Agricultural and non-agricultural determinants of Italian farmland values

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Abstract

Interest towards farmland market has been increasing in recent years. In developing countries there is rising concern about land being purchased by foreign investors, while in the developed world the debate is centred 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 panel data techniques during the time span 1992-2010. 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 agricultural prices only slightly affect average land values in Italy. Main determinants of land prices are GDP per capita, land productivity, house prices, farm subsidies, and, especially for permanent crops and vineyards, increasing aridity due to climate change. For arable land also environmental regulations for livestock farms positively affects values.

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

JEL classification: C23, E32, Q24.

1. Introduction

In recent years concern over the farmland market 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 are increasing at the highest rates since the 70s, showing a clear relationship with agricultural price trends. In Europe concerns over farmland prices refer particularly to the possible impact of the Common Agricultural Policy reform process aiming at higher market integration of the European market with the world one, meaning an increased transmission of price volatility to the domestic market. 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, there had been a few studies on the functioning of land markets in the EU, if compared with the USA, mainly due to the lack of reliable time series on land prices and other related factors. Another reason may be the relatively low importance given to this production factor - as capital value *per se* - both in scientific and policy discussions. Only once the CAP policy reform started to significantly affect the level of agricultural subsidies with an increasing distinction between farmers and landowners, the concern about land market started to be involved in the policy debate. It remains not completely clear what is the role of "external" - that is non-agricultural factors on farmland values evolution. The price of agricultural land is clearly linked to the expected returns from farming activities but the behaviour of landowners - either farmers, non-agricultural landowners or 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 part of household savings than as production factor.

Also the climate plays a role. It is clear that the climatic conditions of a place determine what can be cropped and what cannot be cropped in a given area and therefore to land values. A remote and semi-arid mountain area in Sicily is much less fertile than an alluvial plain, rich in water, in the Northern part of the country and values reflect this difference. Since climate is changing, it is reasonable to think that the “climatic gap” between Northern and Southern Italy, which has been widening in recent years (more rain in the North and less in the South), plays a significant role in determining land value changes.

The Italian farmland market is characterized by all these aspects. Historically Italian land values have been influenced by natural characteristics of the land. Italy has a very diversified territory with marked pedological and climatic differences between lowland, hilly and mountain areas. Moreover the climate is almost temperate/continental in Northern regions, while predominantly Mediterranean in Central and Southern regions. Physical characteristics explain the differences in farmland values in absolute terms but if we consider the evolution of the market, other factors must be analysed to understand the trend in the last decades. Moreover Italian land market is likely characterized by a different perception of the uncertainty of returns on land investments across regions since – during the last twenty years - the difference in average land prices between the North and South of the country has considerably increased.

The aim of this work is to assess the role and the importance of internal factors (agricultural prices, land productivity, *etc.*) as determinants of farmland values in Italy, in comparison to external factors, such as total economic growth, land use changes, and urban real estate trends. Section 2 reviews some evidences from the existing literature on the determinants of farmland values. Section 3 retraces 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. LAND MARKET: GENERAL ASPECTS

The literature on the determinants of land values is quite extensive since land – as fixed factor – is very important for farm operators, although the majority of the existing literature on land values is mostly about the United States and Canada. The EU farmland market is much 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. Until the 50s the capitalization approach was considered indisputably correct by US economists since the evolution of real farmland value and agricultural income went in the same direction. However, agricultural income started to decrease starting from the 60s, while land value kept increasing and this raised doubts regarding the appropriateness of this approach. GUTIERREZ et al. (2005) utilized panel unit root and cointegration analysis to test whether the present value model holds for a sample of 31 US states during the period 1960-2000. The present value model can in fact be formally tested using cointegration analysis. Results showed that the cointegration hypothesis cannot be rejected if there is a regime shift and the authors conclude the present value model cannot be excluded once one allows for a time-varying discount rate.

