Agricultural and non-agricultural determinants of Italian farmland values

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Summary

Interest towards farmland market has been increasing in recent years. In developing countries there is a rising concern about land being purchased by foreign investors, while in the developed world the debate is focused on whether agricultural factors are still the main determinants of land values or not. This work assesses the determinants of land values in Italy using TSCS data techniques during the time span 1992-2013. In Italy farmland values have historically been influenced more by natural characteristics of the land than agricultural prices. However, lately non-agricultural factors have been increasing their importance. We find that the main determinants of Italian farmland prices are population density, GDP per capita, land productivity, agricultural prices and farm subsidies. In the case of vineyards, changing rainfall patterns due to climate change have also a significant impact. Environmental regulations for livestock farms positively affects arable land values.

Keywords: farmland prices, land market, panel data models, farmland values determinants

JEL Classification codes: C23, E32, Q24

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1. INTRODUCTION

In recent years interest on farmland markets has increased across the world. In developing countries land is being purchased by foreign investors – even governments – giving rise to the "land-grabbing" phenomenon. Farmland values in the United States have been increasing at the highest rates since the 70s, showing a clear relationship with agricultural price trends. In Europe the debate on farmland prices focused particularly on the possible impact of the Common Agricultural Policy (CAP) reform process and on the possible capitalization of CAP subsidies in land prices. In many countries agricultural prices have been amongst the most important determinants of land values for decades, but the recent increase in price volatility may have modified its relevance in comparison with other factors.

Until the early 2000s, only a few studies investigated the functioning of land markets in the EU, if compared with the United States, mainly due to the lack of reliable data on land prices and on their possible determinants. Another reason may have been the relatively low importance given to land - as capital value *per se* - both in scientific and policy discussions. Only once the CAP shifted from market measures to direct payments to farmers (often coupled with production) – generating a distinction between farmers and landowners – the farmland market started to be involved in the policy debate.

The role of non-agricultural factors on farmland values might be substantial but it is not easy to assess. The price of agricultural land is linked to the expected returns from farming activities but the behaviour of landowners - either farmers, non-agricultural landowners and companies - is affected by factors outside the agricultural sector, such as economic growth, inflation rate, possible land development and the presence of recreational amenities. In other words, sometimes the farmland capital is conceived more as a part of household savings than as a production factor.

It is arguable that also climate plays a role. It is clear that climatic conditions determine what can be cropped and what cannot be cropped in a given area, therefore affecting land values. Since climate has been changing in the last decades, it is reasonable to think that such changes had repercussions on land values.

In general the land values are influenced by natural characteristics of the land. In this terms, Italy has a very diversified territory with marked pedologic and climatic differences between lowlands and hilly and mountain areas. Moreover the climate is almost temperate/continental in Northern regions, while predominantly Mediterranean in Central and Southern regions. The aim of this work is to assess the role of agricultural (agricultural prices, land productivity, etc.) and non-agricultural factors (total economic growth, land use changes, and urban real estate trend) as determinants of farmland values in Italy. Section 2 reviews the existing literature on the determinants of farmland values . Section 3 illustrates the evolution of farmland values in Italy. Section 4 is about the econometric methodology used to perform the analysis, section 5 describes the dataset, section 6 shows and comments the results, while section 7 concludes and provides some hints for future research.

