when farmland is irrigated or has good drainage (Bastian et al., 2002; Kostov, 2009; Ma and Swinton, 2011; Perry and Robison, 2001; Sardaro et al., 2020; Tsoodle et al., 2006), whereas slope of land implies a negative effect (Ervin and Mill, 1985; Hilal et al., 2016; Ma and Swinton, 2011; Sardaro et al., 2020; Sardaro et al., 2021; Tempesta et al., 2021). Distance from both urban areas and the road network reduce the price (Drescher et al., 2001; Khalid, 2015; King and Schreiner, 2004; Kostov, 2009; Ma and Swinton, 2011; Maddison, 2009; Sardaro et al., 2018a; Sardaro et al., 2020; Sardaro et al. 2021; Snyder et al., 2008; Tsoodle et al., 2006). Farmland's prices depend also on land use policy and urban growth (Abelairas-Etxebarria and Astorkiza, 2012; Delbecq et al., 2014; Guiling et al., 2009; Géniaux et al., 2011; Jaeger et al., 2012; Livanis et al., 2006; Ma and Swinton, 2012; Tempesta and Thiene, 1997). Urban growth raises expectations of land use change and land appreciation even in agricultural areas that are not directly affected by new urban settlements. As highlighted by Varian (2014, p. 206) in the assets with consumption returns market this will lead to an increase in the price of real estate.

Nevertheless, there are other aspects that can play a key role and that should be considered in the analysis of agricultural land price such as, for instance, the characteristics of buyers and sellers and the agents' expectations. These aspects have been detected sporadically (Colyer et al., 1978; Perry and Robinson, 2001; Tempesta et al., 2021; Tsoodle et al., 2006), despite it is clear that economic actors do not only consider current conditions of market, but also discount possible future changes in returns and values (Plantinga et al., 2002). Indeed, it can be assumed that the land market is largely motivated by expectations of an increase in land and property income. This is particularly true both when the purchase is motivated by agricultural purposes and when there are interests linked to possible changes in land use (Plantiga et al., 2002). In the case of expectations on possible changes of land use, motivations may be more articulated in some respects, but they can be traced back to: *i*) the presence of information asymmetries; *ii*) the different availability of capital to invest; and *iii*) the different propensity to risk and the different expected rent existing between buyers and sellers.

It follows that, at least on a theoretical level, in areas characterized by the coexistence of overlapping and interacting alternative land uses, it is difficult to assume that an equilibrium price trend can exist. Similar lands may in fact belong to different market segments, and such segmentation depends essentially on the characteristics of the potential buyers, and it is not entirely attributable to the objective characteristics of the property itself.

All these aspects show an evident spatial variability also in areas where different segments of market can coexist. Therefore, when analyzing the factors influencing land prices, it becomes particularly important to also consider the price spatial variability (Sekáč, et al., 2017; Sklenicka et al., 2013).

The purposes of this paper are manifold. Firstly, it aims at verifying what intrinsic land characteristics, locational features, urban planning decisions and structural constrains influence the value of agricultural land. Secondly, it aims at detecting the role in the price formation of variables related to the characteristics of buyers and sellers, such as for instance if the sale happened between relative or the corporate form of sellers and buyers. These aspects have never been studied in previous studies, despite they should be considered to verify if price formation is consistent with conditions and definition declared in the regulation (EU) n. 575/2013. This latter definition is, in fact, mandatory both for the assessment of the market value and the identification of comparables. Thirdly, the paper addresses the spatial dimension of data by testing the use of spatial models able to account for spatial lags in the data. Spatial regression models have never been used in Italy to analyze agricultural land market with the unique exception of De Noni et al. (2019). Here we account for spatial correlation using several models given that spatial correlation can affect the dependent variable, the independent variables, and/or the error terms (Manski, 1993). Across the different models suggested by the literature, the spatial lag of X (SLX) model seems to be particularly suitable for the purposes of this paper, for different reasons. As a first, according to Gibbons and Overman (2012), in comparison to other specifications, this model is not affected by identification problems. Moreover, in the SLX model direct and indirect effects do not require further calculations. Finally, effects might be different from one explanatory variable to another, and the spillover effects are local (Elhorst, 2017). Due to this flexibility, the SLX model is then a more attractive point of departure in an empirical study than other spatial regression specifications (Elhorst, 2014).

The area under study, located between Treviso and Montebelluna, is particularly suitable to achieve the aims of this analysis. In the past, also due to town planning policies, a widespread network of residential and productive settlements was formed. The possibility of use land for urban purposes is far from remote. The area falls within the 'Sport system of Asolo and Montebelluna' industrial district, and furthermore, given the nature of the subsoil, characterized by the high presence of gravel, there are numerous active and inactive quarries. Moreover, the territory has recently been crossed by the Veneto Piedmont Motorway (Superstrada Pedemontana Veneta) and three motorway toll stations are located within it. In this regard, it can be assumed that the motorway, by improving the accessibility of the entire area, has favored the emergence of new urban rent phenomena that also affect agricultural areas.

## 2. MATERIALS AND METHOD

### *2.1 The area of study*

The area falls in the municipalities of Povegliano, Paese, Vedelago, Volpago del Montello, Trevignano, Giavera del Montello and Montebelluna located in the upper Treviso plain (Veneto region, Italy) and has a surface of approximately 260 km$^2$ (see Figure 1).

Only flat lands have been considered for this analysis, excluding plots following in the hilly part of the municipalities of Montebelluna, Volpago del Montello and Giavera del Montello.

The area is characterized by a continental climate, with relatively harsh winters and hot, sultry summers. Annual temperatures are, on average, around 12°C and the annual average rainfall is just over 1,100 mm. Although rainfall shows normally a peak both in autumn and spring, only January and February have in general a monthly precipitation lesser than 75 mm.

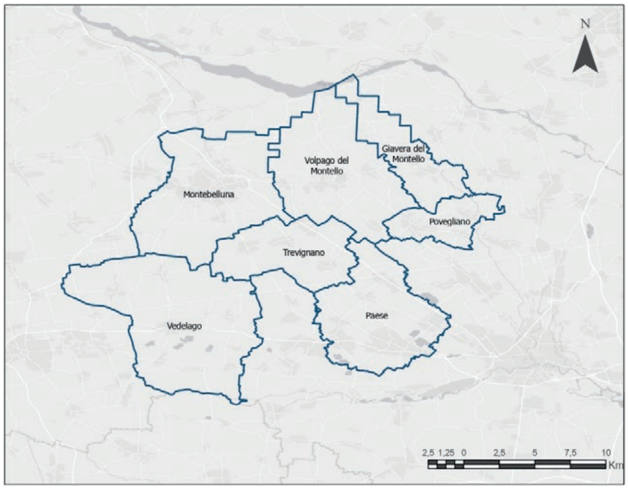


**Figure 1.** Area of study.

From a pedological point of view (see Figure 2), soils can be divided into two distinct categories (Regional Agency for Environmental Protection and Prevention of the Veneto - ARPAV, 2008), that are those with a prevalence of gravel and sand, and the ones that containing clays, silts and gravels. The former category of lands occupies mostly of the detected area. Such soils are characterized by high permeability and low fertility. The latter category, instead, occupies a narrow strip to the northern