Among the few studies dealing with the determinants of farmland price in Europe, DUVIVIER et al. (2005) estimate the determinants of arable farmland prices using a balanced panel of 42 Belgian districts for the period from 1980 to 2001. In this framework they thought average sale price of arable land (per hectare) to be a linear function of both demand-side and supply-side factor. The authors estimated the model using several different techniques, finally opting for a fixed effect estimator. The authors found that the exchange price of arable farmland is affected by compensatory payments and that the expected land rent from market sales exerts an important effect on arable farmland price, especially before the 1992 CAP reform.

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 the 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) identify the relative importance of farmland price determinants in Minnesota, including, among the explanatory variables, the urban “sprawl”, that is the percentage of farmland lost in each county between 1982 and 1992. They found the coefficient of the “sprawl” variable to be positive and significant. In the last decade there have been increasing attempts to better understand land market behaviour using external factors as explanatory variables. In addition to urban pressure, infrastructure and recreational amenities are other important drivers of farmland prices (STROTZ, 1968; ROSEN, 1974; FREEMAN, 1979). Recently FLEISCHER and TSUR (2009) analyse rural–urban land allocation in the light of the increasing environmental role of agricultural landscapes, emphasizing the effects of an optimal crop mix on the landscape amenity value of farmland. CHO et al. (2009) shows that land values in areas close to greenways, parks and water bodies increase over time.

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). JOHNSON (1990) pointed out the inconsistency of the behaviour of farmland prices in the United Kingdom, if the explanations are only based on the evolution of farm income and other standard factors. Non-farming characteristics have to be taken into consideration to justify different prices for parcels of farmland that are agriculturally similar, such as housing development. A French study demonstrates that the influences of urbanisation premium of farmland values gradually declines across the peri-urban belt, probably due to the offsetting of rural amenities on the distance effect (CAVAILHÈS and WAVRESKY, 2003). More recently JACK et al. (2009) demonstrate that household behaviour of small scale farms is influenced by expected capital asset returns, alongside lifestyle and profit reasons. In these cases land as a tangible asset is perceived to be a relatively stable and secure investment involving less risk than alternatives such as equities.

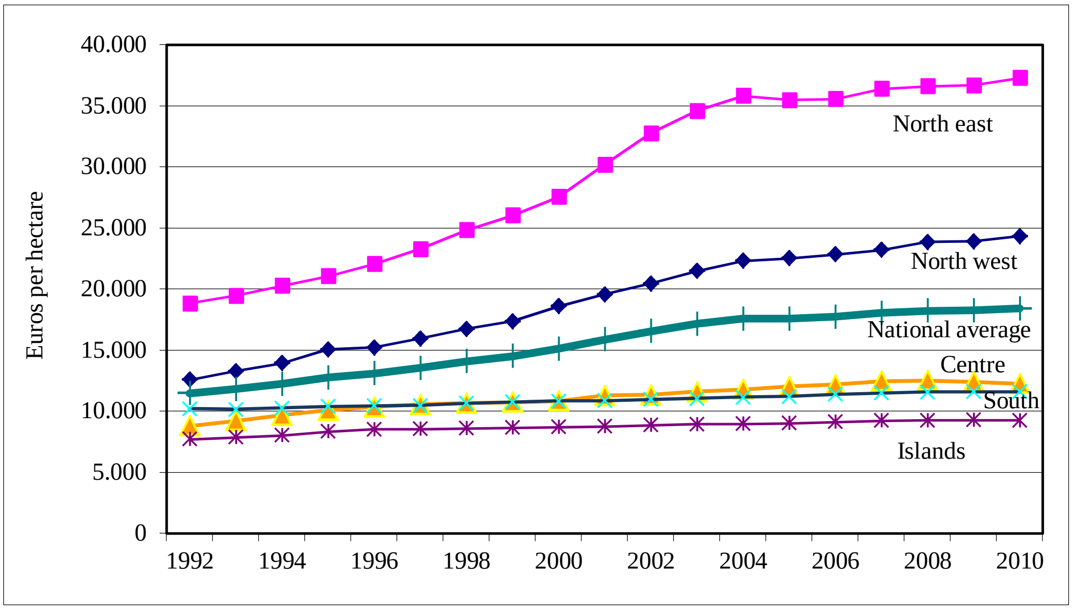
Land values, it has been argued in several papers, might also be affected by agriculture support policies. Even if the primary objective of such programmes is to protect farmers from the inherent market and production risks they face, the payments provided to farmers may also be capitalized into the value of assets such as land. The extent of the contribution of agricultural support has been extensively reviewed by LATRUFFE and LE MOUEL (2009). Most of the studies assessing the impact of support policies on farmland values refer to the US, while, according to CIAIAN et al. (2010), only a handful of studies have investigated the contribution of agricultural policies to farmland values in Europe: TRAILL (1980), GOODWIN and ORTALO-MAGNÉ (1992) and DUVIVIER at al. (2005). 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, it was pointed out that the impact of subsidies on farmland values depends also on policy implementation details 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).

