Vineyard Land Use Change in Residential Use:

An Empirical Investigation of the Bordeaux Urban Fringe

Stéphanie Pérès, Nathalie Gaussier

GREThA, UMR CNRS 5113

Université Montesquieu – Bordeaux IV

Avenue Leon Duguit

33608 PESSAC Cedex France

gaussier@u-bordeaux4.fr

peres@u-bordeaux4.fr

The authors are, respectively, doctor and assistant professor, GREThA, UMR CNRS 5113, Montesquieu Bordeaux IV University. This study is part of a research program granted by the ANR (French Research Agency) called “Real Estate Dynamics of the New Urban Configurations”. We are grateful to Guillaume Pouyanne for helpful comments. All remaining errors are our own.

Vineyard Land Use Change in Residential Use:

An Empirical Investigation of the Bordeaux Urban Fringe

ABSTRACT

This paper studies vineyard land-use change in residential use in the Bordeaux exurban area, France, from 2000 through 2005. The aim is to capture and analyse the urban sprawl phenomenon through the vineyard dynamics which is a typical feature of the Bordeaux urban and rural landscape. The originality of the paper stands in developing a monocentric model that enables to define different exurban rings in which the same logit model of vineyard land use change is tested. The marginal effects of significant explanatory variables differ from one ring to another, suggesting different dynamics in each exurban ring. (JEL R14, R52)

1. INTRODUCTION

There exists a great amount of literature that deals with the questions of land use change. The studies are generally divided into two categories. One category of studies examines spatially explicit models because of the availability of a vast number of spatially disaggregate land use data. These models merge estimations and simulations to illustrate the spatial and temporal patterns of land conversion. They are generally developed in environmental science and geography literature. They capture economic effects in including variables such as distance to urban centre or distance costs. These variables are considered *ad hoc* so that they illustrate land conversion without explaning the underlying economic process. The second category of studies focuses on economic models that attempt to explain the economic process of land conversion. They mobilize different methods such as hedonic price (Garrod, 1994; Powe *et*

al., 1995) or duration and logit models to capture the main factors of the parcels transactions (McMillen, 1989; Claassen and Tegene, 1999; Ding, 2001; Irwin and Bockstael, 2002; Carrion-Flore and Irwin, 2004; Bell *et al.*, 2005). Following Plantinga and Irwin (2005), the structure of the models varies according to the spatial level of data considered in the analysis (p. 113). All of these studies have a common theoretical underpinning: the issue of land-use change is based on the traditional bid-rent model and takes into consideration different structural and geographical variables such as roads, rivers, waterfront, and location of the parcel, metropolitan characteristics or distance to the roads... This paper is rooted in that common theoretical underpinning. The aim is to understand the determinants of vineyard land use change in the particular case of the Bordeaux urban fringe which addresses the conversion of vineyard parcels to residential use within the Bordeaux exurban areas.

The originality of the paper is twice. First, it focuses specifically on vineyard parcels transactions in residential use. It is interesting to note that vineyard parcels are still present in the city of Bordeaux: there exists a quality vineyard, some well-known appellations such as Margaux or Haut Brion, which are located in the city and resist pressure to urban spreading (Peres, 2007). Vineyard dynamics is a typical feature of the Bordeaux periurban landscape and convenient to analyse urban spreading. Second, the paper uses the specification of exurban areas to explore the dynamics of vineyard land use change in residential use. The literature provides various operational definitions of exurban areas (Nelson, 1992), considered as regions outside the suburbs of a city or following Bell and Irwin (2002, p. 218) "*those areas that fall beyond the outer-belt of a major metropolitan area but within its commuter shed.*" According to a growing land use pressure, several papers deal with the issue of land use change at the rural-urban fringe or in exurban areas (Irwin, Bell, Geoghegan, 2003; Bell, Irwin, 2002). Nevertheless, little empirical work has been devoted to

exploring the pattern of land use change in the entire suburban areas of a metropolitan area. Studies usually focus on a particular county known as one of the fastest growing exurban counties, for instance Mc Henry County Illinois in the Chicago Metropolitan area (Mc Millen, 1989), Calvert County in Maryland (Irwin, Bell, Geoghegan, 2003; Irwin, Bockstael, 2004), or more generally the impact of zoning on the price of parcels in a single municipality, for instance Chicago, Illinois (Munneke, 2005). Hence, we develop a monocentric approach to define the Bordeaux urban fringe that is able to deal specifically with exurban areas of the Bordeaux metropolitan area when considering vineyard land use change.

The paper is structured as follows: Section 2 offers an overview of some of the major land-use change models applied to the urban context and provides a description of hypotheses. Section 3 presents the data and method. We first define the Bordeaux exurban area by introducing different rings, then we test the logit model of vineyard lands converted to residential use on each ring. Section 4 is a discussion of the results of the estimates of the econometric model. Finally, conclusions and suggestions are presented in Section 5.

2. THEORETICAL AND EMPIRICAL FRAMEWORK

Economic models of land-use conversion explicitly focus on explaining a change in land use. They have a common theoretical underpinning based on von Thünen spatial model of land use and on the classic urban bid-rent model of Alonso and Muth. The main idea consists in capitalizing transportation costs into land values and demonstrating that urban land rents are decreasing with distance from central business district. In that perspective, a land conversion into residential use is more likely expected as the land is closer to an urban area. Then the study of land-use conversion of parcels that are located outside the city, in the periurban belt for instance, set important theoretical and empirical issues linking land-use conversion with

urban sprawl and planning policy. Empirical studies generally enlighten different factors that underline the economic process of conversion and cause a change in land use.

Indeed, a landowner who owns an undeveloped land parcel makes a discrete choice either to convert the parcel into residential use or to keep it in an undeveloped use according to his profit-maximizing and expected utility. The main argument here is the economic efficiency. For instance, in Munneke (2005), returns to conversion are valuated through price differential-land use defined as the difference between the maximum of land price in uses other than the current use and the land price in its current use. McMillen (1989) considers a model of land use based on the land value in a current use that depends on the characteristics of the parcels and the adjustment cost of converting a land from a use to another one. More generally, net expected returns to conversion are a function of a variety of land attributes that are assumed to influence land use conversion (Nelson, Hellerstein, 1997). In that connection, empirical studies attempt to explain land values in determining how the various characteristics of a parcel are valued in the market (Geoghegan, 2002; Munneke, 2005). In the same line of argument, price differential-land use is interpreted as the extent to which there is pressure for a land to be converted to another use as in McMillen (1989) or Munneke (2005). As a consequence, land value is a dependent variable either in hedonic model or in land use change models. Furthermore, the individual landowner's decision may include neighbourhood amenities of surrounding land-use as in Cavailhès *et al.* (2003), Irwin *et al.* (2003) or Segerson *et al.* (2005).