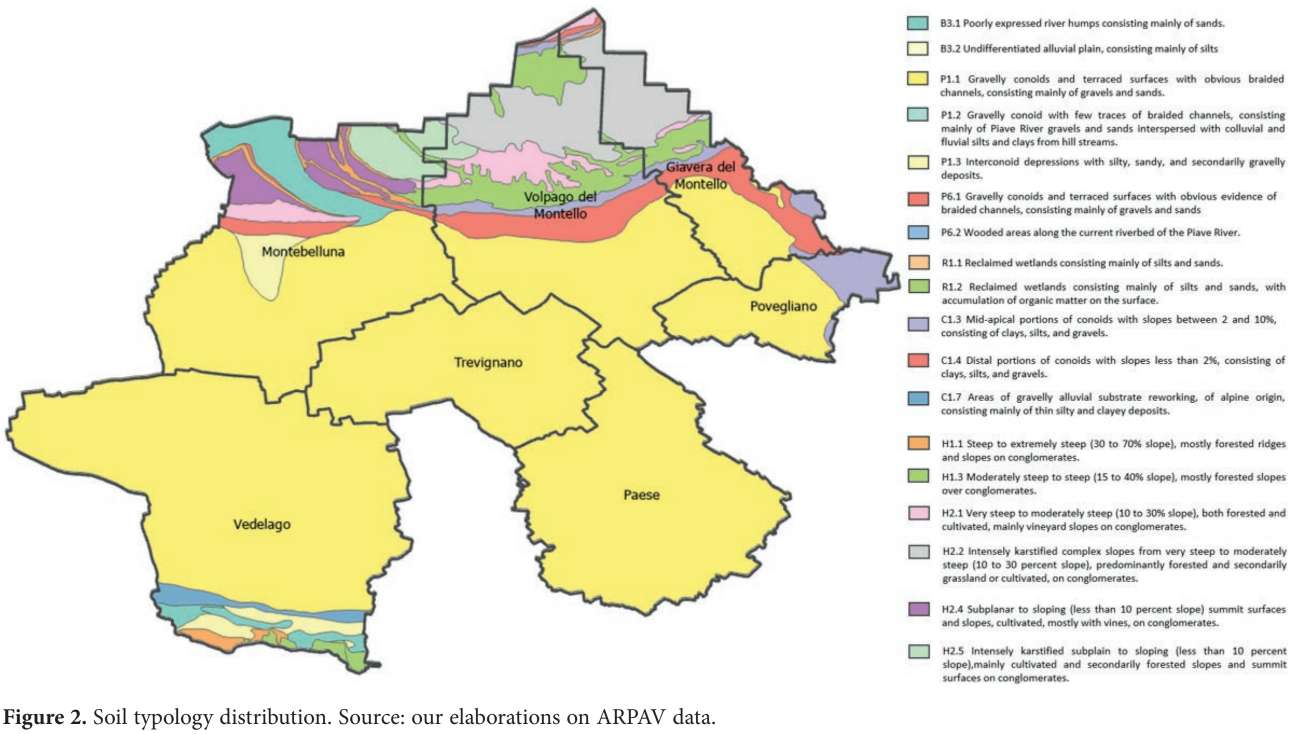


**Figure 2.** Soil typology distribution. Source: our elaborations on ARPAV data.

of the study area, located at the foot of the Montello hill. These soils are characterized by lower permeability and a greater capacity to store water. The whole territory is included in the irrigated area of the Piave Land Reclamation Consortium. In the past it was irrigated prevalently using the surface-flow method. Nowadays, a transformation project is underway in favor of a higher diffusion of pressurized irrigation systems that consume less water and make irrigation operations more flexible. Approximately two thirds of the study area is still irrigated by surface border (or flooding) system.

From an economic point of view, the area is characterized by a considerable diffusion of artisan and industrial activities and by a high spatial dispersion of both residential and productive areas. The municipalities of Montebelluna, Giavera del Montello, Volpago del Montello and Trevignano are part of the sportsystem di Asolo e Montebelluna industrial district. In the past, the municipalities of Vedelago and Ponzano Veneto were also part of the sports shoe and footwear district. According to data from the Provincial Territorial Plan, there are 109 industrial areas in the municipalities, 65% of which have a surface area of less than five hectares. The municipality of Montebelluna has a population of about 31,000 inhabitants and is an urban pole of regional relevance.

From an infrastructural point of view, the entire territory is crossed by a dense network of municipal, provincial, and state roads that make it easy to reach in a short time all the towns and the urban poles of Montebelluna, Treviso and Castelfranco. In 2023 the construction of Veneto Piedmont Motorway was completed. It crosses the territory of the analyzed municipalities in an east-west direction and provides a rapid connection between the entire territory and the main motorways of the Northern-Eastern Italy (A4, A31 and A27). In the territory under analysis there are three motorway toll stations. Finally, with reference to the possible effects on land values, the presence of an airport and widespread quarrying activities should be mentioned. The areas located near the military airport of Istrana are encumbered by an airport constraint that reduce sometimes drastically the possibility of building new houses or factories. Moreover, given the geological nature of the terrain, the entire territory was subject to intense excavation activity after World War II, so much so that, according to the data reported in the Provincial Territorial Plan, at the beginning of the 2000s, the active quarries occupied an area of 797 hectares and those no longer active 200 hectares.

### *2.2 Data collection*

To test our research hypotheses, we collected data on 225 deeds of sale, which took place in the period 2017-2021. Data are related to soil plots located in places classified as agricultural zone by the municipal general urban plan (see Figure 3). All plots are characterized by the absence of buildings.

Deeds of sale were directly downloaded from SISTER, a web portal dedicated to professionals providing services by the Italian Land Registration System.

We chose this primary source of data for many reasons. As a first, it gives us the possibility to directly collect for each selling data on the sold area and selling price. Moreover, the deed of sale reports information on the presence of various factors that may limit the ownership rights and, therefore, the market value of the lands, such as the presence of some easements (for example, methane pipeline or power line) and the proximity to airport runway clear zones. Furthermore, the deed of sale reports also key information on aspects related to the peculiarities of participants in the transaction that can influence the selling price, such as the legal status of the buyers and sellers (persons, partnerships and corporations), the presence of straight relatives between the parties, the position of the buyer in relation to the agricultural activity (professional farmer or active mainly in other activities), the municipality of residence (Cotteleer et al., 2008; Perry and Robinson, 2001; Tempesta et al., 2021).

However, there are many other intrinsic and extrinsic factors which can affect the price of agricultural land and that are not included among the information reported in the deed of sale. Some examples are the soils characteristics, the proximity to urban areas or to the main roads, areas under high-voltage overhead transmission line restrictions, and so on.

To account in the analysis also for these features, we followed the procedure proposed by Tempesta et al. (2021). Firstly, each land plot was georeferenced using cadastral data by consulting the WMS cadastral cartography based on the Web Map Service 1.3.0 standard, available in the Revenue Agency's Cadastral Cartographic Geoportal. This procedure allowed interfacing the cadastral data with Google Earth. Then, by means of placemarks, we identified location of the land on Google Earth and the geographical coordinates of its central point. Through Google Earth, we analysed the historical aerial images to learn the land use at the time of sale and to know the shape of the plots. Thus, by means of the shapefiles relating to various territorial themes available on the Geo-portal of the Veneto Region (https://idt2.regione.veneto.it), we derived data about the characteristics of each plot, such as the agronomic peculiarities of lands and their position with respect to the road network and urban and rural settlements. Finally, in the case of companies, for both sell-