2. A SHORT LITERATURE REVIEW ON THE DETERMINANTS OF LAND VALUES

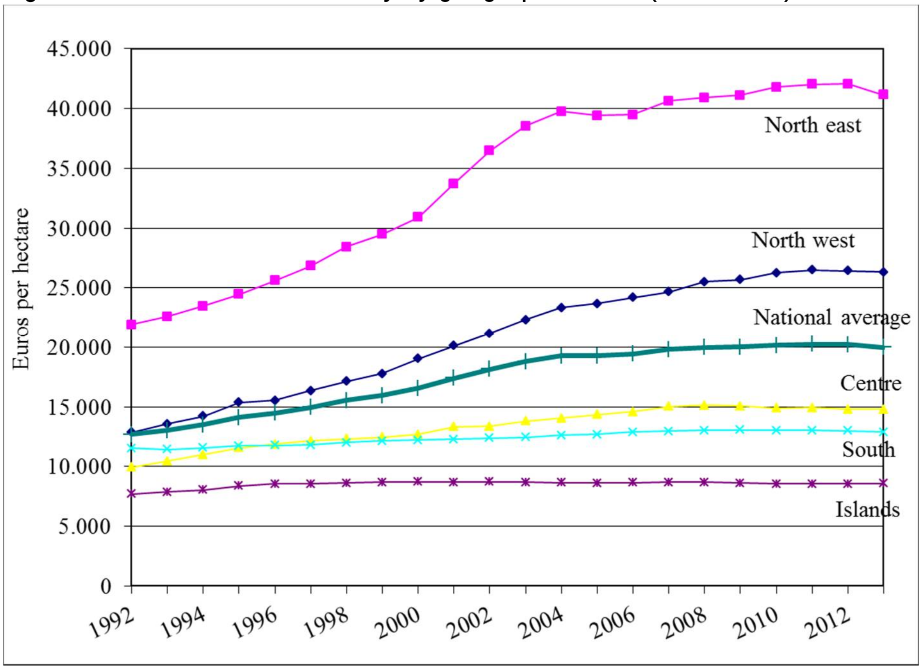
The literature on the determinants of land values is extensive since land – as fixed factor – is very important for farmers. In the specific case of EU farmland market, is more difficult to investigate than the American one, mostly because it is extremely hard to find reliable and constant data about land values and rents, not to mention actual land transactions, on which most of the American studies are based upon. It is also not easy – for many EU countries – to have data about the amount of subsidies paid to a given country and/or region (NUTS2), a factor that many studies have found to significantly affect land values. The capitalization/present value approach, widely used in these studies, assumes that the price of farmland equals the present value of all future expected cash flows produced by the use of land for productive purposes. The farmland prices and cash rents are non-stationary and non-cointegrated, an assertion directly at odds with present value model. In fact, it is need to consider many other factors that determine farmland values, such as the presence of structural changes, as well as some forms of government transfers to the agricultural sector that are capitalised into the value of farm assets (Gutierrez *et al*., 2007). Also the spatial effects that may characterize the determination of agricultural land values, in particular the spatial dependence that should be taken into account in estimating an econometric model that aims at explaining the factors that contribute to land value formation (Saguatti *et al*., 2014). Starting from the 80s, several US farmland price studies focused not only on farmland primary price determinants but also on non-farm factors, such as proximity to urban areas. Non-farm factors have been increasing their importance over time, especially in developed countries, and became – in some cases – one of the most important factors affecting the price of land (Drescher *et al*., 2001). The difficulty to explain the evolution of farmland values only in terms of agricultural factors is not new, even in Europe. The recognition of external influences was already known in the XIX century for England and Wales (Peters et al., 1982) and some evidences about the role of external factors were identified also in Italy (Einaudi, 1934). Afterwards there have been studies attempts to better understand land market behaviour using external factors as explanatory variables (Strotz, 1968; Rosen, 1974; Freeman, 1979; Johnson, 1990). More recent studies confirmed and demonstrate the strong influence of external factors in the farmland values, such as urban pressure, rural amenities, distance effects, capital asset returns, etc.. (Cavailhès and Wavresky, 2003; Jack *et al*., 2009; Salois *et al*., 2012; Mishra and Moss, 2013; Sklenicka et al., 2013). Several studies focus on environmental drivers in farmland price level (O'Donoghue *et al*., 2015), as the effects of an optimal crop mix on the landscape value of farmland (Fleischer and Tsur, 2009), or the proximity in areas close to greenways, parks and water bodies that increase land values over time (Cho *et al*., 2009). Also the land tenure systems and agricultural practices have a role on farmland values, considering that the land owned may be under better conservation practices than land rented, as there may be less incentives to adopt long-term practices for the latter (Choumert and Phélinas, 2015). Finally, the relationship between climate change and farmland value seems to be one of the most interesting field of analysis, due to the likely effects of climate change on the agricultural sector (Mendelsohn *et al*., 1994; Deschenes and Greenstone, 2011).

Land values, it has been argued in several papers, might also be affected by agriculture support policies. Even if the primary objective of such programmes is to protect farmers from the inherent market and production risks they face, the payments provided to farmers may also be capitalized into the value of their assets such as land. Most of the studies assessing the impact of support policies on farmland values refer to the US, while only a handful of studies have investigated the contribution of agricultural policies to farmland values in Europe (Traill, 1980; Goodwin and Ortalo-Magné, 1992; Duvivier *at al*., 2005; Ciaian et al., 2010). CAP subsidies have an impact on land values but this varies substantially across countries and is relatively modest if compared with other factors, especially where land values are high (Ciaian et al. 2011). Moreover, the impact of subsidies on farmland values depends also on policy implementation strategies and market imperfections. Among these factors the influence of land management regulations and land use policy on land mobility has to be more carefully considered, disentangling its effects from the most usual parameters used in the capitalisation formulae (Latruffe and Le Mouel, 2009). In this sense some studies showed that agricultural subsidies are capitalized into land rental prices (Guastella *et al*., 2013), although the dynamics of capitalization depends on credit market imperfections and capitalization of direct payments higher in countries where the financial sector is less advanced and is lower in countries where a significant share of agricultural land is used by large corporate farms (Van Herck *et al*., 2013).