Literature divides these determinants into two broad categories. The first category is focusing on the main physical characteristics of the parcel. The second category is relevant to the spatial context of the parcel.

1. The main characteristics of the parcel.

A number of studies have enlarged the basic model based on private land-use decisions to include the physical characteristics of the parcel (Lichtenberg, 1989; Wu, Segerson, 1995; Miller, Plantinga, 1999). They show the impact of land quality in alternative uses and in comparative returns from that use. Logistic models that estimate the probability of land use change show that land characteristics such as land quality are some important determinant of land-use change (Claassen, Tegene, 1999). Wu and Segerson (1995) or Irwin and Bell (2005) consider the impact of a soil quality indicator considered as a proxy for the agricultural profitability of a land parcel. Nevertheless, Irwin and Bell (2005) show that this variable do not delay the timing of a parcel conversion or isn't a good proxy for the agricultural profitability. Other parcel characteristics such as the size and the location of the parcel, transportation and distance to urban centres or other urban pressure variables such as utilities, public services and policies, railroad and roads are considered. As an example, Carrion-Flore and Irwin (2004) show that some urban factors such as land location and its proximity to cities, the population growth rate and the number of open spaces are statistically significant to estimate land-use change. Access to public sewer or distance to cities measured via the road network are considered to explain land conversion or land value and are found to be positive and significant: access to public service reduces conversion costs and hastens the timing of an undeveloped parcel conversion to residential use (Irwin, Bockstael, 2004; Irwin, Bell, 2005). The size of the parcel and the distance to downtown are significant and negative variables to explain land development or land allocation to residential use: land is more likely to be residential or developed than agricultural the smaller the lot size and the closer it is to a large town (McMillen, 1989; Cho, Newman, 2005).

2. The spatial context of the parcel.

The question of land use change depends on the spatial context of the parcel. Numerous studies show the existence of spatial externalities or spillovers among neighboring land use

(Irwin *et al.*, 2003; Segerson *et al.*, 2005; Cho *et al*, 2005). As an example, Cho and Newman (2005) show that a parcel is more likely to be developed if the parcel is closer to a developed one. Using a hazard model of residential land development, Irwin and Bockstael (2004) show that parcels with more nearby undeveloped and medium-density land will be developed sooner relative to low-density residential land. As a consequence, they find that neighbourhood land use have effects on the conversion timing of undeveloped parcels to residential use. In the same kind of analysis, Irwin and Bockstael (2002) discuss the existence of negative spillovers among exurban land parcels converted to residential subdivisions. They show that undeveloped land that is adjacent to development is less valuable in residential use and that negative externalities create a repelling effect among residential land parcels such as there exists a scattered pattern of residential development in the rural-urban fringe. The definition and the sensitivity of the concept of spatial neighbours are crucial to spatial econometrics application. When data on land use change are limited to a much more aggregate scale, the analysis is necessary limited to modelling larger-scale processes (Wu and Segerson, 1995; Bell and Irwin, 2002). Irwin and Bockstael (2002) show that the larger the share of development within both the inner and outer neighbourhoods, the lower the hazard of development. Moreover, spatial spillovers lead to introduce the impact of urban factors, zoning restrictions and planning policy on land-use change (Bockstael, Bell, 1997; Kline and Alig, 1999; Wu and Cho, 2007). As an example, Irwin and Bockstael (2004) show that parcels with greater amounts of both preserved and unprotected open-space nearby are more likely to have larger hazard rates of development. Irwin and Bell (2005) estimate the influence of several policy variables on the expected returns to development of a parcel. They show that a smart growth policy concentrates development patterns introducing accelerations in land-use changes. Wu and Cho (2007) estimate that local land use regulations on land development reduce the total supply of developed land. Munneke (2005)

considers price differential-land use as an exogenous variable of logit models of zoning change to show that land prices play an important role in the decision to change a parcel's zoning classification.

The structure of the models depends principally on the data used for estimation. Following Irwin and Geoghegan (2001) and Plantinga and Irwin (2005), empirical economic models distinguish between aggregate data models, parcel data models, sample plot data models and simulation based models of land-use and land-use change. The difference comes from the nature of data that researchers have access to.

3. DATA AND METHOD

Data

The model is estimated with transaction level data of vineyard parcels converted in residential use in the Bordeaux exurban area, France from January 2000 through October 2005. Vineyard dynamics is a typical feature of the Bordeaux landscape and it sets the pattern to analyse urban spreading (Peres, 2007). The data were compiled from the inventory of the Land and Rural Settlement Society, SAFER in France. It collects data on all agricultural land sales in order to determine whether property in a county is systematically under- or over-assessed. The main SAFER mission is to develop open space, forest and agricultural land and to help installation of young farmers. Data were recorded at sale-time. They include the size of the parcel (in acres) and the use of the sold vineyard property (vineyard or residential use). Of the 8236 vineyard parcels of the Bordeaux exurban area, 3183 have been sold to be converted in a residential use from 2000 to 2005. To account for spatial characteristics such as median income, demographic pressure or distance to Bordeaux city centre, that are available at the municipality-level, the smallest administrative and

institutional level in France, the parcel-level data have been grouped together by municipality. The data have been augmented with the spatial characteristics of the municipality in which the sold vineyard parcel is located. Data are derived from the French National Institute of Statistics and Economics Studies (INSEE) which has led the census of the population in 1999. The Bordeaux urban area is composed of 191 municipalities that represent a total of 930,000 inhabitants and a global density of 239 inhabitants per squared kilometre. As shown in map 1, the parcels transactions of vineyard land use into a residential use are quite important in the eastern part of the map. Indeed, numerous vineyards in that part of the Bordeaux urban area are known to be subjected to the Bordeaux urban spreading. One can expect land use to change in such areas.

[Map 1 about here]

In a monocentric model perspective, we have considered the time distance of each municipality to the Bordeaux city centre. Distances are extracted from mappy, which is free software (www.mappy.fr) that computes time distances in standard transportations conditions, without traffic congestion and considering a small car.

Method

The issue consists in determining the probability that a vineyard parcel is changed in residential use at the time of sale, in the Bordeaux exurban areas. The method is twofold. First we define the Bordeaux exurban areas considering the distribution of vineyard lands change in residential use in the Bordeaux urban area according to the municipalities' distances to Bordeaux city centre. Second we develop a logit model of land-use change in each Bordeaux exurban areas.