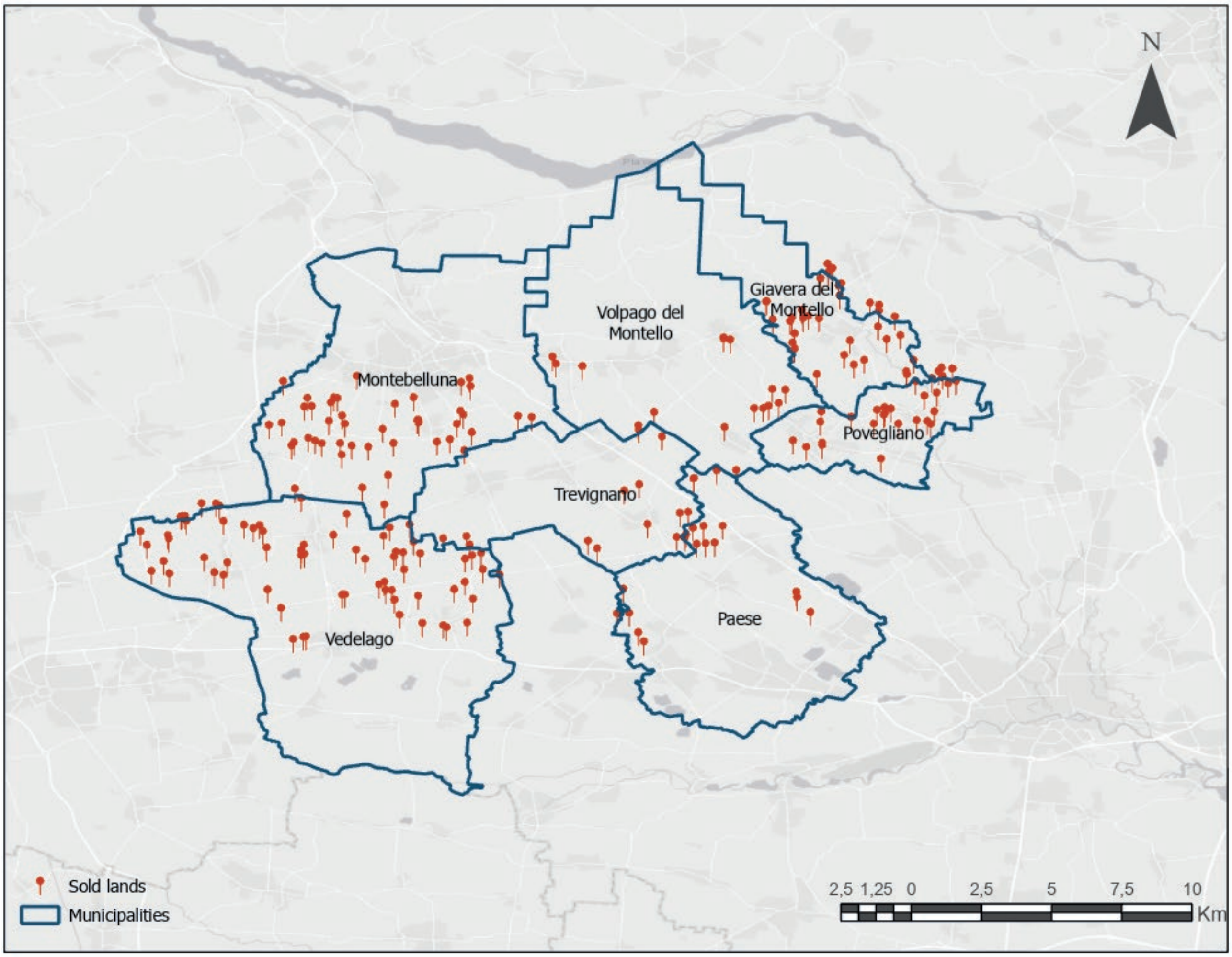


**Figure 3.** Sold farmlands localization.

ers and buyers, we collected information on the main business sector analysing their corporate website. Table 1 identifies data source for each intrinsic and extrinsic characteristic included in analysis. Figure 4 illustrates the spatial distribution of infrastructures.

### *2.3 Intrinsic characteristics of farmlands*

Collected deeds of sale are related to a total surface equal to 250.40 ha, mostly consisting of arable land (84.4%) and vineyards (11.8%), while the presence of orchards and gardens (3.8%) is marginal. Orchards and gardens were often sold with other crops (especially arable crops). These combinations of land use represent the 8.1% of sales.

The sold plots have an average area of about 11,000 m$^2$, ranging from 100 m$^2$ to approx. 133,000 m$^2$. In the 87% of the sales, the surface area was less than 2 ha. Thus, the land market in the study area, predominantly, concerns small-sized plots.

Land plots are generally regular in shape (64.9%) and consist of a non-fragmented plot of land in almost all cases. The 72% of the sold lands is not encumbered by any easement. The most widespread is the power line easement (9.3%), followed by methane pipeline and aqueduct easements (8.4%). Much more widespread are road easements (30.7%) and those deriving from the presence of water bodies (27.6%). Despite less prevalent, airport (10.7%) and power line (9.3%) easements are particularly important due to the restrictions they impose on building and cultivation activities (Table 4).

Physical and agronomic characteristics of the sold lands reflect those of the study area (Table 2). Only for the 7.1% of the sales, the soil has a skeleton presence in the first 50 cm that is lesser than 5%, for the 74.2% of

**Table 1.** Data sources.

| Variable | Source |
|---|---|
| Municipality in which the land is located | Deed of sale |
| Year in which the sale took place | Deed of sale |
| Sheet and cadastral parcel number | Deed of sale |
| Surface of the land | Deed of sale |
| Selling price | Deed of sale |
| Land sold with CAP entitlements | Deed of sale |
| Land leased at the time of purchase and sale | Deed of sale |
| Exercise of the right of first refusal | Deed of sale |
| Legal nature of buyers and sellers (natural person, partnership, corporation) | Deed of sale |
| Relationships between buyers and sellers | Deed of sale |
| Buyer professional agricultural entrepreneur or direct farmer | Deed of sale |
| Place of residence of buyers and sellers | Deed of sale |
| Presence and type of easement (passage, methane pipeline, hydraulic, power line) | Deed of sale |
| Presence of buffer strips (road, hydraulic, hydraulic pipeline, methane pipeline, airport or railway) indicated in the land use certificate | Deed of sale |
| Homogeneous Territorial Zone of belonging indicated in the certificate of urban destination | Deed of sale |
| Preliminary purchase and sale agreement registered with the Inland Revenue Office (preliminary real estate contract or preliminary sales agreement) | Deed of sale |
| Road network | Geo-portal of the Veneto Region |
| Regional hydrographic network | Geo-portal of the Veneto Region |
| Soil map | Geo-portal of the Veneto Region |
| Soil permeability map | Geo-portal of the Veneto Region |
| USDA Hydrologic Soil Group | Geo-portal of the Veneto Region |
| USDA soil classification | Geo-portal of the Veneto Region |
| Land capability classification | Geo-portal of the Veneto Region |
| Map of the texture and gravel within the first 50 cm of soil | Geo-portal of the Veneto Region |
| Land use map (2018) | Geo-portal of the Veneto Region |
| "Historical Centres" and "Minor Historical Centres" taken from the Atlas of the historical centres of the Veneto Region. | Geo-portal of the Veneto Region |
| Areas under hydrogeological restriction | Geo-portal of the Veneto Region |
| Other land use restrictions (road, railways, etc.) | Geo-portal of the Veneto Region |
| "First rank regional centres"; "Second rank intermediate urban centres"; "Third rank local urban centres"; "Local urban centres of the fourth rank" and "Local urban centres of the fifth rank" | Geo-portal of the Veneto Region |
| Companies main business sector | Corporate websites analysis |

the sample it is between 5% and 15%; and for the rest of observations (18.7%) it is between 15% and 35%. It follows that a large proportion of the soils have a high permeability and belong to Class III of the Land Capability Classification. Thus, in these circumstances, only the presence of irrigation can allow the cultivation of arable lands. As already noted, the entire territory analyzed is served by an irrigation network that derives its water from the Piave River. The 38.2% of the analyzed land has a pressurized water distribution system, while in the rest of the surface the traditional method of surface border system is prevalently used.

### *2.4 Extrinsic characteristics of farmlands*

Arable land is the most significant land use in the sold plots neighboring area within a radius of 250 m (75.3%) (Table 3). Built-up areas or areas affected by other urban uses (roads, car parks, urban parks, etc.) occupy, on average, 14.2% of the neighboring lands (e.g. neighboring area within a radius of 250 m). However, this percentage varies considerably and exceeds a percentage equal to 30% for the 17% of the land sold.

This reflects the situation of the entire upper Veneto plain, characterized by a significant urban sprawl. It follows that the distance from the main hamlets of the municipalities or from the municipal centre is generally rather lim-