3. FARMLAND VALUES IN ITALY

In Italy farmland values have increased by about 60% on average during the period 1992-2013, more or less to the same extent as the inflation rate. Land prices showed a steadily increase until 2003-2004, more than the inflation rate, while in recent years the rise of prices was lower than inflation. Farmland prices in Northern regions are 2-3 times higher than in Centre-Southern regions. Also prices trends differ between the North and the South: values (in current terms) almost doubled from 1992 to 2013 in Northern Italy while in Centre-Southern regions increased by 15-30% only (Figure 1).

Figure 1: Farmland values in Italy by geographic areas (1992-2013) at current prices.



Source: CREA, Database on farmland values.

Note: An opinion survey on the farmland market is carried out annually by CREA (Council for Agricultural Research and Economics) since 1947 (as INEA). The price refers to bare land, therefore excluding the value of buildings or plantations. CREA identifies average land prices, based on the survey, at sub-regional scale (767 Nuts 4 areas) and for 11 types of crop. Then a set of average land prices at national and regional level is calculated, using a weighting system based on the distribution of agricultural land as reported by Censuses of Agriculture (Povellato, 1997).

Besides agricultural factors (soil fertility, climate conditions, irrigation facilities and other agricultural infrastructure) that indubitably explain a significant share of the difference between Italian regions, other factors have arguably played an important role such as: economic growth, land use planning, inflation rate, and environmental policies. Economic growth in the wealthiest regions is likely to have boosted real estate prices, which effects have spilled over the rural market: Rosato (1991) provided evidence in this direction. Poor land planning increased urban sprawl, therefore inflating agricultural land price through expectations of higher prices due to possible land development (Tempesta and Thiene, 1996). Inflation rate and stock exchange market volatility increase the interest of investors for safer capital values not arbitrarily linked to economic volatility, such as agricultural land. The inflation rate was the main external factor affecting farmland values found by Zuccolo (1991) in the analysis of Italian farmland values 1961-1987. The recent economic crisis and the high volatility in stock markets is one of the reasons at the basis of the relatively constant farmland values in last few years. Also environmental policies have an effect on land values. The Nitrate directive (Directive 91/676/EEC) mandates farmers to spread manure from their farms on land only up to a certain quantity per hectare. The highly concentrated intensive livestock sector in few regions of Po Valley (North Italy) increase the demand of land for manure disposal, therefore exerting an upward pressure on land values.

Another important factor, tested in our analysis, is represented by land degradation, mainly due to climate change. Severe drought periods have affected many parts of Italy in the last two decades, especially in the Southern regions. A recent study (Salvati and Bajocco, 2011) shows clear evidences of an increasing sensitiveness of Southern regions to land degradation, due to climatic vulnerability and anthropogenic factors (poor farming system management, slow economic growth and pressure from other land use in more fertile areas). The different variation rate of farmland values between Northern regions on one side and Central and Southern regions on the other side, evidenced in the last two decades, may reflect different expected returns from the land in these regions.

4. METHODOLOGY

In the literature, the approaches followed to assess the determinants of farmland are mainly three: i) simultaneous supply and demand models; ii) hedonic price models; iii) capitalization or net present value models (Latruffe *et al.*,2008, and Devadoss and Manchu, 2007). In this work we follow Duvivier *et al.* (2005), Latruffe *et al.* (2008), Ifft *et al.* (2015) and Devadoss and Manchu (2007) assuming that farmland values reflect land's ability to generate future returns (the net present value approach), which – properly discounted – determine land values. The capitalization formula that expresses current farmland values as a function of discounted future returns is assumed to be, following Weersink *et al.* (1999):

Equation 1

$$V_t = \sum_{i=0}^{\infty} \frac{E_t(R_{t+i})}{(1 + r_{t+1})(1 + r_{t+2}) \dots (1 + r_{t+i})}$$

Where V_t is the value of agricultural land and $E_t(R_{t+i})$ is expected returns in period $t+i$ based on information available in period t. The discount factor r_{t+i} is allowed to vary over time. Expected returns include returns from agricultural production and government payments but also other factors might affect farmland values such as macroeconomic, climatic and demographic factors. Therefore the present value model can be expressed as, following Latruffe *et al.* (2008):

Equation 2

$$V_t = \sum_{i=0}^{\infty} \frac{M_{t+i} + G_{t+i}}{(1 + r_{t+1})(1 + r_{t+2}) \dots (1 + r_{t+i})} + ALIA_t$$

Equation 2 suggests that not only expected returns from the market (M_{t+i}) and government payments (G_{t+i}) affect land values in period t, but also other factors ($ALIA_t$) do (i.e. climate change, potential urban development, livestock intensity, *etc*).