Finally, the relationship between climate change and farmland value seems to be one of the most interesting field of analysis, due to the likely arising effects of climate change on agricultural sector. Again the American literature has been much more frequent on this subject, since the seminal work of MENDELSOHN et al. (1994). More recently, DESCHENES and GREENSTONE (2011) confirm through econometric analysis that the most important impacts of temperature are linked to extreme events and, as recent research suggests, the most substantial impacts on agriculture may be happen especially in areas characterized by irregular rainfall, such as the Southern part of Italy.

3. THE EVOLUTION OF FARMLAND VALUES IN ITALY

In Italy farmland values have increased by 60% on average during the period 1992-2010, more or less to the same extent as inflation rate (+58%). 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 bigger than in Centre-Southern regions. Also prices trends differ between the North and the South: values almost doubled from 1992 to 2010 in Northern Italy while in Centre-Southern regions increased by 15-30% only (Figure 1).

Figure 1 - Farmland values in Italy by geographic areas (1992-2010)



Source: INEA, Database on farmland values.

Note: An opinion survey on the farmland market is carried out annually by INEA (National Institute of Agricultural Economics) since 1947. The price refers to bare land, with the exclusion of the value of any buildings or plantations on the land. INEA identifies average land prices, based on the survey, at sub-regional scale (767 NUTS4 areas) and for 11 types of crop. Then a set of average land prices at national and regional level has calculated, using a weighting system based on the distribution of agriculture land collected by Agricultural Censuses (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 with, which effects have spilled over the rural market: ROSATO (1991) provided evidence in this direction. Poor land planning increases 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. 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 of stock exchanges is one of the reasons at the basis of relatively constant values in the farmland markets in last few years. Lastly also environmental policies do 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 degradations, due to climatic vulnerability and anthropogenic factors (poor farming system management, slow economic growth and pressure from other land use in coastal 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 this work we use panel techniques to investigate the determinants of farm land values in Italy. We regress yearly average farmland values for the 20 Italian administrative regions on an array of explanatory variables for the period 1992-2010. The time period was limited by the availability of systematic database on farmland prices. The panel approach has been preferred over a pure time series or cross-sectional one because it allows explicitly modelling time and heterogeneity effects (through the unit-specific effects) obtaining more efficient estimates (more observations), reducing multicollinearity problems (more variation in explanatory variables thanks to the combination of within and between variation), and - most importantly- reducing the potential missing variable bias since unit-specific effects are included in the model.

The two most important and widely used panel regression models are the fixed and the random effects ones. 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 the between dimension of the data (difference between individuals) 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 (differences within individuals) and does not imposes any restriction upon the relationship between the unit effects and the error term (VERBEEK, 2006).

Usually the FE estimator is used when the interest lies in the individual effects and inference is with respect to the effects that are in the given sample (*i.e.* countries, large companies, industries). The RE effect approach is preferred when one is interested in making inference with respect to the population characteristics. When explanatory variables are correlated with individual effects (and it seems very much the case when analysing land value determinants) one is forced to use FE since RE is biased. The Hausman test (HAUSMAN, 1978) tests the null hypothesis that explanatory variables and unit effects are uncorrelated. Under the null both RE and FE estimators are consistent but RE is also efficient, while under the alternative only the FE is consistent.