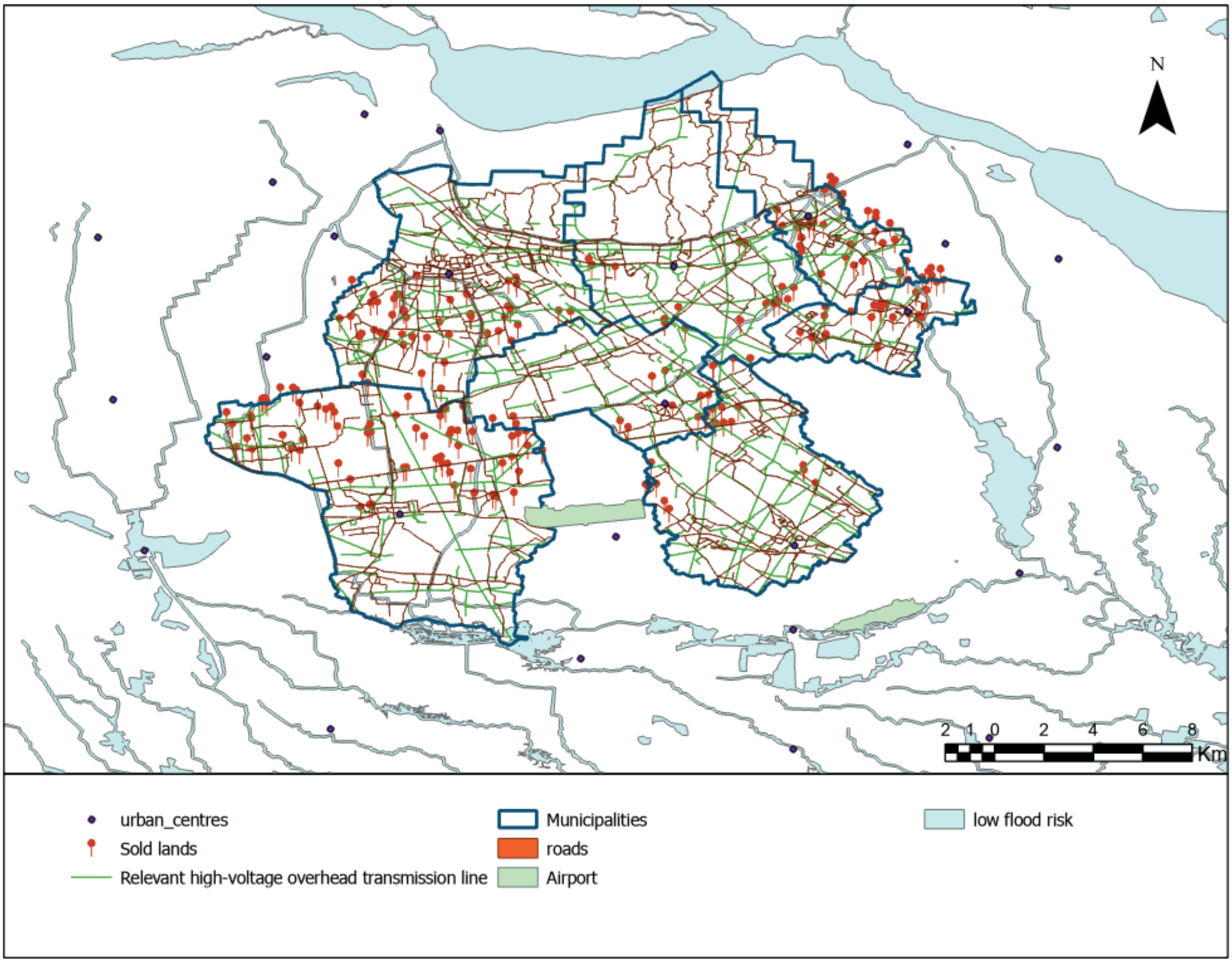


**Figure 4.** Infrastructural networks.

ited and not higher ad equals, respectively, 4 km and 8.4 km. All the sold lands are therefore easily accessible from the main hamlets. This is facilitated also by the presence of a capillary road network that makes it possible to reach in a short time all areas of the surveyed municipalities. On average, the distance to the nearest paved road is only 166 m and does not exceed 1,700 m. In addition, from the sold plots, it is also possible to reach in a short time the main road network consisting of provincial and regional roads. Infrastructural peculiarities of the area outline a potential future further development of the entire territory.

Quarrying activity is widespread throughout the analyzed area. This is also reflected in the sold land, which on average is about 1,700 m from an active or disused quarry. However, only 3.6% of the sold lands is less than 300 m away, and for this reason it can be assumed that quarries should not have had on the average a significant effect on price.

A final extrinsic factor that may affect the spread of urban rents is the recent construction of the Veneto Piedmont Motorway that presumably in the future will further increase the accessibility of a large part of the study area. The distance from the three motorway toll booths, which provide a quick connection to the national motorway network, is on average 3,889 m, ranging from a minimum of 413 m to a maximum of 8,459 m.

### *2.5 Features of buyers and sellers*

The average market value of the sold plots per unit of surface is 8.46 €/m$^2$, a high amount given that the area includes prevalently lowlands with no specific productive vocation. However, prices per unit of surface are strongly variable, ranging from 2.37 €/m$^2$ to 24.80 €/m$^2$.

**Table 2.** Intrinsic characteristics of farmlands.

| Variables | Type of variable | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| Surface (in m$^2$) | Continuous | 11,127.840 | 14,380.301 | 116 | 139,458.000 |
| Rented land (1 if yes) | Dummy | 0.036 | 0.186 | 0.000 | 1.000 |
| Plot shape (not regular) (1 if yes) | Dummy | 0.351 | 0.478 | 0.000 | 1.000 |
| Land shared in two or more plots (1 if yes) | Dummy | 0.062 | 0.242 | 0.000 | 1.000 |
| Absence of easement (1 if yes) | Dummy | 0.720 | 0.450 | 0.000 | 1.000 |
| Right of way easement (1 if yes) | Dummy | 0.049 | 0.216 | 0.000 | 1.000 |
| Gas pipeline easement (1 if yes) | Dummy | 0.084 | 0.279 | 0.000 | 1.000 |
| Waterline easement (1 if yes) | Dummy | 0.084 | 0.279 | 0.000 | 1.000 |
| High-voltage overhead transmission line easement (1 if yes) | Dummy | 0.093 | 0.292 | 0.000 | 1.000 |
| Pressurised irrigation system (1 if yes) | Dummy | 0.382 | 0.487 | 0.000 | 1.000 |
| No land use restriction (1 if yes) | Dummy | 0.400 | 0.491 | 0.000 | 1.000 |
| Road land-use restriction (1 if yes) | Dummy | 0.307 | 0.462 | 0.000 | 1.000 |
| Water body land-use restriction (1 if yes) | Dummy | 0.276 | 0.448 | 0.000 | 1.000 |
| Relevant high-voltage overhead transmission line land-use restriction (1 if yes) | Dummy | 0.098 | 0.298 | 0.000 | 1.000 |
| Gas pipeline land-use restriction (1 if yes) | Dummy | 0.076 | 0.265 | 0.000 | 1.000 |
| Airport zoning restriction (1 if yes) | Dummy | 0.107 | 0.309 | 0.000 | 1.000 |
| Gravel within the first 50 cm of soil: common (1 if yes) | Dummy | 0.071 | 0.258 | 0.000 | 1.000 |
| Gravel within the first 50 cm of soil: frequent (1 if yes) | Dummy | 0.742 | 0.438 | 0.000 | 1.000 |
| Gravel within the first 50 cm of soil: abundant (1 if yes) | Dummy | 0.187 | 0.391 | 0.000 | 1.000 |
| Soil texture: clay loam (1 if yes) | Dummy | 0.080 | 0.272 | 0.000 | 1.000 |
| Soil texture: other (1 if yes) | Dummy | 0.920 | 0.272 | 0.000 | 1.000 |
| Land Capability Classification: II class (1 if yes) | Dummy | 0.116 | 0.320 | 0.000 | 1.000 |
| Land Capability Classification: III class (1 if yes) | Dummy | 0.884 | 0.320 | 0.000 | 1.000 |
| Soil permeability: moderately low (1 if yes) | Dummy | 0.080 | 0.272 | 0.000 | 1.000 |
| Soil permeability: moderately high (1 if yes) | Dummy | 0.920 | 0.272 | 0.000 | 1.000 |
| Fraction of the plot's surface with vineyards | Continuous | 0.067 | 0.250 | 0.000 | 1.000 |
| Fraction of the plot's surface with arable crops | Continuous | 0.853 | 0.346 | 0.000 | 1.000 |
| Fraction of the plot's surface with orchards and gardens | Continuous | 0.081 | 0.261 | 0.000 | 1.000 |

Only in a few cases, CAP entitlements have been transferred with the sale (5.8%). In 94.2% of the sales, the owners of the neighboring lands did not have the titles to apply for the right of first refusal.

The sale between relatives can be considered quite widespread since it concerns 10.7% of the acts surveyed.

Sale happened among relatives in the 11% of the cases. The practice of depositing the preliminary deed of sale with the revenue agency seems to be very limited (7.1%), probably because the negotiation very often involves people residing in the same municipality, between whom there is a mutual trust on the outcome of the bargaining.

There are significant differences between sellers and buyers in terms of both legal characteristics of the companies and place of residence of the contracting parties. Table 4 shows that the average number of sellers involved in each sale is considerably higher than that of buyers (1.84 vs.1.16). Moreover, in the case of sellers, only in the 48.9% of cases, owners reside in the same municipality where the land is located. This percentage rises to 71.6% among buyers, implying that in the area, at least on the demand side, the market has a strongly local dimension.

Difference between buyers and sellers emerges more clearly when their corporate form is considered (see Figure 5). The 92% of the sellers are natural persons. This percentage is considerably lower among buyers (62.7%). For the latter, both partnership (25.8%) and corporation (11.6%) are much more numerous.