In the empirical model, we regress yearly average farmland values (total UAA, arable land and vineyards) for the 20 Italian administrative regions on proxies for market-based returns, government-based returns and other factors potentially affecting land values for the period 1992-2013. We take into consideration demand-side factors only, since we assume that – in the time span considered for the analysis – the supply of land is perfectly inelastic. The time series – cross section approach (TSCS) allows to explicitly model unit-specific unobservable effects (i.e. soil fertility), which are likely to affect land values, overcoming one of the main limitation of the net present value approach as highlighted by Latruffe and Le Mouël (2009).

We employ a Correlated Random Effects (CRE) model as firstly suggested by Mundlak (1978) (but following the specification of Bell and Jones (2015)) instead that the conventional Random (RE) or Fixed (FE) effects models which are – by far - the most commonly used models to analyse panel and TSCS data in the economics and social science literature (Dieleman & Templin, 2014). The fixed effects (FE) model is a linear regression model in which the intercept terms vary over the individual units, while the random effects (RE) model assumes that all factors that affect the dependent variable – but that have not been included as regressors – can be summarized by a random error term. The RE model exploits both the between and within dimension of the data and assumes that explanatory variables are strictly exogenous and uncorrelated with the individual specific effects. The FE estimator exploits the within dimension of the data only, and does not imposes any restriction upon the relationship between the time-invariant unit effects and the error term (Verbeek, 2006).

Nevertheless, endogeneity is very common in non-experimental economic datasets (it is very likely that some unobserved characteristics of a given Italian region affect the independent variables or vice-versa) and for this reason the model of choice in economics studies with TSCS data has historically been the FE model, which, although less efficient (it relies on the within variation only), is consistent in the likely case in which unobservable time-invariant variables are correlated with time-variant independent variables. The Hausman test (Hausman, 1978) is generally employed to tests the null hypothesis that explanatory variables and unit effects are uncorrelated.

Bell and Jones (2015) argue that this endogeneity is the result of multiple processes related to any given time-varying covariate (level 1 variable), which is made up by two parts: one that is specific to the higher-level entity (in our case Italian regions) and does not vary between occasions (time), and one that represents the difference between occasions, within higher-level entities. The former part has a “between” effect, while the former a “within” effect and together represent the total effect of a given time-varying variable.

According to Allison (2009), Wooldrige (2013) and Schunck (2013), the RE model is consistent (and therefore more efficient than the FE model) only if the within and between effects are equal; in case they are not, the estimation is affected by omitted variable bias since the between effect is not explicitly modelled. In the case of TSCS data on political entities, it is extremely unlikely that the between and the within effects are the same: the same increase in Gross Domestic product (GDP) per capita, for example, is unlikely to have the same effect on land values in regions characterized by very different levels of GDP per capita (i.e. Trentino Alto Adige, the richest Italian region, and Calabria, the poorest). Therefore, the unaccounted variance will be absorbed by the unit-specific error terms and will inevitably been correlated with the independent variables, violating one of the assumptions at the basis of the RE model. This problem is usually circumvented in the literature using FE models although they do not make an efficient use of the data and, as Plümper and Troeger (2007) suggest, they are also inefficient in estimating the effect of variables that have little within variance with respect to between variance, that is variable that vary little over time and within the same unit (i.e. GDP per capita).

The CRE model allows to fully exploit the advantages of the RE model explicitly modelling the within and between components (therefore solving the endogeneity problem) in order to be able to understand the role of context (in our case Italian regions) that defines the higher level. In other words, with the CRE models it is possible to identify the impact of a change in one the independent variables both within the same region (along time) and between different regions. The CRE model proposed by Bell and Jones (but already known since Mundlak's paper) has been recently used in many empirical studies in the field of economics and social sciences [see, among the others: Asane-Otoo, 2016; Izadi, 2016; Fox and Bell, 2016; Tezcur, 2016; Bell *et al.* 2016; Nieuwenhuis *et al.*, 2016; Ma, 2016; Banchefsky *et al.*, 2016; Rosas and Manzetti, 2015; Vincens and Stafström, 2015; Hao-Chun Chuang and Oliva, 2015).

The estimated RE model is:

Equation 3

$$y_{it} = \alpha + \beta(x_{it} - \overline{x}_i) + \gamma\overline{x}_i + \delta z_i + (u_i + e_{it})$$

Where y_{it} is land values for region i and year t, x_{it} is the series of time-variant variables expected to influence land values in Italian regions (expressed in natural logarithms), $\overline{x}_i$ are region-specific means for each of the time-varying variables (which can be thought as the time-invariant component of such variables). The error term is decomposed in u_i, the time-invariant unobservable, and e_{it}, the idiosyncratic shocks. The only time-invariant z variable included in two the regressions (total UAA and arable land) is the share of mountain area on total regional area.