1. Definition of the Bordeaux exurban area.

The Bordeaux exurban area is defined on the basis of a monocentric approach. It assumes that Bordeaux city centre is the Central Business District that creates a standard bid-rent model. We have divided the Bordeaux urban area in nine rings or areas *A* of an equal step (5 minutes by drive) and according to the time-distance of each municipality centre to the CBD Bordeaux. In each ring, the number of vineyard land transactions (grouped together by municipality) has been computed in order to capture the dynamics of the urban structure. Statistics of vineyard land transactions from 2000 to 2005 are presented in the box plot as shown in graph 1. The graph groups together rings 1, 2 and 3 and rings 9, 10 and 11 because of the weak number of transactions. Ring 6 is characterized by the highest median value of vineyard parcel transactions in residential use. Moreover, rings 6, 7 and 8 have the highest dispersion. As a consequence, it seems that the municipalities located in rings 6, 7 and 8 are the most submitted to the process of urban spreading in the Bordeaux urban area.

[Graph 1 about here]

Since exurban areas are defined as an interface between urban and rural areas, we assume that exurban areas are areas where urban pressure is the highest: that means areas where the number of vineyard land transactions to residential use is the highest. To compare together the number of vineyard land transactions in each ring, we suppose that the probability a transaction occurs in each ring is the same. Following Gaussier (2001), let A_k be the surface of the different areas concerned with each ring of equal step *dr*, then:

$$A_k = \pi(2k-1)dr^2, \text{ with } k \in \mathrm{N}^*$$

The different values of *k* enable us to determine the different A_k areas. For example, the first area is concerned with the first ring for *k=1,* it is a *dr*=5 radius circle; then $A_1 = \pi \times (5)^2$. The

second area is concerned with the second ring for *k=2*, it is the difference of two circles areas: $A_2 = \pi(2\times5)^2 - \pi(5)^2 = \pi\times3\times(5)^2$.

Hence, the number of vineyard land transactions in each ring is divided by A_k for each entire value of *k*. The density of vineyard land transactions from 2000 to 2005 are presented in graph 2. The results strengthen the analysis of data in graph 1. They show that three main rings (Rings 6, 7 and 8) concentrate the vineyard to residential land-use transactions in the Bordeaux urban area and have been under a growing pressure since 2000: it seems as if urban spreading process shift from urban to rural areas. These rings are supposed to represent the Bordeaux exurban areas, *i.e.* the areas under the highest urban pressure of vineyard in residential land-use transactions. As a consequence, we estimate the logit model of vineyard parcel transactions to determine the variables of the conversion process only on the rings 6, 7 and 8 that we define as Bordeaux exurban areas.

[Graph 2 about here]

2. The logit model of vineyard parcel transactions in Bordeaux exurban areas

The purpose of the logit model is to determine the explanatory variables of the transition process from vineyard to residential land-use in Bordeaux exurban areas. The model suggests that any exogenous variable that influences land values have to be considered. The probability a vineyard parcel *i* is sold for residential use (*Trans*) in a municipality *j* is estimated through the following logit form:

$$Logit(Trans_{ij}) = Ln\left[\frac{P(Trans_{ij})}{1-P(Trans_{ij})}\right]$$

The Logit transformation is used as a dependent variable in the regression equation, where X_{ij} is a set of independent variables which affect the urbanization of undeveloped land, β is a

set of estimated regression coefficients and ε_{ij} is the error term, which is independent and identically distributed.

$$Logit(Trans_{ij}) = \beta X_{ij} + \varepsilon_{ij}$$

Explanatory variables fall into three broad categories: (a) the urban characteristics *URB*; (b) the parcel characteristics *PARC* and (c) the zoning policies *ZON*. The regression equation estimated is:

$$Logit(Trans_{ij}) = \beta_0 + \beta_1(URB_{ij}) + \beta_2(PARC_{ij}) + \beta_3(ZON_{ij}) + \varepsilon_{ij}$$

where β_0 is an intercept term and β_1 though β_3 are the matrix of regression coefficients to be estimated.

URB variables include the population growth rate (*POP*) and the household median income of the municipality in which the vineyard parcel is located (*INCOME*). These *URB* variables account for factors of urban pressure. It is expected that *POP* increases the conversion probability: a higher municipality population growth rate should have a positive impact on the probability a municipality vineyard parcel is converted to a residential use. The expected sign of *INCOME* variable is more ambiguous. As an example, Alig, Kline and Lichtenstein (2004) show that a variable per capita income is expected to increase the consumption of land for urban uses. All else equal, Geoghegan (2002) shows that higher median household income increases housing value. Inversely, higher median household income can decrease the conversion probability when considering both net returns to vineyard production compared to a residential use, and the expected amenities of vineyard open spaces (Brueckner *et al.*, 1999).

PARC variables include the size of the parcel (*AREA*) in acre, its status, rented or not at sale-time (*RENT*) and the existence of buildings (*BUILT*). All the previous studies state the size as

an explanatory variable for land conversion or land value. Nonetheless, they show the ambiguity of the expected sign of this variable: when housing strategies suppose a positive influence on urbanization development, a lot of empirical and theorical works show that agricultural benefits are sufficiently high in large parcels so that it isn't necessary for land-farmers to sell them (Carrion-Flores and Irwin, 2004; Pérès, 2007). It is expected too that a rented vineyard parcel would decrease the conversion probability because of the expected net returns to vineyard land use compared to a residential use. Inversely, a built vineyard parcel is expected to increase the conversion probability because it seems that it has already shaped and moved on the urbanization process.

The third category of variables consists of zoning variables. In France, the urbanization process is regulated and controlled by a set of zoning and growth management policies. Different levels of planning policies are considered according to their decreasing level of rigidity: *PLU*, in the case of inter-municipality plans, *POS*, in the case of a municipality urban planning and *CC* considering a rural municipality planning. They account for land protection, urban pressure and individual or inter-municipality strategies of development and spatial planning. The existence of planning policies is expected to decrease the probability of land-use change, as they protect natural areas (Irwin, Bockstael, 2002) and control urban spreading (Grieson, White, 1981; Pogodzinski, Sass, 1990) or reduce the total supply of developed land (Wu, Cho, 2007).

The set of these explanatory variables is defined in Table 1.

