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Universita degli Studi di Padova
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SESSION VII: SUSTAINABLE DEVELOPMENT OF AGRICULTURE IN METROPOLITAN AREAS

PAPER 4: AGRICULTURAL LAND VALUES AND URBAN GROWTH

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AGRICULTURAL LAND VALUES AND URBAN GROWTH

by

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AGRICULTURAL LAND VALUES
AND
URBAN GROWTH

Tiziano Tempesta, Mara Thiene[1]

1. INTRODUCTION

Study of the dynamics of the land market has shown for some time that the value of land is related to a number of different economic and non-economic factors and that many people involved in land sales are unconnected with the primary sector (Grillenzoni, Grittani, 1990). It is not only agronomic characteristics (soil fertility, supply of fixed assets, dimensions etc.) that now affect the value of a plot of land, but also many other aspects, like distance from urban areas, vicinity to services, the road network etc.

This situation involves a modification in the market mechanisms, and in particular the passing from a purely competitive market towards other forms such as oligopoly and monopoly.

The demand for different uses also includes all the non-farmers who consider land as a good protection against the loss of purchasing power of money (Gallerani, Grillenzoni, 1983). Added to this is the community's altered conception of land, which is no longer traditionally considered as a production factor but rather like a consumer good. This all contributes towards explaining the wide variability of prices that characterise the land market, even relating to similar plots sold during the same period (Di Sandro, 1972).

Recent studies have analysed the relationships between property values and landscape-environmental characteristics, with the aim of determining how environmental quality can influence prices (Randall, 1987; Pearce, Markandya, 1989).

In general, the trend in land values is related to land use demand, that falls into three categories: agricultural production, residential and other uses (Grillenzoni, 1981).

A particularly important role in fixing land values is played by urban planning that determines the type of use to which a plot of land can be destined. The territorial plans, furthermore, through zoning and forecasts relating to the road network, can encourage an indirect change in land values as they are able to reduce accessibility to urban areas. It is in fact known that, according to the economic spatial models elaborated by Von Thunen and Christaller, the price of plots of land is profoundly affected by the costs of access to central areas. The urban plan can also contribute directly to variations in land values (indicating the type of activity that can be carried out) and indirectly (modifying access costs to central areas and encouraging the spread of building possibilities).

Major changes in terms of land values are usually in areas where the urban instrument provides for sizeable changes in the destination of use such as, for example, the change from agricultural area to areas of urban expansion. The impact of the change of destination of use on land values can be determined in a simple way. The differential of the value depends in

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fact on the changes of land rents attainable before and after the change of use. Identification of the indirect effects is much more complex, especially in the regions of the north-east where a pattern of scattered settlement has become established. In these regions urban growth has progressively incorporated rural areas, often without taking the agronomic characteristics into account, altering the land market dramatically. In particular, in the fringe districts between urban areas and the open countryside, the type of land being sold appears different from the typical land sales that characterise either areas of declared rural tradition or urban centres.

This phenomenon is clearly seen in metropolitan areas, characterised by a wide-based economy and expansion, typical, for example, of the situation on the Veneto plain, where the interaction between the urban system and agricultural one is deeply rooted (Camagni, 1994). In Veneto, in fact, building development has occurred through the largely uncontrolled growth of numerous small villages that at one time had an essentially rural connotation. In this case, economic development based on the expansion of the city is favoured less than the progressive transformation of small rural villages into urban areas, generally of modest dimensions, integrated into the countryside. This has involved, in many cases, the disappearance of the hypothetical dividing line between built-up areas and farm land, transforming the entire territory into an urban-rural continuum.

Within a similar context the land market is characterised by a wide variability of prices depending on the expectations and potentials linked to the single plots of land.

The present research is aimed at verifying which factors determine land values in a territorial context deeply permeated by the urban effect, that of the metropolitan area of Padova. It can be hypothesised that, in such a context, typically agricultural factors like soil fertility, the presence of typical crops and the availability of water for irrigation now have secondary importance in determining the value of land. On the other hand, variables such as urban destination of use, accessibility to various types of urban areas and vicinity to important routes of communication could assume a predominant role.