The FE model has the big drawback that does not allow the estimation of time-invariant variables since it uses only the within variation and disregards the between variation in estimation. Even if in this work none of the variables is time-invariant, many of them change much less within the same unit than they do across units. This can be a problem when estimating the model since the FE is inefficient in estimating the effect of variables that have very little within variance (PLÜMPER and TROEGER, 2007). Inefficiency does not only translate into low significance levels but also into unreliable point estimates of the coefficients. PLÜMPER and TROEGER (2007) suggest an alternative estimator that allows the estimation of time-invariant variables and that is more efficient that the conventional FE model in treating rarely-changing variables. This model is called fixed effects vector decomposition (FEVD) because decomposes the unit-specific effects into an unexplained part and a part explained by the time-invariant or the rarely-changing variables. This method implies establishing *a priori* which variables are time-invariant, which are rarely-changing, and which are changing. PLÜMPER and TROEGER (2007) suggest to consider as rarely-changing variables those for which the ratio between the between and the within variance is higher than 2.8. The FEVD involves three steps: in the first one a FE model is estimated on the baseline model (only changing variables), in the second step the procedure splits the unit effects into an explained and an unexplained part by regressing the unit-specific effects from step 1 on the time-invariant and rarely-changing variables, finally the third step consists in a pooled OLS estimate of the full model (containing all variables) including the residuals from step 2 (unexplained part of the FE vector). The third stage allows computing correct SEs for (almost) time-invariant variables. In this stage it can also be controlled for serial correlation of the error term. The FEVD model can be formally expressed as:

(1) $y_{it} = \alpha + \sum_{k=1}^{K} \beta_k x_{kit} + \sum_{m=1}^{M} \gamma_m z_{mi} + u_i + \varepsilon_{it}$

Where x variables are time-varying and z variables are assumed to be time invariant or rarely-changing. u_i are the unit-specific effects (FE), ε_{it} is the independent and identically distributed error term, α is the intercept and β and γ are parameters to be estimated.

In this work the determinants of Italian land values are assessed through the RE, FE, and FEVD methods. The Hausman test is used to choose which, among the RE and FE model is more appropriate.

Since most of the explanatory variables have a very low longitudinal variance during the time span considered the model has been estimated also using the FEVD technique.
Most econometric textbooks suggest the use of the Hausman-Taylor procedure for panel data in presence of time-invariant variables and/or correlation between explanatory variables and unit-specific effects. In this framework exogenous time-varying variables are used as instruments for the endogenous time-varying variables, and the unit means of the exogenous time-varying variables as instruments for the endogenous time-invariant variables. Even if the procedure is econometrically correct, in practice, it is very difficult to identify the correct instruments, since the procedure works well only if the instruments are uncorrelated with the errors and the unit effects are highly correlated with the endogenous variables, while the unit effects are unobserved (PLÜMPER and TROEGER, 2007). For these reasons and for the fact that, in our model, there are not time-invariant variables but only rarely-changing ones, it has been decided to follow the FEVD approach.
We have created four models: one general model for the whole land market corresponding to the total utilised agricultural area (UAA) and three crop models for arable land, permanent crops (olive and citrus groves and orchards) and vineyards.
All variables are expressed in natural logarithms to both reduce heteroskedasticity 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 2010 (19 periods) for a total of 380 observations. The dependent variable is represented by the average yearly land values (thousand euro/ha) for total utilized agricultural area (UAA) in the general model and land values for arable land, permanent crops and vineyards in the three crop models. Explanatory variables have been selected on the basis of the existent literature and according to what economic theory would suggest. Land rents were not included among explanatory variables because in many regions verbal and informal rent agreements are still quite common and a complete time series for each region of average values is not available. A detailed description of each explanatory variable is provided below.
Land productivity - Land productivity has been calculated as the ratio between production value and UAA, with the figures provided by Economic Accounts for Agriculture and Structure of Agricultural Holding databases. In the case of arable land, productivity has been computed as the ratio between production value of arable crops and arable land area. The same ratio has been used for permanent crop (excluded viticulture) and vineyard productivity.