[TABLE 1 about here]

Descriptive statistics associated with each variable in each ring of the Bordeaux exurban area (rings 6, 7 and 8) in 2005 are shown in table 2. Several obvious patterns emerge from this

table. For example, variables illustrate the shifting from urban to rural areas as a major issue of exurban areas. Nevertheless, they cannot be considered conclusive as they do not control for the effects of the other variables. The logit model of vineyard land use change in residential use answers this question.

[TABLE 2 about here]

3. RESULTS AND DISCUSSION

Regression results

The logit estimation results of vineyard parcels transactions in residential use are presented in table 3. The logit model is tested both on the entire Bordeaux exurban area, and separately on each ring of the Bordeaux exurban areas (rings 6, 7 and 8). Estimates are reported respectively in the four columns in table 3: logit *A6-A7-A8*, logit *A6*, logit *A7* and logit *A8*. To ensure that the model is properly identified, distance to Bordeaux city centre and the price of vineyard parcels have been excluded from the explanatory variables because of multicollinearity problem. Moreover, rings in the Bordeaux exurban area are built around distance to Bordeaux city centre which directly account for distance. The discussion concentrates on the determinants of land-use change in each ring of the Bordeaux exurban area.

[TABLE 3 about here]

Goodness-of-fit measures indicate that all four of the estimated logit models fit the data reasonably well. The Chi-squared statistics are all significant. The pseudo-R^2 for the entire exurban area and the three rings are over 0.20, which is respectable for logit estimates. The likelihood ratio test shows the overall significance of the parameters. Prediction success results are presented for each logit model and for how often each model correctly predicted

the transition of vineyard parcel in residential use. Prediction success is a way to gauge the model performance since original data are used to test the percentage of times that the fitted logit model correctly predicts a vineyard land-use change in residential use. Table 3 shows that prediction successes are over 69%: the percentage correctly predicted is of 73.9% in ring 6, 72.9% in ring 7 and 69.1% in ring 8, decreasing with distance to the Bordeaux city centre. These results are consistent with other studies that have measured land use change (McMillen, 1989; Irwin, Boeckstael, 2004).

All estimated coefficients are generally found to be statistically significant and consistent with findings in earlier studies. Median incomes, parcel size, rented parcels and the presence of zoning regulations, have a significant negative influence on the transition of a vineyard parcel to a residential land-use. Inversely, past population growth rate or built vineyard parcels contribute positively to the transition of a vineyard parcel to a residential land-use.
Looking closer at each ring of the Bordeaux exurban area, the population growth rate effect is not of the expected sign in ring 8. It seems that higher population growth rate has a negative influence on the transition of a vineyard parcel to a residential land use in that ring. This effect likely reflects the fact that higher population growth rate is not of major importance for vineyard land use conversion in the last ring of the Bordeaux exurban area: other kind of land-use transitions than vineyard land-use might be involved. Certainly, other kinds of lands are first converted in residential land-use, then vineyard land use. As a consequence, the positive marginal effect of the population growth rate is increasing from ring 6 to ring 7, suggesting that the pressure of the population growth rate on vineyard land-use is higher in the core of the exurban area (ring *7*) than in the first ring of the exurban areas (ring 6). The outer ring of the exurban areas (ring 8) is a break in this general pattern as if net returns to vineyard production were superior to residential land use. Moreover, the negative

coefficients for the median income in the exurban areas are consistent with findings by Brueckner *et al*. (1999): amenities and relative net returns of vineyard production compared to residential use matter. Nevertheless, the marginal effect of median households' income remains low in each ring, implying the low impact of this variable on vineyard conversion into residential use.

The results suggest that increasing the size of a vineyard parcel will decrease the probability that land is converted into a residential use. Since the absolute marginal effect is decreasing from distance to the Bordeaux city centre from ring 6 through ring 8, the results suggest that increasing the size of the parcel will tend to decrease much more the probability in the first ring (ring 6) of the Bordeaux exurban area rather than in the last ring (ring 8), as if vineyard benefits compared to residential use were higher in large parcels in the first ring of the exurban area than in the last ring (ring 8). The size of a vineyard parcel is clearly a resistance to urban sprawl. Nonetheless, marginal effects of the *AREA* variable are low in each ring. The influence of *RENT* variable is quite the same: the negative marginal effect of a rented vineyard parcel at sale-time is higher in the last ring of the exurban area (ring 8) than in the first ring (ring 6) suggesting that a rented vineyard parcel in ring 8 will create higher benefits compared to residential land use at sale-time than in the first ring (ring 6). Urban pressure seems to diminish the vineyard land value at sale-time compared to residential land use in the first ring of the exurban area. We have to note that the effect of variation in the rented status of the parcel is not found to be significant in the core of the exurban area (ring 7), and only significant at the 10% level in the first ring (ring 6). Considering the built characteristics of the vineyard parcels, the estimated coefficients are significant with a positive sign: a built parcel increases the conversion probability of a vineyard parcel into a residential use. The marginal effects are decreasing with distance from ring 6 to ring 8, suggesting that urban pressure is higher in ring 6 and decreasing with distance as a feature of urban sprawl.

Finally, the estimated coefficients of the zoning policies variables are significant and behave as expected: zoning policies seem to decrease the probability of land-use change. While *CC*, a zoning policy of a rural municipality, is not significant in the first ring of the exurban area (ring 6), it is significant in rings 7 and 8 with quite important marginal effects, which are superior to the marginal effects of the other kinds of planning tools as *PLU* and *POS*. Indeed, following descriptive statistics in table 2, it seems that the rings 7 and 8 mobilize more often rural policy zoning. As a consequence, the rigidity of policies from urban to rural policy zoning is not of importance in the analysis of the magnitude of the zoning variable effects. Rural planning policies such as *CC* regulate the vineyard land transition in residential use in the last rings (rings 7 and 8) of the Bordeaux exurban area.

Discussion

The overall pattern that emerges of the analysis of vineyard parcels transactions in residential use is as follows: (a) the Bordeaux exurban area might be divided into different rings characterized with different functioning and logics, (b) the first and last ring of the exurban area qualify respectively as urban and rural fringe of the exurban area: exurban area is clearly an urban-rural fringe with a core which merges rural and urban issues.