2. SURVEY METHODS

It has been recognised for some time that there is a lack of information in Veneto on the main factors characterising the land market, there being no data gathering service or databank.

Faced with this lack, in an attempt to increase knowledge of land market trends in a rural area with a high urban incidence, a study was done of transactions of rural plots of land in the metropolitan area of the city of Padova. Data relating to 81 sales were gathered in the six communes neighbouring Padova, belonging to the first and second metropolitan belts.

The choice was motivated by the fact that this area is fully explanatory of the more turbulent rural land market. The communes that form the first and second rings, in fact have recently been subject to heavy building development, that has partially overrun the rural area. Many of the communes studied are characterised by a territory divided into various districts, and this has contributed to considerably increasing the variability of market conditions.

The study covers the period between 1990 and 1995, during which the largest number of sales have been concentrated in the last two years.

To find out the actual selling prices of rural property a survey was done partly through questioning estate agents and partly by directly consulting the people involved in the transactions. This was to learn the real values of the properties sold. It is in fact well known that the value declared in the deed of sale tends to be much lower than the real one to reduce the duties payable, the exceptions being cases where the right of pre-emption is exercised or companies that have to present an annual balance sheet (Fratepietro, 1990).
As well as the appropriately deflated[2] selling price, information has been gathered with the aim of distinguishing in detail the type and condition of the rural properties sold.
These variables, reported in tab.1, belong to four main categories: agricultural production characteristics, urban area (actual and future), landscape-environmental aspects and access.
The production characteristics of the land sold that have been singled out are the surface area, presence of irrigation, the form of management, essentially either family-run farm or non-farmers, and the agronomic quality of the soils, divided into three classes. The presence of any buildings, habitations or outbuildings was also surveyed and their respective cubic measurements taken. Lastly, any constraints on the land were identified, in particular that of right of entry: methane gas, power lines, aqueducts and military.
There were three main types of possible access to the land from the local or provincial road network: fronting the road, on a dirt track, across field ends. Obviously the different types of access to the land influence both the costs of agronomic practices and the possibility of building on it. For many reasons it can be hypothesised that the latter tends to influence the value of agricultural land more than the former.
With reference to the urban aspects, for each property sold the homogeneous territorial zone (HTZ) defined by the Master Plan (MP) in force was specified. In the cases where a revision of the MP is underway an attempt was made to identify what the future HTZ would be. A margin of uncertainty obviously exists in defining the latter parameter since, between the planning phase of a variant to the MP and it's final adoption, sizeable modifications of the initially proposed zoning can be introduced.
As well as the different "urbanistic type" characteristics, two variables which take into account the presence of a constraint of destination for public-open spaces or car-parking and the strip of protected land bordering rivers and graveyards have also been considered. Lastly the location was also indicated of plots falling within the confines of the Medio Brenta as defined by the PTRC of Veneto, and the Bacchiglione (proposed by the PTP of the province of Vicenza).
Attention was also paid to the landscape/environmental characteristics by surveying any elements like natural areas, rivers, parks etc., close to the rural land sold, able to improve the environmental setting, and, at the same time, the presence of quarries, dumps and other factors that, on the contrary, can reduce the quality.
Lastly, the sites of the rural plots were thoroughly analysed in relation both to their distance from major towns and in respect to the main services. The distance (in km) was therefore measured not only from the provincial capital, but also from the local town and nearest inhabited district. To complete the picture, the location in relation to the services of hospital, bank, railway station, motorway access points, school and nearest artisan/commercial zone was surveyed.

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[2] While it is difficult to identify a correct deflator for land values, it was decided, following other authors, to consider the wholesale price index (Rosato,1991)