Aridity index - This index was chosen to incorporate the perception of sellers and buyers on climate changes and consequently their influence on the estimation of land values. In order to reflect this perception, based on previous evolution of climate, the annual aridity index (AI) has been obtained by the average of the previous decade. So, for example for 1992 the *AI* is the average of the period 1982-1992, The bioclimatic AI is based on UNEP methodology (MIDDLETON and THOMAS, 1992) to quantify the drought occurrence at each region and defined as,

(4) $AI = \frac{P}{PET}$

where PET is the annual cumulative evapotranspirations (mm) and P is the regional average annual cumulative precipitation (mm). The data used are the average annual cumulative precipitations and annual cumulative evapotranspiration, both referred to period 1982-2010 for each region. The elaboration is based on data recorded in regional weather stations. The interpretation of the index is characterized on three classes of reference. 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 wetlands and sub-humid areas.

Agricultural prices - In the general model we have used the implicit agricultural output price deflator calculated for each region on the basis of Economic Accounts for Agriculture. In the three crop models it has been decided to use agricultural price indices calculated through a weighted average of prices for main regional crops, weights being the average production value during the 1992-2010 period. In the arable land model it has been included also a livestock output price index.

Farm subsidies - It has only been chosen the annual monetary value of gross transfers from taxpayers to agricultural producers provided by public authorities at European, national and regional level.

*Pig densit*y - A proxy of the presence of relevant environmental regulations is represented by the ratio between pig population and UAA.

GDP per capita - Gross Domestic Product and population at regional level has been obtained by the Economic Accounts database.

Urban sprawl index - The metric of urban sprawl has been based on synthetic urban sprawl index. We adapted the methodology proposed by JAT et al. (2008) using the Shannon's entropy to measure the degree of spatial concentration or dispersion of a geographical variable. More precisely we assume the resident population in urban zones as a geographical variable over a period of 20 years (1990-2010) and we calculate the entropy (*H*) by

(2) $H = -\sum_{i=1}^{n} P_i \log(P_i)$

where P_i is the proportion of the regional population in the *ith* urban areas on the total regional population and *n* is the total regional urban areas p.a.. The H was standardized through relative entropy to obtain the *relative sprawl index* (Sir) to compare different regional results by

(3) $SIr = \frac{H}{\log(n)}$

The SIr may assume values from 0 to 1. For values closer to unity the SIr indicates that the regional population in the urban centres is spread, which indicates occurrence of urban sprawl. Conversely if the SIr is near to 0 mean that urbanization has a more compact distribution. The discrimination between urban and rural areas was done according to the definition given by OECD (1994), based on population density, so if this is less than 150 inhabitants per km^2, the area is classified as rural, otherwise it is an urban centre.

House prices - Average house prices were provided by the Bank of Italy.

All monetary variables are expressed in current terms. It has been decided not to adjust for inflation because it would be necessary to use different deflators for different variables (GDP deflator for GDP/per capita and the consumer price index for prices) potentially modifying the relationship between variables themselves.

6. RESULTS

The Hausman specification test rejects the null hypothesis of no correlation between the unit effects and the explanatory variables in all regressions. It means that the RE yields inefficient estimates and that FE has to be preferred. Results from the RE model are reported in table 1 and those from the FE model in table 2. Since the Durbin-Watson statistic (DW) is well below 2 – indicating positive autocorrelation of the residuals - the model has been estimated using heteroskedasticity and autocorrelation standard errors (HAC).

The only variable that is significant in all regressions is GDP per capita, which coefficients range from 0.22 (permanent crops) to 0.61 (arable land). Pig density coefficient, as one might expect a priori, is significantly greater than zero in the total UAA and arable land regressions, being in both cases equal to 0.14 (a 1-percent increase in pig density triggers a 0.14-percent increase in land values). The coefficient is significant (at 10 percent significance level) also in the case of permanent crops but its magnitude is much lower (0.07).

Land productivity is significant (at 5 and 10 percent significance level) only for arable land (-0.16) and permanent crops (0.072). In the former the coefficient is negative, contrary to what theory would suggest. Agricultural (relative) prices, house values, and the aridity index are significant (but at a relatively low significance level) only in the vineyard regression. Finally, the amount of EU transfers per hectare of UAA does not have an impact on farmland values in none of the regressions.