Coefficients to be estimated are: α, that represent a constant term common to all units and time periods, βs that represent the within-effects of each variable, γs that give the between effects and δ that is the coefficient of the only time-invariant variable included in the model (for the total UAA and arable land regressions only). It is worth noting that βs are identical to the FE estimate. The CRE model, in the Bell and Jones specification, can be extended in order to include random slopes, that is let the coefficients βs assume different values for different units (Schunck, 2013).

Three versions of **Errore. L'origine riferimento non è stata trovata.** have been estimated: one for total utilised agricultural area (UAA), one for arable land, and one for vineyards. The independent variables were not the same for all the regressions (i.e. selling prices of agricultural outputs), as explained in the data section.

All variables are expressed in natural logarithms to both reduce heteroscedasticity problems and to allow the interpretation of coefficients as constant elasticities. They measure the relative change in the dependent value due to a relative change in one of the independent variables, so that the coefficient of one of the explanatory variables represents the percent change in the dependent variable due to a 1 percent change in the independent variables, *ceteris paribus*.

5. DATA

The dataset is a balanced panel including average yearly values for every Italian region (20 units) from 1992 to 2013 (22 periods) for a total of 440 observations. Three regressions have been estimated: one for total utilized agricultural area, one for arable crops and one for vineyards. In all cases the dependent variable is farmland values, while independent variables vary slightly across equations to better capture the dynamics of land values formation in each of the land types considered. Such independent variables have been chosen, according to economic theory, on the basis of the available literature on land values determinants. All monetary variables have been expressed in constant 2010 euros, in order to control for inflation.

Average yearly land values (thousand euro/ha) for total utilized agricultural area (UAA), arable land, permanent crops, and vineyards are from the Italian National Database on Farmland Values provided by CREA (National Council for Research in Agriculture and Agricultural Economics) as well as data on cropped areas. Population density and GDP figures at regional level were provided by ISTAT (Italian Statistics Institute) and SVIMEZ (Association for the Industrial Development of Southern Italy) respectively.

A time-invariant variable – the share of mountain area on total area – has been included in the total UAA and arable land regressions in order to take into account the fact that agricultural activity is more difficult to carry out in mountainous areas.

Farmland productivity for a given region and a given year has been calculated – separately for total UAA, arable land, and vineyards - as the five-year moving average of the ratio between the value of production and cropped area. In the case of total UAA the value of agricultural production is the total agricultural output (excluding forestry and fishery), in the case of arable crops is the value of the production of arable crops plus the value of production of the livestock sector (excluding sheep and goats), while in the case of vineyards is the value of wine and table grapes production. Figures on the value of agricultural production are from the Economic Accounts of Agriculture database (ISTAT).

The bioclimatic aridity index (AI) is based on the UNEP methodology (Middleton and Thomas, 1992) to quantify drought occurrence. It has been calculated, for each Italian region, as follows:

Equation 2

$$AI = \frac{P}{PET}$$

where PET is the annual cumulative evapotranspiration (mm) and P is the annual cumulative precipitation (mm). Data are from the Italian National Institute for Environment Protection and Research (ISPRA). For values of AI lower than 0.2 areas are defined as “dry”, for SI values lower than 0.5 areas are considered “semi-arid”, while and higher values identify sub-humid and humid areas. We incorporated an aridity index in the regressions because we believe that farmland values might be affected by the perceptions that buyers and seller have on climate change, which, in Italy, translates into an increasing risk of desertification, especially in Southern and, to a lesser extent, Central Italy.

In order to reflect this perception, based on past meteorological events, the aridity index (AI) for year t and region j is defined as:

Equation 3

$$AI_{tj} = \frac{AI_{t-1j} + AI_{t-2j} \dots AI_{t-nj}}{n}$$

Where AI_{tj} is the value of the aridity index for region j in year t to be included in the regression and $n = 10$.

Environmental regulations (especially EU Directive 91/676/CEE) are likely to have had an impact on farmland values, especially in regions were intensive livestock farming is present and where farmers need to own or rent a given amount of land for each animal raised. For this reason livestock units (LSU) per hectare have been included among the explanatory variables (source Eurostat database).

Agricultural output prices have been calculated in three steps. The first step consisted in computing the ratio between the value of agricultural production (at constant prices) and the quantity produced for each product in each region for each year (1987-2013, ISTAT). The second step was the calculation of "weighted averages" of such prices in order to obtain "price series" representing the movements of agricultural prices for each region in the period considered; the weights used for this step were the share of each product's production value on total agricultural output for each region and each year. For the "total UAA" regression all products were considered, for the "arable crops" regression arable crops and livestock products (except sheep and goat) and for the "vineyards regression" table grapes and wine. Finally, in the third step, we computed the five-year moving average of each price series since we reckon that buyers' and sellers' decisions in time t are based on price movements in previous years rather than on prices at time t.