Tab. 1 Description of the surveyed variables

VARIABILE	DESCRIZIONE
VALORE	value of sale (liras)
SUP	surface area (m^2)
LIREMQ	value of sale per m^2
VIGNETO	area of vineyard (m^2)
FRUT	area of orchard (m^2)
PERLEGNO	percentage of tree crops
VOLCASE	volume of houses (m^3)
VOLANN	volume of outbuildings (m^3)
CASE	presence of houses
ANNES	presence of outbuildings
FABBRIC	presence of buildings (houses and outbuildings)
CONDUZ	form of management
QUALIT1	good agronomic quality of the soil
QUALIT2	average agronomic quality of the soil
QUALIT3	poor agronomic quality of the soil
IRRIG	presence of irrigation
ZTOB	homogeneous territorial zone "B"
ZTOC	homogeneous territorial zone "C"
ZTOD	homogeneous territorial zone "D"
ZTOE	homogeneous territorial zone "E"
ZTOF	homogeneous territorial zone "F"
ACCESS1	access to the land straight from the road
ACCESS2	access to the land by dirt track
ACCESS3	access to the land across field end
QUALITY	soil agronomic quality
ZTOFUT	future homogeneous territ. zone of the site
ACCESSO	type of access to the land
PASSAG	right of way
METANO	right of entry for gas
ELETTR	right of entry for power lines
MILIT	military right of entry
ACQUED	right of entry for aquaduct
VERDE	area destined for car-parking or public parks
VARZTOC	variation of homogeneous territorial zone in C
FRISPET	zone in protected strip of land bordering graveyard or river
PARCHI	zone within perimeter Parco Brenta, Parco Bacchiglione
CAVE	vicinity of quarries
DISCAR	vicinity of dumps
FIUMI	vicinity of rivers

Segue tab.1

VARIABLE	DESCRIPTION
VALPAES	zone rich in green areas &/or natural beauty
KMINDU	distance from nearest commercial/artis./industr. area(km)
KMPD	distance from centre of Padova (km)
KMCAB	distance from nearest inhabited centre (km)
KMCOM	distance from local town (km)
KMBANK	distance from nearest bank (km)
KMH	distance from hospital (km)
KMFT	distance from nearest railway station (km)
KMAUTS	distance from nearest mororway access point (km)
KMSCU	distance from a school (km)
KMBUS	distance from nearest bus stop (km)
LNVALORE	log. natural sale value of the plot
LNSUP	log. nat. surface area
LNVOL	log. nat. volume of houses +1
LNVOL1	log. nat. volumeof outbuildings +1
LNVALMQ	log. nat. value per square metre
VOLTOT	total volume of buildings (m^3)
LNVOLT	log. nat. total volume of buildings +1
INDCO	soil cover index (m^3/m^2)
LNINCO	log. nat. soil cover index
KMINDU1	lg. nat. distance from nearest comm./artisan area +1
KMPD1	lg. nat. distance from centre of Padova (km) +1
KMCAB1	lg. nat. distance from nearest inhabited centre (km) +1
KMCOM1	lg. nat. distance from local town (km) +1
KMBANK1	lg. nat. distance from nearest bank (km) +1
KMH1	lg. nat. distance from hospital (km) +1
KMFT1	lg. nat. distance from nearest railway station (km) +1
KMAUTS1	lg. nat. distance from nearest motorway access point (km) +1
KMSCU1	lg. nat.distance from a school (km) +1
KMBUS1	lg. nat. distance from the nearest bus stop (km) +1

3. CHARACTERISTICS OF THE STUDY SAMPLE

The property transactions surveyed involved a total surface area of 1,693,522 m^2, with an average surface area of 20,907 m^2. The dimensions of the single plots sold vary from a minimum of 100 m^2 to a maximum of 243,300 m^2. Despite a slight variability, a lot of the plots were less than 6,000 m^2 (42.0%) and, of these, around 30% were smaller than 3,000 m^2.