Table 1 Random Effects estimates and Hausman specification test.

Variables	Total UAA	Arable land	Permanent crops	Vineyards
Constant	-3.217***	-3.549***	-0,075	-3.970***
Land productivity	0,049	0.071*	0.083***	0.092*
Aridity index	0.160***	0.150**	-0.109**	0.458***
Output prices	-0.230**	-0.108***	-0,037	0,083
Animal output prices	n.a.	-0.207***	n.a.	n.a.
Farm subsidies	0.107***	0.104***	0.035*	0.116***
Pig density	0.119***	0.084***	0.068***	0.068**
GDP/capita	0.436***	0.459***	0.225***	0.438***
Urban sprawl (pop)	0.337**	0.299**	-0,026	0.431**
House values	0.106**	0.125***	0,014	0.232***
Observations	380	380	380	380
Breusch-Pagan	1,900.18***	1,654.94***	2,486.22***	2,172.5***
Hausman	41.63***	90.82***	22.22***	14.04*

*,**,*** denote 10, 5, 1 significance level respectively.

Source: own calculations.

Table 2 Fixed Effects estimates with HAC standard errors.

Variables	Total UAA	Arable land	Permanent crops	Vineyards
Constant	-2.678**	-2.210**	0.006	-3.438**
Land productivity	-0.199	-0.162**	0.072*	0.089
Aridity index	0.088	0.067	-0.135	0.408*
Output prices	-0.076	-0.003	-0.031	0.102*
Animal output prices	n.a.	-0.133	n.a.	n.a.
Farm subsidies	0.098	0.082	0.034	0.113
Pig density	0.140***	0.136***	0.068*	0.086
GDP/capita	0.602***	0.607***	0.222**	0.381**
Urban sprawl (pop)	0.120	0.196	-0.033	0.523
House values	0.071	0.01	0.02	0.252**
Observations	380	380	380	380
R-squared adjusted	0.968	0.982	0.985	0.96
DW	0.22	0.30	0.26	0.18
F-test for common int.	96.71***	119.68***	516.24***	116.57***

*,**,*** denote 10, 5, 1 significance level respectively.

Source: own calculations.

The fact that all the other coefficients are not significant and often have the “wrong” sign induces to think that there might be some problem due to the fact that some of the variables have a very little within variance. As PLÜMPER and TROEGER (2007) point out, FE estimates are inefficient when some of the variables included in the model have little longitudinal variance if compared to between variance. This inefficiency does not only yields wrong standard errors but also unreliable point estimates. The FEVD model overcomes this problem. PLÜMPER and TROEGER (2007) suggest to consider as “rarely-changing” variables those with a between/within ration higher than 2.8. Rarely changing variables have to be treated differently during the estimation. The ratio between within and between variance has been calculated for all explanatory variables. Total UAA land productivity (3.90), arable land productivity (6.47), permanent crops productivity (3.06), pig density (6.51), urban sprawl, and the aridity index (3.70) are rarely-changing variables. FEVD estimates (with HAC standard errors) are reported in table 3.

Table 3 Fixed Effects Vector Decomposition Estimates with HAC standard errors.

Variables	Total UAA	Arable land	Permanent crops	Vineyards
Constant	-7.048***	-7.230***	-2.770***	-3.559***
Land productivity	0.444***	0.488***	0.334***	0.065***
Aridity index	0.257***	0.281***	0.687***	1.047***
Output prices	-0.142	-0.102**	0.017	0.130*
Animal output prices	n.a.	-0.172**	n.a.	n.a.
Farm subsidies	0.132***	0.113***	0.040**	0.132***
Pig density	0.073***	0.137***	-0.031***	-0.004
GDP/capita	0.434***	0.495***	0.233***	0.347***
Urban sprawl (pop)	0.032	0.002	-0.333***	0.224***
House values	0.147***	0.124***	0.054***	0.298***
Residuals from step II	0.995***	0.999***	1.002***	0.980***
Observations	380	380	380	380
R-squared adjusted	0.965	0.981	0.985	0.959
DW	0.137	0.185	0.173	0.149

*,**,*** denote 10, 5, 1 significance level respectively.