The magnitude of the marginal effects in each ring suggests that different sub-groups of variables are predominant features in each ring. The probability of vineyard change in residential use in the first ring of the exurban area (ring 6) is characterized by urban pressure such as a growing population rate and built vineyard parcels, whereas urban planning tools such as *POS*, seem to regulate and compel urban sprawl. Nevertheless, absolute marginal effects of zoning policy are quite less important to really compel the urban dynamics. The first ring suggests an urban fringe already concerned with urban sprawl. As the PLU negative marginal effect suggests the first ring is characterized by a lack of urban inter-municipalities

strategies. The second ring (ring 7) is defined in connection with the first one. Vineyard lands transactions in residential use are mainly supported by a growing population rate then built vineyard parcels and regulated both with urban and rural policy zoning (*CC* and *POS*) which underline the mix of urban and rural logics. As these variables suggest, the vineyard landscape in the second ring is under increasing population pressure to reduce: it's clearly the planning issue of a core of an exurban area. Finally, the probability of vineyard parcel conversion in residential use in the last ring of the exurban area (ring 8) is rather characterized by previous built parcels, a pattern of an urban process compelled with respectively the rented status of the vineyard parcels at sale-time, the existence of rural policy zoning such as *CC*, and a growing population rate which certainly focus on other kind of parcels than vineyard ones. This last ring suggests a rural fringe in which the wide variety of parcels or the higher agricultural benefits in vineyard parcels compared to residential land use in this ring are able to transfer urban sprawl on other parcels than vineyard ones.

The model predicts the probability of a vineyard parcel conversion accurately in each ring: vineyard land use is nearly always predicted to be changed in residential use when it is transferred in residential land-use. It reminds that our model is rather an urban one, based on a standard bid-rent model with higher predictions closer to the urban centre. Table 4 presents the prediction error ratio that is the ratio of the number of the model error predictions divided by the number of vineyard parcels converted into a residential use in each municipality.

[TABLE 4 about here]

Table 4 clearly shows the three different logics and prediction errors of the vineyard transactions to residential use in the Bordeaux exurban areas (ring 6, 7 and 8). The model predicts relatively well vineyard conversions to residential use in the core of the Bordeaux

exurban area (rings 7 and 6). Note that two municipalities in the core of the Bordeaux exurban area, which represents respectively 4/5 and 105/126 errors of prediction of the model compared to sold vineyard parcels in residential use, have high error ratios which dramatically increase the cumulative error ratio. Moreover, graph 3 suggests that vineyard conversions to residential use in the urban fringe are better predicted than in the rural fringe: as an example, in 75% of municipalities the error ratio is fewer than 35% in the urban fringe, whereas, it is fewer than 50% in municipalities of the rural fringe of the exurban area. Other dynamics exist in the rural fringe that our model, based on vineyard transactions in residential use, does not catch.

4. CONCLUSION

This study presents an empirical model of vineyard land-use change in residential use in the Bordeaux exurban area, France. It enlightens a part of the agricultural dynamics in the urban belt of the Bordeaux metropolitan area through vineyard transactions into residential use. The main idea consists in developing a monocentric model devoted to the capture and the analysis of the urban sprawl phenomenon through the vineyard dynamics. This is a way to reverse the usual urban issue that consists in studying the impact of urban sprawl on rural and agricultural areas. The empirical model fits the data relatively well; it predicts accurately vineyard land use change in residential use and suggests some interesting features. The Bordeaux exurban area can be divided into three fringes with different dynamics from urban to rural issues. In the urban fringe, population growth rate and built parcels increase the probability a vineyard parcel is changed in residential use. Absolute marginal effects of zoning policy are quite less important to really compel the urban dynamics. In the core of the exurban area, the population growth rate exerts the major marginal effect to increase the probability a vineyard parcel is converted to residential use. The pressure of rural and urban

policy zoning is more important than in the urban fringe but it seems that inter-municipalities strategies are undeveloped to decrease the vineyard conversion probability and to control urban spreading. In opposite, population growth in the rural fringe of the exurban area is not of the expected sign, suggesting that vineyard parcels are not threatened with urban sprawl yet. Only previous built parcels impacts positively on the probability a vineyard parcel is changed in residential use. As a consequence, the Bordeaux exurban area is a discontinuous area: the core is a mix of urban and rural dynamics whereas urban and rural fringe are rather supported respectively by a predominant urban and rural dynamics. It will be certainly interesting to refine the analysis of the exurban area with different range of rings and geographical sectors. Such an analysis will overcome more directly spatial autocorrelation in the analysis of vineyard parcel transactions.

REFERENCES

Alig, R.J., J.D. Kline, and M. Lichtenstein. 2004. "Urbanization on the US Landscape: Looking Ahead in the 21st Century." *Landscape and Urban Planning* 69: 219-234.

Bell, P., K.J. Boyle, and J. Rubin. 2005. *Economics of Rural Land-Use Change.* Ashgate.

Bell, P., and E.G. Irwin. 2002. "Spatially Explicit Micro-Level Modelling of Land Use Change at the Rural-Urban Interface." *Agricultural Economics* 27: 217-232.

Bockstael, N., and K. Bell. 1997. "Land Use Patterns and Water Quality: The Effect of Differential Land Management Controls." In *International Water and Resource Economics Consortium, Conflict and Cooperation on Trans-Boundary Water Resources*, R. Just and S. Netanyahu, Kluwer Publishing.

Bell, K., and N.E. Bockstael. 2000. "Applying the Generalized Methods of Moment Approach to Spatial Problem Involving Micro-Level Data." *Review of Economic and Statistics* 82(1): 72-82.

Brigham, E.F.1965. “The Determinants of Residential Land Values.” *Land Economics* 41 (4): 325-334.

Brueckner, J.K., J.F. Thisse, and Y. Zenou. 1999. “Why is Central Paris Rich and Downtown Detroit Poor? An Amenity-Based Theory.” *European Economic Review* 43(1): 91-107.

Carrion-Flores, C., and E.G. Irwin. 2004. “Determinants of Residential Land Use Conversion and Sprawl at the Rural-Urban Fringe.” *American Journal of Agriculture Economics* 86: 889-904.

Cavailhes, J., D. Peeters, E. Sekeris, and J.F. Thisse. 2003. “La Ville Périurbaine.” *Revue Economique* 54(1): 5-24.

Cho, S.H., and D.H. Newman. 2005. “Spatial Analysis of Rural Land Development.” *Forest Policy and Economics* 7: 732-744.

Claassen, R., and A. Tegene. 1999. “Agricultural Land Use Choice: a Discrete Choice Approach.” *Agricultural and Resource Economics Review* 28(1): 26-36.

Correll, M.R., J.H. Lillydahl, and L.D. Singell. 1978. “The Effects of Greenbelts on Residential Property Values: Some Findings on the Political Economy of Open Space.” *Land Economics* 54 (2): 207-217.

Ding, C. 2001. “An Empirical Model of Urban Spatial Development Patterns.” *Review of Urban and Regional Development Studies* 13: 123-136.