Farm subsidies are the annual monetary value of gross transfers from taxpayers to agricultural producers provided by public authorities at European, national and regional level, collected over the years by INEA-CREA.

Gross Domestic Product and population at regional level has been obtained by the Economic Accounts databases (ISTAT). Finally, average house prices were provided by the Bank of Italy.

6. Results

The interpretation of regression coefficients and relative standard errors has to be made taking into account that the error terms of each regression do not respect the homoscedasticity and serial independence assumptions: the Durbin-Watson (DW) statistic for FE panel data (Bhargava, Franzini, & Narendranathan, 1983) and the Wooldrige (2002) test for serial correlation in FE panel data[1] both induce to think that the errors are serially correlated, as one might expect, given the long time dimension of the data (22 periods). In presence of autocorrelation and heteroscedasticity estimated standard errors can be misleading and it is

[1] Since the FE estimator can be applied – since it is consistent – also when the RE effects estimator is both consistent and efficient (that is when the unit time-invariant effects are not correlated with the explanatory variables), the heteroscedasticity and autocorrelation tests for the FE effects model can be applied also in the RE case (Verbeek, 2006).

common practice to estimate an autocorrelation - and heteroscedasticity - robust covariance matrix (HAC standard errors) following Arellano (1987). However, such robust standard errors are valid only when N (number of unit) is much larger than T (number of periods) and this is clearly not the case in our sample of 20 regions (N) and 23 years (T). Since it is also likely that the data are spatially correlated (i.e. farmland values are likely to be high in regions bordering regions with high farmland values) an heteroscedasticity - autocorrelation - and spatial correlation-robust covariance matrix has been estimated as suggested by Driscoll and Kraay (1998), which is particularly recommended when T becomes large, like in our case.

In the total UAA regression (Table 1) only few between coefficients are significant: agricultural output prices, land productivity and LSU per hectare. Between regions, a 1% increase in land productivity triggers a 0.85% increase in farmland values, while the impact of the same increase in LSU per hectare implies just a 0.06% increase in farmland values. The sign of the between coefficient of the price variable is negative, contrary to what one could expect, even if barely significant. This is because land values in some scarcely populated regions (i.e. Valle D'Aosta and Trentino Alto Adige) are very high due to local factors which were not possible to model. The between coefficient of the aridity index is positive (0.646) and highly significant, as we expected *a priori*: less arid are characterized by higher farmland values.

Table 1. Correlated random effects estimates – Total UAA regression

Independent variables	Coefficients	Asymptotic standard errors	P-values	Sig.	Robust SE (Driscoll and Kraay, 1998)	P-values	Sig.
Constant	6.416	2.522	0.011	**	2.589	0.014	**
Share of mountain area	-0.170	0.081	0.035	**	0.106	0.109	
Farmland productivity (b)	0.849	0.241	0.000	***	0.495	0.087	*
Farmland productivity (w)	-0.035	0.060	0.562		0.103	0.737	
Aridity index (b)	0.646	0.274	0.019	**	0.179	0.000	***
Aridity index (w)	0.002	0.058	0.972		0.039	0.959	
LSU per hectare (b)	0.064	0.063	0.314		0.035	0.064	*
LSU per hectare (w)	0.109	0.042	0.009	***	0.055	0.045	**
Agricultural prices (b)	-0.486	0.245	0.048	**	0.254	0.056	*
Agricultural prices (w)	0.173	0.040	0.000	***	0.045	0.000	***
Subsidies per hectare (b)	0.094	0.219	0.668		0.148	0.527	
Subsidies per hectare (w)	0.148	0.023	0.000	***	0.023	0.000	***
GDP per capita (b)	0.183	0.498	0.714		1.220	0.881	
GDP per capita (w)	0.422	0.094	0.000	***	0.136	0.002	***
Population density (b)	-0.483	0.216	0.026	**	0.343	0.160	
Population density (w)	0.930	0.201	0.000	***	0.136	0.000	***
House prices (b)	0.230	0.373	0.538		0.768	0.765	
House prices (w)	-0.015	0.042	0.722		0.053	0.778	

***, ** and * denote significance at 1, 5 and 10% confidence levels respectively.

The within-region variation of farmland values is well explained by population density (coefficient of 0.930), GDP per capita (0.422), agricultural output prices (0.173), farm subsidies (0.148) and LSU per hectare (0.109): *ceteris paribus* an increase of each of these variables - over time and within the same region

– pushes farmland prices up. The effect of population density (a proxy of the urban pressure) and GDP per capita is the strongest one, but also agricultural prices and farm subsidies play a significant role. The effect of LSU per hectare is positive and significant since, due to environmental regulations, livestock farmers must own (or borrow) a given amount of land for each animal raised in order to reduce soil and aquifer pollution from nitrates.