Source: own calculations.

Looking at the results of the FEVD estimations the main driver of farmland values varies across the four models. In the case of total UAA the main factor affecting farmland values is land productivity (0.44), which represents a proxy of potential profits obtainable from land, followed by GDP per capita with a slightly lower level (0.43). Land productivity is very important also in the case of arable land model (0.49) for which, however, the most important driver is GDP per capita (0.50). These two factors are less important for permanent crop and vineyard models.

In the total UAA model, a 1-percent increase in GDP per capita translates into a 0.43 percent increase in land values, while in the arable crop model the increase is of about 0.50 percent. Regions characterized by a high GDP per capita are also those more likely to have a strong, structured, intensive, and therefore more profitable agricultural sector. This translates into higher demand for land (which supply is by definition limited) and higher land values than in relatively poorer regions.

For permanent crops and vineyards – according to the estimates – the main driver of land values is climate change, here proxied with the average aridity index for the past 10 years. During the time span taken into consideration the aridity index increased (meaning less aridity) in Northern Italy, while remained stable or declined in the Mediterranean part of the country (from Tuscany southwards). For permanent crops the aridity coefficient is about 0.69, meaning that a 1 percent increase in the aridity index (that is wetter conditions) implies a 0.69 increase in farmland values. For vineyards the impact is even bigger, with the coefficient being higher than 1. The impact of the climatic variable is much lower for total UAA and arable crops (but still significant at 1 percent level) measuring 0.26 and 0.28 respectively. The difference might be explained by the fact that permanent crops are usually located in Central and Southern Italy, the most aridity-prone regions of the country, and in hilly areas, where irrigation is not an option. Even if it is difficult to summarize all the effects of climate change simply with an aridity index, these results are certainly not in contrast with the implications that climate change can have in Europe: increase in productivity in temperate areas (due to higher temperatures, longer growing period, and more abundant rainfall) and progressive desertification of the Mediterranean basin. Of course, this would (already have) an effect on land values of very important crops such as orchards, olive and citrus groves and, especially vineyards, famous for the quality of their products.

Pig density is an important factor in the case of arable crop model: the coefficient is highly significant and equal to 0.14, similarly to what DUVIVIER at al. (2005) found (0.10) in their work assessing the main drivers of Belgian farmland values. Pig farmers, in order to comply with the Nitrate directive need given amounts of land in order to minimize their environmental impact. This increases demand for land and therefore exerts an upward pressure on land values, especially where intensive pig farms are located (Northern regions). Pig density is still significant in the total UAA regression (since arable crops represent 70 percent of total UAA) but the coefficient is of lower magnitude (0.07). As one would expect pig density does not play a role in determining the price of neither permanent crops nor vineyards since they are mostly located in hilly areas of Central and Southern Italy.

Farm subsidies do have an effect on land values (capitalization of public subsidies into land values), which is almost equal for total UAA (0.13), arable land (0.11), and vineyards (0.13), while it is sensibly lower for permanent crops (0.04). The difference can be explained by the fact that permanent crops have historically been much less subsidized than other crops, also because they represent a small share of total UAA in most of the member states, exceptions being Mediterranean countries such as Italy, Spain, Portugal and Greece.

Agricultural prices have only a marginal role in explaining land values, the coefficient is significant only for arable land (-0.10) and vineyards (0.13) at 5 and 10 percent significance level respectively. The negative coefficient that characterizes agricultural prices in the arable land regression is explained by the fact that prices are higher in the South, where vegetables are more commonly cropped than in the North, where cereals (usually characterized by lower prices than vegetables) are more widespread. Wine (and table grapes) prices have a positive effect on vineyards values, as one could expect *a priori* since wine is more of the most market-oriented agro-food products. It might be stressed that the (relative) price of animal products have a significant but negative effect on arable land values (it has been decided to include these prices only in the arable land regression since it is in lowlands, otherwise usable for intensive agriculture, that most livestock farms are located). However, also in this case, the negative sing depends on the fact that prices are higher in Southern regions.