Garrod, G.D. 1994. “Using the Hedonic Pricing Model to Value Landscape Features.” *Landscape Research* 19 (1): 26-28.

Gaussier, N. 2001. “The Spatial Foundations of Obnoxious Goods Location: The Garbage Dumps Case.” *Regional Studies* 35(7): 625-636.

Grieson, R.E., and J.R. White. 1981. “The Effects of Zoning on Structure and Land Markets.” *Journal of Urban Economics* 10(3): 271-285.

Irwin, E.G., and K.P. Bell. 2005. “Estimating a Spatially Explicit Model of Residential Land-Use Change to Understand and Predict Patterns of Urban Growth at the Rural Urban Fringe.” In *Economics of Rural Land-Use Change* Ed K.P. Bell *et al.* Ashgate. Chapter 9: 147-160.

Irwin, E.G., K.P. Bell, and J. Georghegan. 2003. “Modelling and Managing Urban Growth at the Rural-Urban Fringe: a Parcel-Level Model of Residential Land Use Change.” *Agricultural and Resource Economics Review* 32: 83-102.

Irwin, E.G., and N.E. Bockstael. 2002. “Interacting Agents, Spatial Externalities and the Evolution of Residential Land Use Patterns.” *Journal of Economic Geography* 2: 31-54.

Irwin, E.G., and N.E. Bockstael. 2004. “Land Use Externalities, Open Space Preservation, and Urban Sprawl.” *Regional Science and Urban Economics* 34: 705-725.

Irwin, E.G., and J. Georghegan. 2001. “Theory, Data, Methods: Developing Spatially-Explicit Economic Models of Land-Use Change.” *Journal of Agriculture Ecosystems and Environment* 85(1-3): 7-24.

Kline, J., and R.J. Alig. 1999. “Does Land Use Planning Slow the Conversion of Forest and Farm Lands?” *Growth and Change* 30: 3-22.

Lichtenberg, E. 1989. “Land Quality, Irrigation Development and Cropping Patterns in the Northern High Plain.” *American Journal of Agricultural Economics* 71(1): 187-194.

Miller D.J., and A.J. Plantinga. 1999. “Modeling Land Use Decisions with Aggregate Data.” *American Journal of Agricultural Economics* 81(1): 180-194.

McMillen, D.P. 1989. “An Empirical Model of Urban Fringe Land Use.” *Land Economics* 652: 138-145.

Munneke, H.J. 2005. “Dynamics of the Urban Zoning Structure: An Empirical Investigation of Zoning Change.” *Journal of Urban Economics* 58: 455-473.

Nelson, A. 1992. “Characterizing Exurbia.” *Journal of Planning Literature* 6(4): 350-368.

Nelson, G., and D. Hellerstein. 1997. “Do Roads Cause Deforestation? Using Satellite Images in Econometric Analysis of Land Use.” *American Journal of Agricultural Economics* 79: 80-88.

Pérès, S. 2007. “La vigne et la Ville: Forme Urbaine et Usage des Sols . ” PhD Dissertation, Bordeaux University, France.

Plantinga, A.J., and E.G. Irwin. 2005. “Overview of Empirical Methods” In *Economics of Rural Land-Use Change* Ed K.P. Bell *et al.* Ashgate.Chapter 7: 113-134.

Pogodzinski, J.M., and T.R. Sass. 1990. “The Economic Theory of Zoning: A Critical Review.” *Land Economics* 66 (3): 294-314.

Powe, N.A., G.D. Garrod, K.G. Willis. 1995. “Valuation of Urban Amenities Using an Hedonic Price Model.” *Journal of Property Research* 12:137-147.

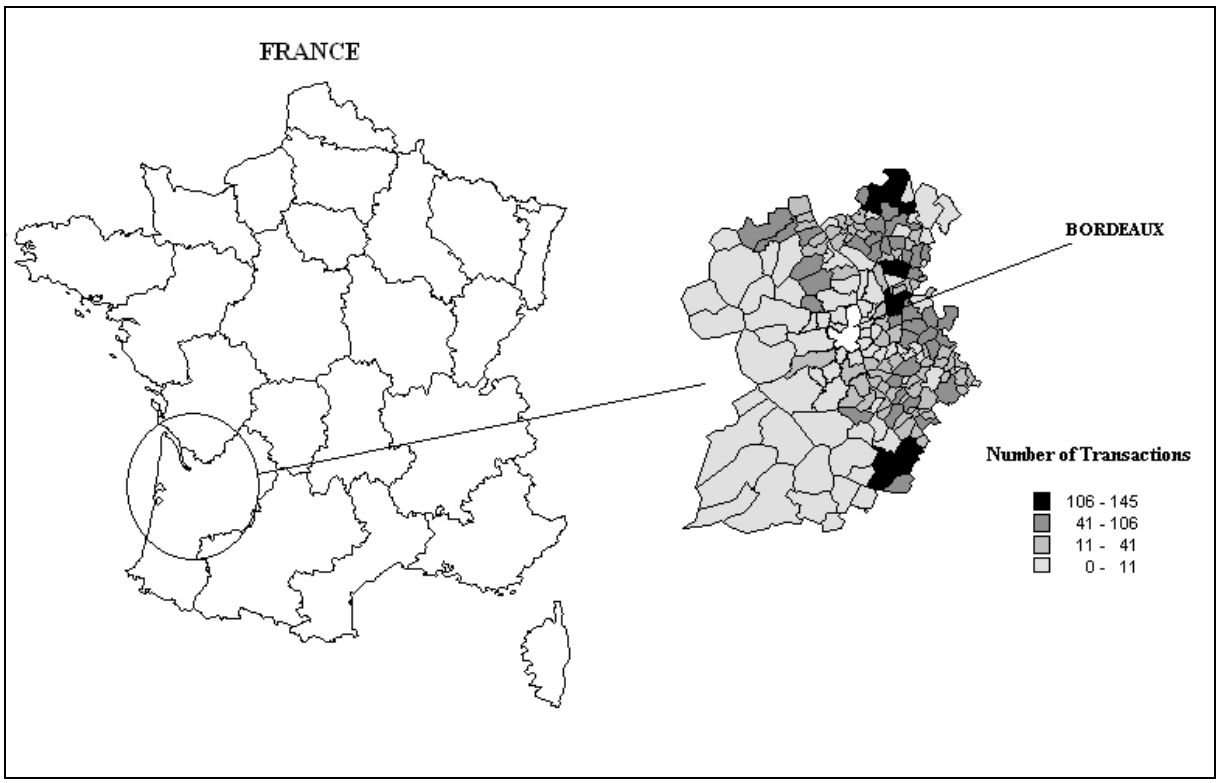
Segerson, K, A.J. Plantinga, and E.G. Irwin. 2005. “Theoretical Background.” In *Economics of Rural Land-Use Change*, ed K.P. Bell *et al.* Ashgate. Chapter 6: 79-111.