The results from the arable land regression (Table 2) are somewhat similar to those of the total UAA regression even though with some substantial differences. First of all, the coefficient of the time-invariant variable representing the share of mountain area on total regional area is significant and negative (0.139) meaning that a 1% increase, between regions, in mountain area's share leads to a 0.139 decrease in arable land values. This means that mountainous regions tend to have lower arable land values. Land productivity is another important factor in explaining arable land values differences between regions (0.639), while the aridity index coefficient – similar in magnitude with that of the total UAA regression – is significant just at 10% confidence level.

Table 2. Correlated random effects estimates – Arable land regression

Independent variables	Coefficients	Asymptotic standard errors	P-values	Sig.	Robust SE (Driscoll and Kraay, 1998)	P-values	Sig.
Constant	1.392	2.962	0.639		2.712	0.608	
Share of mountain area	-0.139	0.098	0.158		0.045	0.002	***
Farmland productivity (b)	0.639	0.131	0.000	***	0.154	0.000	***
Farmland productivity (w)	0.194	0.053	0.000	***	0.069	0.005	***
Aridity index (b)	0.507	0.292	0.084	*	0.308	0.100	*
Aridity index (w)	0.104	0.055	0.059	*	0.048	0.030	**
LSU per hectare (b)	0.006	0.067	0.934		0.082	0.946	
LSU per hectare (w)	0.065	0.040	0.107		0.048	0.179	
Agricultural prices (b)	-0.307	0.464	0.509		0.769	0.690	
Agricultural prices (w)	0.538	0.074	0.000	***	0.099	0.000	***
Subsidies per hectare (b)	-0.158	0.252	0.530		0.422	0.708	
Subsidies per hectare (w)	0.118	0.021	0.000	***	0.021	0.000	***
GDP per capita (b)	1.059	0.499	0.034	**	1.310	0.419	
GDP per capita (w)	0.721	0.101	0.000	***	0.120	0.000	***
Population density (b)	-0.085	0.144	0.553		0.154	0.580	
Population density (w)	1.575	0.232	0.000	***	0.278	0.000	***
House prices (b)	-0.235	0.409	0.566		0.761	0.757	
House prices (w)	-0.019	0.035	0.583		0.031	0.531	

***, ** and * denote significance at 1, 5 and 10% confidence levels respectively.

Within regions the main drivers of arable land prices are almost the same of those of total UAA even though they differ greatly in magnitude. A 1% increase in population density triggers almost a 1.6% increase in arable land values: this can be explained by the fact that arable land is usually located in plain areas and therefore more subject to urban sprawl. With respect to the total UAA regression, also the magnitude of the GDP per capita (0.721) and agricultural output prices (0.538) increase. The magnitude of the within farm support coefficient is similar to that of the total UAA regression (0.118). even though only at 5% confidence level, also the within coefficient of the aridity index is significant, implying that, within regions, an 1% increase in the index (meaning a wettest climate) implies a 0.104% increase in arable land values.

In the case of vineyards (Table 3) none of the between coefficients is significant, meaning that none of the variables included in the model explains the different level of vineyard prices between regions. Similarly to the other regressions, within regions, the main drivers of vineyard prices are population density (1.764), GDP per capita (0.742) and the price of wine and table grapes (0.110). While the magnitude and significance of the GDP per capita coefficient can be interpreted by the fact that rich regions are more likely to host high-quality wine farms to fulfil local demand, the magnitude population density coefficient is more difficult to interpret. The magnitude of the coefficients of wine and table grapes prices and agricultural subsidies is similar and close to 0.100. Finally, in the case of vineyards, important drivers of land prices – within regions – are the number of Protected Designation of Origin (PDO) wines (0.067) and, most importantly, the aridity coefficient, meaning that an increase in drought episodes due to climate change can potentially have a negative effect on the profitability of the Italian wine industry and, in turn, on vineyards values.