The importance of corporations in the agricultural land market is even greater when the purchased area and the amount spent to purchase land are analyzed: corporations acquired 54% of the land sold and spent 58% of the sums invested in the purchase of land (Tables 5-8). Furthermore, the average area, the average price and the

**Table 3.** Extrinsic characteristics of farmlands.

| Variables | Type of variable | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| Fraction of surface with vineyards in the radius of 250 m | Continuous | 0.044 | 0.081 | 0.000 | 1.000 |
| Fraction of surface with arable crops in the radius of 250 m | Continuous | 0.753 | 0.159 | 0.300 | 1.000 |
| Fraction of surface with woods and hedgerows in the radius of 250 m | Continuous | 0.014 | 0.030 | 0.000 | 0.250 |
| Fraction of surface with orchards in the radius of 250 m | Continuous | 0.016 | 0.037 | 0.000 | 0.300 |
| Fraction of surface with scattered urban settlements in the radius of 250 m | Continuous | 0.031 | 0.040 | 0.000 | 0.250 |
| Fraction of surface with urban areas in the radius of 250 m | Continuous | 0.081 | 0.100 | 0.000 | 0.450 |
| Fraction of surface with other land use (road, car parks, etc.) in the radius of 250 m | Continuous | 0.061 | 0.078 | 0.000 | 0.450 |
| Distance from the nearest asphalted road (in m) | Continuous | 166.400 | 278.100 | 0.000 | 1,700.000 |
| Distance from the nearest provincial or state road (in m) | Continuous | 653.400 | 597.700 | 0.000 | 2,700.000 |
| Distance from urban centres (in m) | Continuous | 1,177.200 | 848.700 | 0.000 | 4,000.000 |
| Distance from municipality centres (in m) | Continuous | 3,039.900 | 2,243.600 | 200.000 | 8,400.000 |
| Distance from industrial areas (in m) | Continuous | 2,451.600 | 1,358.900 | 100.000 | 6,000.000 |
| Distance from the nearest quarry of gravel (in m) | Continuous | 1,730.100 | 1,091.200 | 0.000 | 8,500.000 |
| Distance from the Veneto Piedmont Motorway (in m) | Continuous | 2,643.800 | 1,990.900 | 0.000 | 8,400.000 |
| Distance from the nearest exit of the Veneto Piedmont Motorway (in m) | Continuous | 3,889.000 | 1967.500 | 413.000 | 8,459.000 |
| Fraction of the territory with low flood risk within a radius of 500 m | Continuous | 2.022 | 3.302 | 0.000 | 14.000 |
| Municipality of Montebelluna (1 if yes) | Dummy | 0.188 | 0.391 | 0.000 | 1.0000 |

**Table 4.** Features of buyers and sellers.

| Variables | Type of variable | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| Selling price (in €) | Continuous | 95,485.860 | 133,236.578 | 850.000 | 1,255,164.000 |
| Price per unit of surface (in €/m$^2$) | Continuous | 8.460 | 3.037 | 2.370 | 24.840 |
| Transfer of CAP entitlements (1 if yes) | Dummy | 0.058 | 0.234 | 0.000 | 1.000 |
| Pre-emption right absent (1 if yes) | Dummy | 0.942 | 0.237 | 0.000 | 1.000 |
| The seller is a natural person (1 if yes) | Dummy | 0.916 | 0.314 | 0.000 | 1.000 |
| The seller is a partnership (1 if yes) | Dummy | 0.018 | 0.127 | 0.000 | 1.000 |
| The seller is a corporation (1 if yes) | Dummy | 0.067 | 0.256 | 0.000 | 1.000 |
| The buyer is a natural person (1 if yes) | Dummy | 0.627 | 0.483 | 0.000 | 1.000 |
| The buyer is a partnership (1 if yes) | Dummy | 0.258 | 0.442 | 0.000 | 1.000 |
| The buyer is a corporation (1 if yes) | Dummy | 0.120 | 0.311 | 0.000 | 1.000 |
| Sellers all reside in the same municipality where the sold land is located | Dummy | 0.489 | 0.501 | 0.000 | 1.000 |
| At least one seller resides in a municipality adjoining the municipality where the sold land is located (1 if yes) | Dummy | 0.276 | 0.445 | 0.000 | 1.000 |
| At least one seller resides in a municipality not adjoining the municipality where the sold land is located (1 if yes) | Dummy | 0.236 | 0.437 | 0.000 | 1.000 |
| Buyers all reside in the same municipality where the sold land is located (1 if yes) | Dummy | 0.716 | 0.453 | 0.000 | 1.000 |
| At least one buyer resides in a municipality adjoining the municipality where the sold land is located (1 if yes) | Dummy | 0.178 | 0.393 | 0.000 | 1.000 |
| At least one buyer resides in a municipality not adjoining the municipality where the sold land is located (1 if yes) | Dummy | 0.107 | 0.297 | 0.000 | 1.000 |
| Buyer is a Professional Agricultural Entrepreneur (PAE) (1 if yes) | Dummy | 0.547 | 0.497 | 0.000 | 1.000 |
| Sale between relatives (1 if yes) | Dummy | 0.107 | 0.304 | 0.000 | 1.000 |
| Preliminary contract of sale was registered to the Italian Revenue Agency (1 if yes) | Dummy | 0.071 | 0.237 | 0.000 | 1.000 |
| Sellers involved in each sale (n.) | Continuous | 1.840 | 1.934 | 1.000 | 17.000 |
| Buyers involved in each sale (n.) | Continuous | 1.164 | 0.379 | 1.000 | 3.000 |

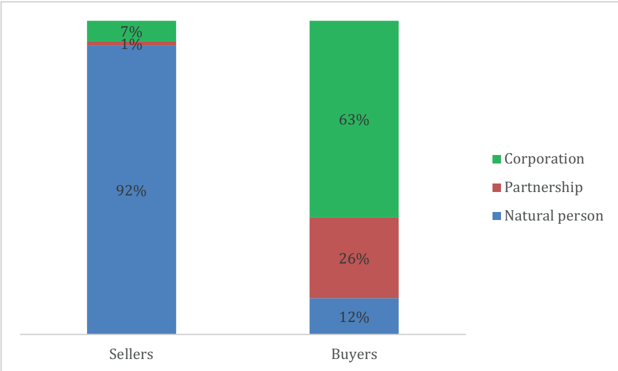


**Figure 6.** Corporate form of sellers and buyers.

average price per unit of surface are significantly higher in the case of land purchased by companies than in the case of land purchased by individuals (Tables 6-8). Finally, in the 54% of sales, the buyer is a Professional Agricultural Entrepreneur (PAE). Their role in the land market is much more significant since they purchased 72% of the total land sold and spent 75% of its value. The average purchased area and the average expenditure incurred by PAEs is significantly higher than that of other buyers (Table 9) while the unit price is not statistically different, with 95% probability.

In Table 9 the average purchased area, the average selling price and the average price per unit of surface are shown by groups of purchasers according to the type of company and whether or not they have the status of professional farmer or direct cultivator. In general, professional entrepreneurs tended to pay a higher price than non-professional entrepreneurs.

Collected data through the corporate website produce interesting insights on the development of the land market in the study area. Despite the limited number of observations, both on the side of the demand and the supply, the identification of the activity field suggests a changing in comparison to the past on the parties interested in acquiring land. The crisis in the construction market has led many companies engaged in the gravel quarries to sell their owned agricultural land. On the other hand, probably due to the effect of the construction of the Veneto Piedmont Highway, the presence of industrial and real estate companies on demand side of the agricultural land market is higher in comparison to the supply side. Thus, the amount of land owned by companies operating in non-agricultural sectors has increased.

### *2.6 Econometric model*

Econometric analysis is based on spatially lagged X (SLX) model (Elhorst, 2010; Elhorst, 2014; Elhorst and Halleck Vega, 2017; Kopczewska, 2020).