It is a widely opinion that house prices have an indirect effect on land values, especially in densely populated areas of the Po valley and the plains surrounding big cities such as Rome and Naples where house values tend to "pass through" to land values because of operators' expectation that agricultural land would become suitable for building. The impact of house prices in the total UAA regression is not negligible, and is equal to 0.15, while it is lower for arable land (0.12) and, especially, permanent crops (0.05). Quite surprisingly, the highest coefficient for house prices is that of the vineyard regression (0.30), this might be explained by the fact that the most valuable vineyards are located in Northern Italian regions and Tuscany, in areas (such as *Valpolicella*, *Langhe*, *Chianti*), which are also famous touristic destinations, not too far from big urban areas (Verona, Turin, Florence) and where the demand of land for building Summer houses and holiday resorts is high.

The urban sprawl is not significant, neither in the total UAA nor in the arable crops regressions. This is not as one could expect *a priori* since it is reasonable to think that arable land prices, usually located in lowlands and highly populated areas, would be affected by the pressure exerted by the degree to which the population is spread on the territory. The coefficient is highly significant, however, for both permanent crop (-0.33) and vineyard (0.22) models even though with opposite signs. The negative sign, in the permanent crops case, can be explained by the fact that olive and citrus groves and orchards are usually located in scarcely populated areas, hilly or mountainous, especially in the central and southern part of the country, where population tend to be less "sparse" and more concentrated in urban centres. Conversely, vineyards, are present in the whole country, also in the Northern regions (where the most expensive land for vineyard is located) where the population is more evenly distributed.

7. CONCLUSIONS

This work assesses the determinants of farmland values in Italy during the period 1992-2010 using panel econometric techniques. It is the first attempt of quantitative analysis regarding land values in Italy. Four regressions have been run: for total UAA, arable land, permanent crops, 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 several (even if only potential) alternative land uses and urban pressure is much higher than it used to be.

Land productivity and GPD per capita are the main determinants of land values in the case of total UAA and arable crops (the latter representing 70 percent of total UAA). For permanent crops and vineyards the main determinant is the aridity index, a measure of the ongoing climate change affecting in different ways the different parts of the country: wetter conditions in the North (together with higher temperatures) and drier conditions in the Centre and the South of the country. GPD per capita is important also for permanent crops and vineyards but less than for total UAA and arable crops, which are in turn less effected by climate change.

Pig density is an important driver of arable land values since intensive piggeries are mostly located in lowlands in the North of the country and compete with arable crops for land since the EU mandates that intensive pig farms to operate on given amounts of land to minimize their environmental impact.

House values are important, accordingly to what one could expect *a priori*, for total UAA and arable crops, which are likely to be located in lowlands not far from major urban centres. House prices have a much lower impact on the price of permanent crops but a surprisingly high one on vineyards, probably because the most expensive vineyards are located in hilly areas of Northern regions (and Tuscany), which are also famous touristic destinations where demand for housing is high. The urban sprawl, that is a measure of population "dispersion" on the territory is not significant neither in the total UAA nor in the arable crops regressions but it turns to be in the case of permanent crops and vineyards. In the first case the effect is negative, since most of the orchards and olive and citrus groves are located in Central and Southern Italy were the population is less "sparse" and concentrated in urban areas. In the second case, the effect of the urban sprawl is positive since, as mentioned earlier, the most expensive vineyards are those of Northern Italy, where the population is more evenly distributed.

Relative agricultural prices have almost no effect on land values, except, marginally, for vineyards, while farm subsidies are characterized by a positive impact on land values in all regressions.

Summarizing, it can be affirmed that land values, in Italy, are mainly determined by possible 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.

Climate change, approximated with an aridity index, seems to have an impact on land values, especially in the case of permanent crops and vineyards, even though we are well aware that the climate issue should be studied more in dept, 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 agents' 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 of permanent crops and vineyards since they cannot rely on irrigation being located in hilly or mountainous areas.

The main 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 "safe-heaven" 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 and applying more sophisticated econometric techniques such as panel allowing for structural breaks and cointegration analysis. However, data availability seems to represent a bigger problem than the methodological one.

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