Table 3. Correlated random effects estimates – Vineyards regression

Independent variables	Coefficients	Asymptotic standard errors	P-values	Sig.	Robust st.err. (Driscoll and Kraay, 1998)	P-values	Sig.
(Intercept)	1.718	5.602	0.759		4.648	0.712	
Farmland productivity (b)	0.506	0.640	0.430		0.576	0.380	
Farmland productivity (w)	-0.078	0.049	0.113		0.068	0.251	
Aridity index (b)	0.694	0.995	0.486		1.355	0.609	
Aridity index (w)	0.311	0.069	0.000	***	0.090	0.001	***
Agricultural prices (b)	0.357	0.767	0.642		0.619	0.565	
Agricultural prices (w)	0.110	0.065	0.092	*	0.039	0.005	***
PDO vines (b)	0.053	0.321	0.869		0.316	0.867	
PDO vines (w)	0.067	0.026	0.009	***	0.020	0.001	***
Subsidies per hectare (b)	0.222	0.564	0.694		0.292	0.448	
Subsidies per hectare (w)	0.125	0.029	0.000	***	0.020	0.000	***
GDP per capita (b)	0.130	1.270	0.919		1.906	0.946	
GDP per capita (w)	0.742	0.146	0.000	***	0.128	0.000	***
Population density (b)	-0.244	0.479	0.611		0.386	0.528	
Population density (w)	1.764	0.268	0.000	***	0.409	0.000	***
House prices (b)	0.202	0.932	0.828		0.801	0.801	
House prices (w)	-0.047	0.046	0.309		0.050	0.349	

***, ** and * denote significance at 1, 5 and 10% confidence levels respectively.

7. CONCLUSIONS

This work assesses the determinants of farmland values in Italy during the period 1992-2013 using TSCS econometric techniques. It is the first attempt of quantitative analysis regarding land values in Italy. Three regressions have been run: for total UAA, arable land, and vineyards.

The main result that emerges from this work is that the price of farmland, in Italy, is heavily affected by non-agricultural factors and only to a lesser extent by agricultural ones. This outcome is in line with the *a priori* expectations since, in (post)-industrial countries like Italy, agriculture ceased long ago to be the most profitable way to employ land: as a matter of fact, nowadays there is a multitude of alternative land uses and urban pressure is much higher than it used to be.

Within each Italian regions, population density and GPD per capita are the main determinants of land values for total UAA, arable land and vineyards. In the case of arable land the price of agricultural outputs is also an important driver, while in the case of total UAA and vineyards its importance – although relevant – is of a lower magnitude. These results could suggest that changes in the distribution of population and the average income are the main drivers of land value, because may stimulate the urban growth.

Climate change, which in Italy takes the form of increasing aridity, does have an impact on farmland values, especially in the case of vineyards, while the effect is lower (but still present) in the case of arable land, since the most productive arable land, in Italy, is irrigated.

Farm subsidies have a significant impact on farmland values in each regression, although the magnitude of the estimated coefficients is lower than those of other variables. Also the presence of intensive livestock farming does have an impact on arable land values (although not very high), while land values do not seem to be affected by house prices, contrary to what one could expect *a priori*.

Between regions, differences in farmland values are explained (but only for arable land) by land productivity.

Summarizing, land values in Italy are mainly determined by potential alternative uses of land. Farmland in many areas of the country is viewed as a “land reservoir” to which draw when it is needed. Demand for land by farmers is relevant only where the agricultural sector is well structured and able to generate stable and large cash-flows, that is in the flat, well-endowed (in terms of infrastructure) areas of Northern Italy. The influence house prices have on crop land values can be thought as a consequence of operators’ expectations towards agricultural land becoming building land in the future. Despite the progressive dismantling of the CAP, our results show that farm subsidies continue to be capitalized into farmland values.

Climate change, approximated with an aridity index, seems to have an impact on land values, especially in the case of vineyards, even though we are well aware that the climate issue should be studied more in depth, also taking into account other bio-physical variables. We think that climate change, which in a Mediterranean country like Italy translates into an increasing risk of desertification, might change operators’ attitude towards investing in farmland and/or their willingness to pay for it. The negative effect of increasing aridity on land values is particularly clear in the case vineyards since they cannot rely on irrigation being located in hilly or mountainous areas.

One limit of this work is that was not possible to include land rents as explanatory variables. Land rent are likely to influence land values but the Italian rent market is far to be transparent since in many areas (not only remote ones) verbal agreements are still quite common.

Evidence from the literature about the degree to which agricultural subsidies are capitalized into land values has been mixed but, from the results of this work, it emerges that they do have an impact.

Finally it must be borne in mind that land prices are also closely related to macroeconomic factors, fiscal policies, and financial markets since land, other than production factors, is often considered a “safeheaven" or a "refuge-asset" in periods characterized by bad economic trends given its ability to re-evaluate over time.

To the best of our knowledge this work is the first one attempting to assess farmland drivers in Italy and has to be therefore regarded as a starting point for further research. We reckon that more precise results can be obtained both improving the dataset (i.e. performing the analysis at a lower level of spatial aggregation) and applying more sophisticated econometric techniques such as CRE models with random coefficients and explicitly modelling spatial correlation. However, data availability seems to be a bigger problem than the methodological one.

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