The model is a "constrained" Manski model (Manski, 1993) through which it is possible to account for spa-

**Table 5.** Selling surfaces for different corporate form of sellers and buyers.

| | Sellers | | | | Buyers | | | |
|---|---|---|---|---|---|---|---|---|
| | Sold surface (in ha) | % | Mean | Standard deviation | Purchased surface (in ha) | % | Mean | Standard deviation |
| Natural person | 2,057,236 | 82.2 | 9,938.30 | 11,088.10 | 1,151,841 | 46.0 | 8,169.10 | 7,759.90 |
| Partnership | 63,248 | 2.5 | 21,082.70 | 13,097.30 | 901,826 | 36.0 | 15,548.70 | 16,856.10 |
| Corporation | 383,279 | 15.3 | 25,551.90 | 34,785.90 | 450,096 | 18.0 | 173,11.40 | 27,080.60 |
| Total | 2,503,763 | 100.0 | 11127.8 | 14,380.30 | 2,503,763 | 100.0 | 11,127.80 | 14,380.30 |

**Table 6.** Prices for different corporate form of sellers and buyers.

| | Sellers | | | | Buyers | | | |
|---|---|---|---|---|---|---|---|---|
| | Sold price (in €) | % | Mean | Standard deviation | Purchased price (in €) | % | Mean | Standard deviation |
| Natural person | 17,798,875 | 82.8 | 85,984.90 | 105,398.90 | 8,979,987 | 41.8 | 63,687.90 | 68,722.60 |
| Partnership | 687,703 | 3.2 | 229,234.30 | 203,309.20 | 8,019,685 | 37.3 | 138,270.40 | 149,984.70 |
| Corporation | 2,997,741 | 14.0 | 199,849.40 | 312,776.80 | 4,484,647 | 20.9 | 172,486.40 | 255,352.50 |
| Total | 21,484,319 | 100.0 | 95,485.90 | 133,236.60 | 21,484,319 | 100.0 | 95,485.90 | 133,236.60 |

**Table 9.** Corporations by field of activity.

| Field of activity | Sellers | | Buyers | |
|---|---|---|---|---|
| | n. | % | n. | % |
| Agriculture | 6 | 40.0 | 9 | 34.6 |
| Marketing of agricultural products | 2 | 13.3 | 0 | 0.0 |
| Quarry | 5 | 33.3 | 0 | 0.0 |
| Industry | 2 | 13.3 | 12 | 46.2 |
| Real estate companies | 0 | 0.0 | 5 | 19.2 |
| Total | 15 | 100.0 | 26 | 100.0 |

**Table 7.** Prices per unit of surface for different corporate form of sellers and buyers.

| | Sellers | | Buyers | |
|---|---|---|---|---|
| | Sold price per unit of surface (in €/m$^2$) | Standard deviation | Purchased price per unit of surface (in €/m$^2$) | Standard deviation |
| Natural person | 8.53 | 3.11 | 7.85 | 2.14 |
| Partnership | 9.56 | 3.51 | 8.98 | 3.44 |
| Corporation | 7.28 | 1.22 | 10.66 | 4.72 |
| Total | 8.46 | 3.04 | 8.46 | 3.04 |

**Table 8.** Surfaces, prices and unit prices paid by professional and non-professional farmers.

| | n. | % | Surfaces (in ha) | | Price (in €) | | Price per unit of surface in (€/m$^2$) | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean | Standard deviation | Mean | Standard deviation | Mean | Standard deviation |
| Natural person not PAE | 80 | 35.6 | 5,652.9 | 4,430.6 | 42,936.9 | 35,043.3 | 7.91 | 2.07 |
| Natural person and PAE | 61 | 27.1 | 11,469.0 | 9,754.2 | 90,902.3 | 89,865.6 | 7.77 | 2.23 |
| Partnership not PAE | 6 | 2.7 | 7,830.5 | 7,221.3 | 51,205.7 | 48,996.9 | 7.59 | 3.23 |
| Partnership and PAE | 52 | 23.1 | 16,439.3 | 17,453.5 | 148,316.4 | 154,634.6 | 9.14 | 3.46 |
| No corporation | 17 | 7.6 | 10,541.5 | 8,818.7 | 91,503.8 | 67,670.8 | 9.93 | 4.75 |
| Corporation and PAE | 9 | 4.0 | 30,098.9 | 43,068.0 | 325,453.6 | 392,869.9 | 12.04 | 4.61 |
| Total not PAE | 103 | 45.8 | 6,568.5 | 574.3 | 51,238.7 | 4,567.9 | 8.22 | 0.28 |
| Total APE | 122 | 54.2 | 14,908.8 | 1,613.1 | 132,178.6 | 15,044.0 | 8.66 | 0.29 |
| Total | 225 | 100.0 | 11,127.8 | 14,380.3 | 95,485.9 | 133,236.6 | 8.46 | 3.04 |

Note: PAE - Professional Agricultural Entrepreneur.

tial spillover effects across the units in the sample. The SLX model is specified as:

$$y = \alpha i_N + X\beta + W_x X\theta + \varepsilon \quad (1)$$

where:

- y represents an $N \times 1$ vector consisting of one observation on the dependent variable for every unit in the sample ($i = 1, \ldots, N$);
- $i_N$ is an $N \times 1$ vector of ones associated with the constant term parameter $\alpha$;
- $X$ denotes an $N \times K$ matrix of explanatory variables associated with the $K \times 1$ parameter vector $\beta$;
- $\varepsilon = (\varepsilon_1, \varepsilon_2, \ldots \varepsilon_N)$ is a vector of independently and identically distributed disturbance terms with zero mean and variance $\sigma^2$ which represents the idiosyncratic error term;
- $W$ is an $N \times N$ nonnegative matrix describing the spatial arrangement of the units in the sample;
- $\theta$ is the spatial parameter.

WXθ figures out the spatial interaction effects. Since W is $N \times N$ and $X$ is $N \times K$, the WX matrix of spatial lags is also $N \times K$. Consequently, the vector of response parameters θ is order $K \times 1$ (just like β). The spatial spillover effects of this model coincide with the parameter estimates θ of the WX variables, while direct effects coincide with the parameter estimates β of the X variables. The sum of direct and spillover effects is the total effect.

The weight matrix W is exogenously determined and can cause specification problems (Florax and Rey, 1995). Literature suggests the use of different criterion to represent spatial correlation across units, such as the contiguity or the inverse distance ones. Moreover, the matrix can be symmetric or asymmetric (Kopczewska, 2020). We tested the use of different weight matrices (e.g. Queen matrix assuming first and second order of correlation, Root matrix, Euclidean inverse distance matrix and k-nearest matrices, with k ranging from 4 to 6) and we adopted different normalization rules (e.g. none, spectral, min-max and row's sum) to identify the best matrix specification that was, according to our expectations, the one based on an inverse Euclidean distance with spectral normalization.

Furthermore, to be sure that the assumed model specification is the one that better fit our data, we also estimated other spatial models based on one or two spatial effects, assuming significant lags also for the dependent variable and the error terms. To identify the best spatial models, we followed the top-down approach (Elhorst, 2010; Floch and Le Saout, 2018) according to the starting point for the estimation process is the estimate of the Manski model, that account for all the type of spatial lags. Given the insignificance of parameters related to the spatial autocorrelation of the dependent variable and of the error term, the SLX specification resulted to be the model that better fit the data.

When θ = 0, the SLX model reduces to a standard linear regression model. To verify that the SLX model shows better performance than the standard linear regression, we used both "diffuse" and "focused" tests, such as the Moran's I test, the Wald test (or asymptotic t-test) and the Likelihood Ratio (LR) test. The Moran's I test is based on the rejection of the null hypothesis the assume the absence of spatial autocorrelation. The alternative hypothesis assumes the presence of spatial autocorrelation, but not specified what form or process and for this reason the test is considered "diffuse". The other ones, instead, are Maximum Likelihood Based Tests and reject the null hypothesis against a fully specified alternative model that, in this case, is the SLX spatial autoregressive model. Consequently, they are "focused" tests.

**Table 10.** List of independent variables included into the SLX model.

| Indipendent variables | Direct effect | Spillover effect |
|---|---|---|
| Arable crops in the radius of 250 m | ✓ | ✓ |
| Woods and hedgerows in the radius of 250 m | ✓ | ✓ |
| Distance from urban centres | ✓ | ✓ |
| Soil permeability: moderately low | ✓ | ✓ |
| Partnership: PAE* | ✓ | |
| Corporation: PAE* | ✓ | |
| Corporation: no PAE* | ✓ | |
| Sellers residing in the same municipality where the land sold is located | ✓ | |
| Airport zoning restriction | ✓ | ✓ |
| Plot sold in 2020 or 2021 | ✓ | |
| Distance from the nearest toll booths of the Veneto Piedmont Motorway | ✓ | ✓ |
| Relevant high-voltage overhead transmission line land-use restriction | ✓ | ✓ |
| Municipality of Montebelluna | ✓ | |
| Territory with low flood risk within a radius of 500 m | ✓ | ✓ |
| Sale between relatives | ✓ | |

Note: PAE - Professional Agricultural Entrepreneur.

Specifically, Wald test is based on value of the spatial parameter(s) estimate while LR test is based on difference in data-fitting. The SLX model has been estimated by means of the Generalized Spatial Two-Stage Least-Squares (GS2LS) estimator, that assures consistent estimates both in the cases of IID or heteroskedastic residuals (Drukker et al., 2013). Econometric analyses were done using STATA 17.0. Some matrices were generated also using GEODA 1.18.