Wu, J., and S. Cho. 2007. “The Effect of Local Land Use Regulations on Urban Development in the Western United States.” *Regional Science and Urban Economics* 37: 69-86.

Wu, J., and K. Segerson. 1995. “The Impact of Policies and Land Characteristics on Potential Groundwater Pollution in Wisconsin.” *American Journal of Agricultural Economics* 77(4): 1033-1047.

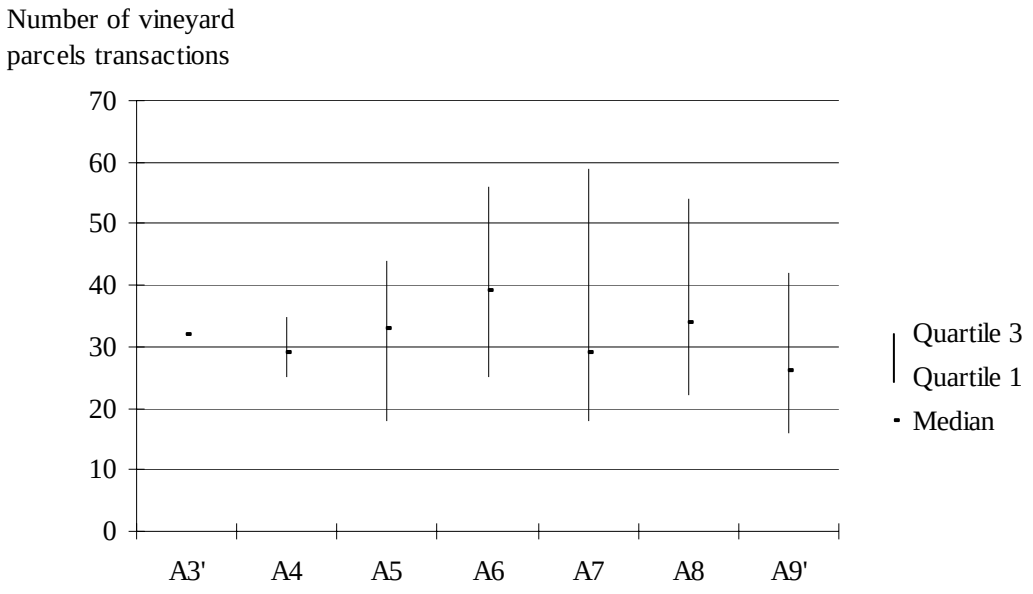
MAPS, GRAPHS AND TABLES

MAP 1: Number of vineyard parcels transactions in the Bordeaux urban area, France 2005



Source: SAFER 2005

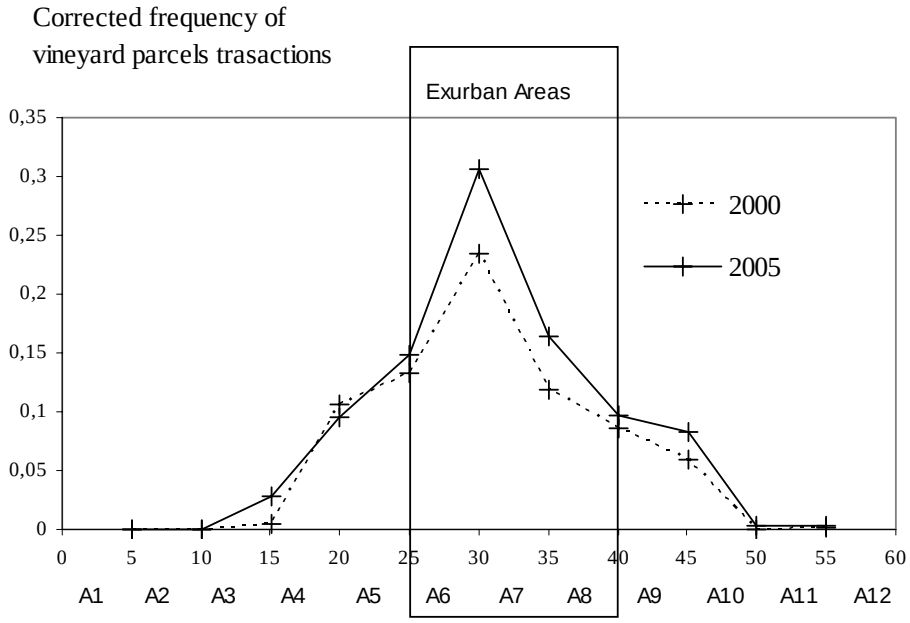
GRAPH 1: Descriptive statistics of vineyard parcels transactions by rings in the Bordeaux urban area, 2000 - 2005.



Rings (Areas *A*) of 5 minutes by drive to Bordeaux centre

Note: A3' and A9' are gathered information on vineyard transactions in residential use of A1, A2, A3 and A9, A10, A11 respectively, because of the small number of vineyard transactions in those rings. As a consequence, A3' goes through 15 minutes by drive to Bordeaux centre.
Source: SAFER 2005 and mappy ©.

GRAPH 2: Corrected frequencies of vineyard parcels transactions (radius=5 mn by drive)



Rings of 5 minutes by drive to Bordeaux CBD

Source: SAFER 2005 and mappy ©.