Table 10 reports the list of the independent variables included into the model and identified those for which a significant spatial component was assumed. As it concerns the dependent variable, we used the logarithm of the price per unit of surface (€/$m^2$) (Bourassa et al., 2005; Tsutsumi et al., 2011).

## 3. RESULTS

Table 11 shows the coefficients estimates for the OLS and SLX models. Apparently, models seem to produce very similar results. The R-square and pseudo R-square values are similar. Even if we take the mean of the absolute percentage deviation between the observed and estimated value (Mean Percentage Absolute Deviation) (Tempesta et al., 2021) as an index of the models' goodness of fit for estimation purposes, we obtain quite similar values (17.63 for the OLS model and 17.85 for the SLX model). The Mean Absolute Deviation between observed and estimated values for both models is 1.49 €/m$^2$.

Statistical tests (Likelihood-ratio test and Wald test of spatial terms) conducted to identify the best model specification suggest the use of the SLX model. Coefficient estimates for this model's specification in comparison to the OLS one assures an improving of the level of significance for all the variables, with the exception of "Relevant high-voltage overhead transmission line land-use restriction". Variables are always significant with at least 95% of probability.

As it concerns the intrinsic characteristics of the sold plots, results suggest that land with low permeability are more expensive than land with higher permeability (the coefficient estimate equals to 0.1429), probably due to the lower expenses for irrigation and soil tillage as well as the better agronomic characteristics of these soils and their higher productivity. Airport zoning restriction and relevant high-voltage overhead transmission line land-use restriction show both a negative effect on the price per unit of surface. Airport and power line easements have little relevance from a strictly agricultural point of view and instead have a strong negative impact on the building susceptibility of soils. The buffer strips of high-voltage power lines under Italian law are de facto unbuildable. Even in the case of airports there are strong limitations on building possibilities that vary according to the distance from the airports. In this regard, however, it must be considered that in both cases, the real impact of the resulting constraints both on agricultural activity and, to a greater extent, on building susceptibility, can be affected by numerous specific factors that are difficult to fully consider. For example, airport constraints are of a different nature and can change depending on the distance from the airport and the position with respect to take-off and landing lines.

Extrinsic factors correlated in a statistically significant way to the unit price are exclusively territorial characteristics. When a piece of land is located in an exclusively agricultural context where there are only arable crops or other woody crops (e.g. hedges and woods) within a 250 m radius, the price drops significantly (-27.6% for arable crops and -73.5% for woody crops). This result can depend on multiple factors, including the spread in the zone of quarries, landfills and other non-productive uses, despite the proximity to active quarries, per se, does not resulted to have a statistically significant effect on prices.

The low hydraulic risk of the area surrounding the sold land also has a positive effect on prices: as the percentage of the area occupied by areas that are poorly subject to flooding increases, the price of land can also rise significantly. In this regard, however, it should be noted that this percentage never exceeds 14% among the land surveyed.

In the municipality of Montebelluna, which as observed constitutes an urban pole of regional importance, agricultural land prices are higher (+19.1%). This is a phenomenon already found in other studies in the Veneto region with reference to rural buildings, which generally reflects the urban rent phenomena typical of the region's real estate market (Tempesta, 2011). However, urban rents in the survey area do not depend only on the main urban pole, since smaller towns are also able to create a not-negligible rent. A piece of land located two kilometers away from population centres is worth 10% less than a piece of land bordering them. This phenomenon can certainly be traced back to Veneto's urban planning practice, which has generally endowed all the main settlements in a municipality with urban expansion and production areas. In fact, the municipality has always been the main actor in regional urban planning policies.

Further, results demonstrate that the realization of a large infrastructure project can lead to a non-negligible redistribution of land rent in the territory. The proximity to the tollbooths of the Veneto Piedmont Motorway increases the value of agricultural land in a non-negligible way. According to the model shown in Table 11, an agricultural land located five kilometers from one of the three toll booths in the investigated territory is worth 9.5% less than one located close to them.

Moreover, the model estimate suggests that over the two-year period 2020-2021, land prices fell by 9%. This result suggests a sharp drop in agricultural land values of the area during the Covid 19 pandemic that does not seem to be motivated by internal difficulties in the primary sector, but rather by the general slowdown in the economy and real estate investments.

A third group of factors influencing the sales price and considered into the analysis concerns the characteristics of buyers and sellers. A first result about these aspects is that if the contractors are relatives, the unit price is 19% lower. This is a somewhat obvious fact but, following the recommendations of the International Valuation Standards, it should always be taken into account when comparables are chosen in the appraisal.

Less obvious and, for some aspects, more difficult to interpret, is the effect on the price per unit of surface of the other characteristics of the contracting parties. As for the sellers, if they all reside in the municipality where the sold land is located, then the price is 8.6% higher. This probably stems from the fact that, in many cases, the sellers reside in other municipalities, sometimes far from the

**Table 11.** OLS and SLX estimates.

| Variable | | OLS (ML estimator) | | SLX (GS2SLS estimator) | |
|---|---|---|---|---|---|
| | | Coefficient | Standard error | Coefficient | Standard error |
| Arable crops in the radius of 250 m (fraction) | $\beta_1$ | -0.2774 * | 0.1422 | -0.3223 ** | 0.1371 |
| Woods and hedgerows in the radius of 250 m (fraction) | $\beta_2$ | -1.3452 ** | 0.5608 | -1.3283 ** | 0.5493 |
| Distance from urban centres (in m) | $\beta_3$ | -0.0001 *** | 0.0000 | -0.0001 *** | 0.0000 |
| Soil permeability: moderately low | $\beta_4$ | 0.1545 ** | 0.0701 | 0.1429 ** | 0.0682 |
| Partnership: PAE (1 if yes) | $\beta_5$ | 0.1341 *** | 0.0418 | 0.1389 **** | 0.0396 |
| Corporation: PAE (1 if yes) | $\beta_6$ | 0.3652 **** | 0.0557 | 0.3594 **** | 0.0595 |
| Corporation: no PAE (1 if yes) | $\beta_7$ | 0.2375 **** | 0.0551 | 0.2259 **** | 0.0561 |
| Sellers residing in the same municipality where the land sold is located (1 if yes) | $\beta_8$ | 0.0832 *** | 0.0305 | 0.0827 *** | 0.0304 |
| Airport zoning restriction (1 if yes) | $\beta_9$ | -0.1933 *** | 0.0620 | -0.1963 **** | 0.0560 |
| Plot sold in 2020 or 2021 (1 if yes) | $\beta_{10}$ | -0.0990 *** | 0.0332 | -0.0940 ** | 0.0371 |
| Distance from the nearest exit of the Veneto Piedmont Motorway | $\beta_{11}$ | -0.00002 * | 0.00001 | -0.00002 ** | 0.00001 |
| Relevant high-voltage overhead transmission line land-use restriction | $\beta_{12}$ | -0.1385 *** | 0.0453 | -0.1071 ** | 0.0437 |
| Municipality of Montebelluna (1 if yes) | $\beta_{13}$ | 0.1791 **** | 0.0488 | 0.1745 **** | 0.0497 |
| Territory with low flood risk within a radius of 500 m (in %) | $\beta_{14}$ | 0.0132 ** | 0.0051 | 0.0120 ** | 0.0050 |
| Sale between relatives (1 if yes) | $\beta_{15}$ | -0.2036 *** | 0.0704 | -0.2102 *** | 0.0668 |
| Constant | $\beta_0$ | 2.3621 **** | 0.1079 | 2.4117 **** | 0.1334 |
| Arable crops in the radius of 250 m (fraction) | $\theta_1$ | | | -0.3199 ** | 0.1543 |
| Woods and hedgerows in the radius of 250 m (fraction) | $\theta_2$ | | | 9.3278 ** | 4.1222 |
| Distance from urban centres (in m) | $\theta_3$ | | | 0.0001 | 0.0001 |
| Soil permeability: moderately low | $\theta_4$ | | | 1.1174 ** | 0.5206 |
| Territory with low flood risk within a radius of 500 m (in %) | $\theta_5$ | | | -0.0682 ** | 0.0342 |
| $R^2$/pseudo $R^2$ | | 0.4833 | | 0.5081 | |
| Likelihood-ratio test[(a)] | | | | 10.99* | |
| Wald test of spatial terms | | | | 15.72*** | |

(a) The test compares OLS and the SLX model's results estimated using the same (ML) estimator. The null hypothesis assumes that OLS (constrained) model is nested into SLX.

(b) The test verify that all the spatial parameters are statistically different from zero. This test is referred to the estimates obtained using the GS2SLS estimator.

* p<0.10; ** p<0.05; *** p<0.01; **** p<0.001.

one where the land is located. If a large number of sellers have received the land as an inheritance and have no interest in cultivating it, it is plausible that there is a tendency to sell the land even at a lower price in order to have an immediate monetary return.

The model's results also point out that when the purchasers are corporations, the price is higher than in the situation where the purchasers are natural persons. In the case of corporations, which under current law are to be considered professional agricultural entrepreneurs, the average price paid is 43.2% higher, and if they are not professional agricultural entrepreneurs, it is 25.3% higher. Even in the case of partnerships established by professional agricultural entrepreneurs or direct farmers, the price is significantly higher (14.9%). A first possible explanation for what emerged is the tendency of partnerships and corporations to be more productive and, therefore, they show a higher willing to pay. This is particularly true when the price paid is particularly high in the case of professional enterprises. A second reason could be connected to the fact that direct farmers and professional farmers pay registration fees in a fixed amount and not proportional to the declared value. They would have no incentive to declare a lower amount than actually paid in order to reduce the taxes to be paid to the State. Concerning corporations, 65.4% were found to be active in industry or real estate. In these cases, it can be assumed that the higher price paid is in some way to be traced back to the expectations of land use change triggered by the construction of the Veneto Piedmont Motorway.

Figure 6 shows the value of the direct and the spillover effects, in percentage, respect the total effect on the

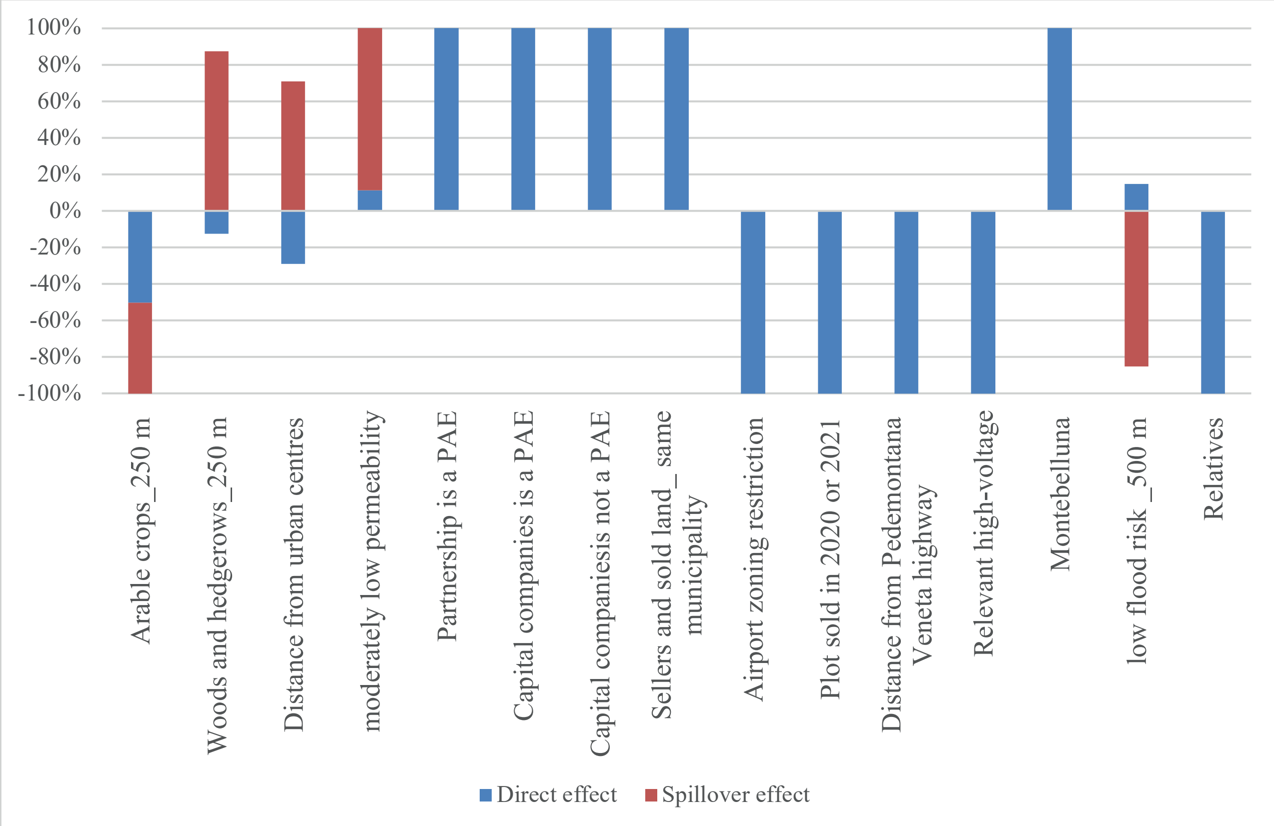


**Figure 6.** Direct and indirect effects in percentage of the total effect. Note: PAE - Professional Agricultural Entrepreneur.

price per unit of surface. Focusing on the variables for which we assumed a significance spatial Durbin effect, direct and the spillover effects are concord in the estimated sign only for the variables named "Arable crops in the radius of 250 m" and "Soil permeability: moderately low", for which the indirect effect represents, respectively, the 50% and the 89% of the total effect on the price per unit of surface. In all the other cases, signs are opposed and the percentage value of the spillover effect on the total one is very high, ranging between the 117% (for the variable named "Woods and hedgerows in the radius of 250 m") and the 169% for the variable named "Distance from urban centres".

## 4. CONCLUSION

This study aims at verifying what intrinsic aspects, locational features, characteristics of buyers and sellers, urban planning and structural constrains influence the value of farmland in some municipalities located in the upper Treviso plain (Veneto, Italy). The main novelty of this study is the use of a spatial model able to treat spatial lags in the data and to account for both direct and indirect (or spillover) effects.

Results confirm empirical evidence already produced by similar studies, especially as it concerns the significance of some intrinsic characteristics, such as the soil permeability, the distance for the urban centres and the presence of easements (e.g. airport zoning restriction and relevant high-voltage overhead transmission line land-use restriction). However, additional information arises regarding what characteristics of buyers and sellers influencing sale prices. According to expectations, if the contractors are relatives, the unit price is 19% lower, while if sellers reside in the municipality where the sold land is located, then the price is 8.6% higher. Moreover, also the corporate form of sellers and buyers matters, implying significant variations both in offered and asked prices. Such results are crucial, especially given the increasing diffusion in the use of valuation standards that identify defined profiles of market operators that, unlikely, often do not coincide with real buyers and sellers. Appraisers should consider how the price changes according to sellers and buyers profiles during the comparables searching phase. This stage in the valuation process is made particularly complicated by the rigidities of the Italian (but not only) rural real estate market, where sales are occasional. Knowing the effect of buyer and seller characteristics on the farmland price is useful to set up factor able to correct prices in the successive analysis.

Further important indications arise by the inclusion in the model of territorial characteristics as determinants on the farmland price. In particular, the land use in the context where the sold plot is located matters, as well as the hydraulic risk of the area and the presence of large infrastructures. Few territorial variables are spatially autocorrelated and this imply the possibility to differentiate the direct from the spillover effect. Estimates suggest that in few cases the spillover effect enhances the direct effect showing the same sign (e.g. fraction of arable crops in the radius of 250 m and soil permeability). The majority of the autocorrelated regressors (fraction of woods and hedgerows in the radius of 250 m, distance from urban centres and percentage of territory with low flood risk within a radius of 500 m), instead, present an indirect effect that is opposite and heavily higher in magnitude than the direct one. This knowledge is crucial to have a more comprehensive understanding of the complex interactions among various factors affecting farmland values.

The main limit of this analysis relates prevalently to territorial data that are available at defined scales, often not suitable for local spatial analyses. However, despite this limitation, the study produces empirical evidence useful for making informed investments and rural market analysis. Understanding the market features allows for identifying opportunities for potential appreciation and to assess the risk associated with the investments. Farmers and agricultural firms, in addition, need to evaluate the cost and benefits of acquiring new farmland or expanding their existing operations. Knowledge of farmland price determinants indicates suitable locations and makes informed decisions about resource allocation. Results of this study are useful also for policy makers and planners in making decisions about land use and development policies. They can identify areas with higher agricultural importance and implement regulations and environmental conservation efforts that protect farmlands from unsustainable farming practices, urbanization or non-agricultural uses.

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