TABLE 1: Definition of explanatory variables

Variable	**Definition**
DIST	Distance by drive of each municipality to Bordeaux city centre 2007 (Mappy).
POP	Population rate of each municipality in 1999 (INSEE)
INCOME	Median income of households in each municipality in 1999 (INSEE)
AREA	Area of the parcel in acre in 2005 (SAFER)
RENT	The status of the parcel: rented or not in 2005 (SAFER) Variable equals 1 if the parcel is rented; 0 otherwise
BUILT	The existence of buildings on the parcel in 2005 (SAFER) Variable equals 1 if the parcel is built; 0 otherwise
PLU	Zoning policy in the case of an inter-municipality association in an urban area in 2005 (INSEE). Variable equals 1 if the municipality have a PLU; 0 otherwise
POS	Zoning policy in the case of a municipality in an urban area in 2005 (INSEE) Variable equals 1 if the municipality have a POS; 0 otherwise
CC	Zoning policy in the case of a municipality in a rural area in 2005 (INSEE) Variable equals 1 if the municipality have a CC; 0 otherwise

TABLE 2: Descriptive Statistics

	A6		**A7**		**A8**	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
POP	0,0598	0,0899	0,0511	0,0650	0,0557	0,0926
INCOME	28673,816	3061,908	27537,696	3411,961	24822,24	2431,755
AREA	6160,104	16753,74	6709,097	34083,919	7378,76	25165,79
RENT	0,0451		0,0280		0,0505	
BUILT	0,2855		0,2329		0,2033	
PLU	0,5574		0,1321		0,1162	
POS	0,2284		0,3089		0,1720	
CC	0,0536		0,0194		0,1929	

Source: INSEE, 2005 and SAFER, 2005

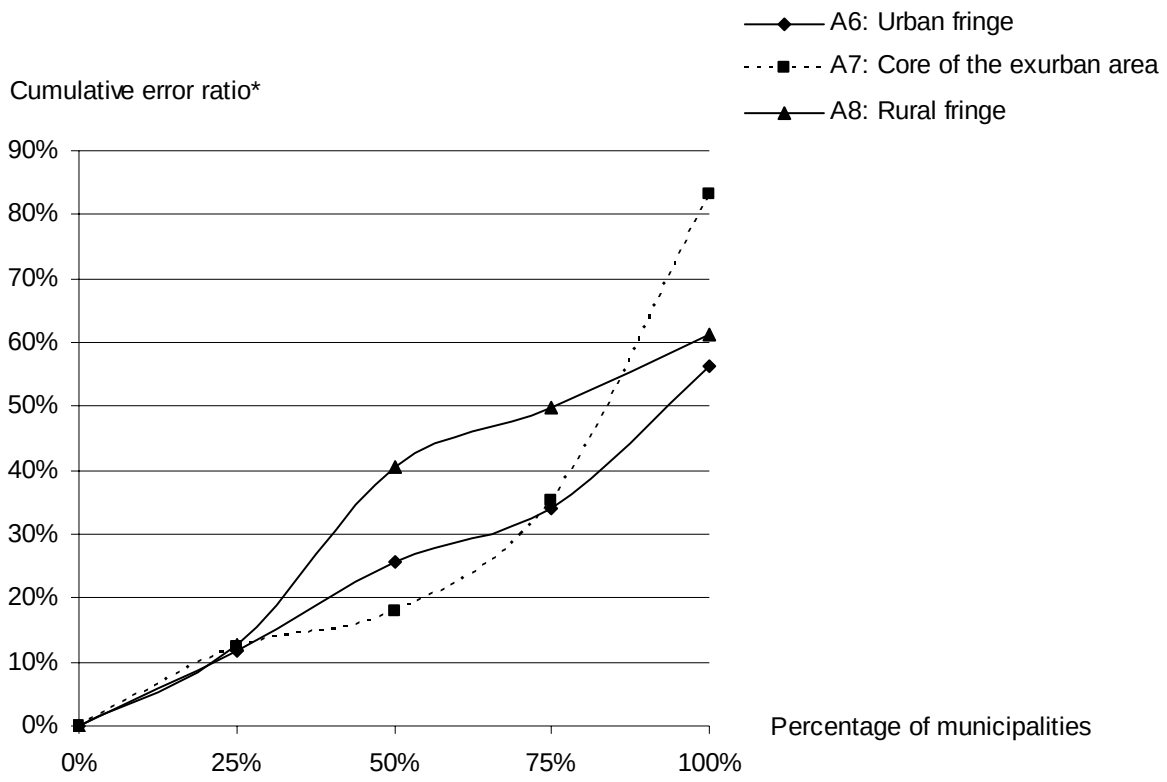
TABLE 3: Estimation results[a] from logit model of vineyard parcels transactions

	LOGIT A6-A7-A8		LOGIT A6		LOGIT A7		LOGIT A8	
	Coef.	**Marg. Eff.**	**Coef.**	**Marg. Eff.**	**Coef.**	**Marg. Eff.**	**Coef.**	**Marg. Eff.**
Constant	1,855***		1,885***	0,471	0,101	2,52E-02	6,326***	1,573
	(8,528)		(4,433)		(0,232)		(9,695)	
POP	2,274***	0,56	2,563***	0,640	7,603***	1,900	-1,506**	-0,374
	(6,956)		(5,334)		(8,671)		(2,405)	
INCOME	-7,77E-05**	0,00	-7,916E-05***	-0,198E-04	-2,761E-05*	-6,90E-06	-2,369E-05***	-5,890E-05
	(9,457)		(5,596)		(1,634)		(9,094)	
AREA	-2,90E-05**	0,00	-3,00E-05***	-0,750E-05	-2,847E-05***	-7,11E-06	-2,376E-05***	-5,900E-06
	(10,870)		(7,139)		(5,901)		(5,203)	
RENT	-0,489***	-0,12	-0,396*	-0,981E-01	-0,187	-4,65E-02	-1,815***	-0,388
	(3,419)		(1,842)		(0,667)		(5,077)	
BUILT	2,770***	0,55	2,922***	0,585	2,876***	0,567	2,565***	0,491
	(35,235)		(25,61)		(20,003)		(13,865)	
PLU	-0,302***	-0,075	-0,355**	-0,884E-01	-0,367**	-9,07E-02	-0,786***	-0,193
	(4,786)		(3,158)		(2,329)		(4,498)	
POS	-0,557***	-0,13	-0,785***	-0,192	-0,493***	-0,122	-0,339**	-8,476E-02
	(7,917)		(5,964)		(3,671)		(2,326)	
CC	-1,026**	-0,24	-0,218	-0,543E-01	-2,102***	-0,391	-1,656***	-0,381
	(9,387)		(1,098)		(4,536)		(9,779)	
N	8236		3541		2777		1918	
Pseudo-R²	0,20191		0,2387		0,219		0,215	
Chi-deux	2304,262		1170,313		840,052		573,043	
Log-Lik.	-4553,901		-1865,525		-1502,119		-1041,507	
% correctly predicted	70,216		73,905		72,920		69,186	

[a] Dependent variable=1 if vineyard land parcel is sold for residential use; =0 if not.

Note: Absolute t-values are in parentheses. Significance at the 1%, 5% and 10% level is denoted by ***, ** and * respectively.

GRAPH 3: Municipalities cumulative error ratio



* Error ratio divides the number of the model error predictions by the number of vineyard parcels converted into a residential use in each municipality.