Agronomically the soils are characterised by a good or reasonable level of fertility, apart 6.2%, considered of low productivity. The practice of irrigation is not very widespread, being regularly carried out on only 16% of the land.
Tree crops are fairly irrelevant, either as regards orchards (only one case), or vineyards (7.4%). The sizes of the vineyards are also modest, occupying a small fraction of the land being sold. From an agricultural point of view the sample can be considered sufficiently representative of the reality in the central and southern Padova plain, where there are few vineyards or orchards and the soils are generally very fertile, though not served by fixed irrigation systems.
An interesting piece of data emerges from analysing the form of management, for most of the rural land resulted as being managed prevalently by people not belonging to the primary sector (85.2%) and the remainder appears entirely constituted by family-run farms. This is in line with what has emerged from a survey in the Euganean Hills area; that in recent years there has been a tendency to the transfer of properties of land from non-farmers to farmers (Tempesta, 1995).
There are buildings, both habitations and outbuildings, on some plots (18.5%) that tend to be in a fairly poor state of conservation and whose volume does not generally exceed 900 m^3.
23.5% of the rural land is also encumbered with various types of constraints. Obviously, the most widespread of these, is that of right of entry (12.3%).
Regarding modes of access to the land, 71.6% of the plots are reachable directly from the local or regional road network, 24.7% by dirt track and only 3.7% across field ends.
Taking the urban aspects, tab.2 shows that the plots of land sold are mainly classified by the Master Plan in force as zone E and are not encumbered by any urban or landscape constraints (55.5%). 7.5% is rural land sited in zones with different urban destinations (in particular B, C, D, F). Moreover in 10% of the plots sold, change of destination of use is planned following urban variants now underway and not yet definitively approved. Generally these plots will be included in zone E, except in one case where a commercial area (D) should be built.
22.2% of the land lies within the confines of regional or provincial parks and 5% of the properties are situated in strips of protected land bordering graveyards or rivers. The study sample therefore includes a wide and exhaustive panorama of the principal urban conditions found in rural areas, both referring to the homogeneous territorial zones indicated by the Ministry of Public Works decree of 2 April 1986, and the other landscape-environmental constraints contained in law 431/1985 and the Veneto Regional Territorial Co-ordination Plan.
As mentioned above, with the aim of quantifying the incidence of the urban effect on land values, the distance of the plots was measured from both towns and the major road network. Most of the land (88.9%) is located at less than 15 km from the centre of Padova, consequently is sited in the communes of the first or second peri-urban belt. Around three quarters of the land is less than 1 km from the nearest village.
The sample can therefore be considered representative of the vast metropolitan area that extends between Padova, Venice, Treviso and Vicenza. The pattern of settlement of central Veneto has historically been characterised by the widespread presence of both scattered houses and small rural villages. Strong economic growth in the seventies and eighties led to the reinforcement of this pattern of settlement so that the most rural villages have by now

assumed urban characteristics, both in terms of types of buildings present and the supply of services.
Consequently, industrial and artisan or commercial areas are also very diffuse. It is therefore not surprising that 81.5% of the plots surveyed are less than 4 km from the nearest commercial/industrial area, and 30.9% are less than 2 km. The position in respect to the nearest bank branch is similar, with 80.2% of plots sited within 4 km. There is also a school in the immediate neighbourhood of the rural plots, with 80.2% being at a distance of less than 3 km, and 40.7% at even less than 1 km. The nearest hospital is situated at a distance varying between 3 and 15 km, this being either the Padova general hospital or that at Camposampiero.
Regarding transport services, 71.6% of the rural properties are less than 1 km from the nearest bus stop, while only 19.8% are less than a half km. Railway stations and motorway access points are less convenient, since in both cases most of the land sold (76.5%) is situated at a distance of more than 5-6 km.
A final set of results are based on the analysis of the landscape-environmental aspects that characterise the rural plots sold. Taking elements that can reduce environmental quality, only a fraction of the land examined (4.9%) is situated near quarries or dumps. The aspects that broadly improve the environmental characteristics of a plot present a different picture. In fact, in 18.5% of cases there are elements of particular landscape/environmental value, such as natural areas, green spaces, parks etc. Lastly, 32.1% of the plots of land sold are near rivers.

Tab. 2 Land sold by urban area and presence of buildings

Rural plots without buildings	Frequency	%	Rural plots with buildings	Frequency	%
Zone E	38	46.9	Zone E	7	8.6
Zone B	1	1.2	Zone B	-	-
Zone C	1	1.3	Zone C	1	1.3
Zone D	2	2.5	Zone D	-	-
Zone F	1	1.2	Zone F	-	-
Variation of zone	6	7.4	Variation of zone	2	2.4
Zone E park	13	16.0	Zona E park	5	6.2
Zone in protrected strip	4	5.0	Zone in protected strip	-	-
				Total	81

4. LAND VALUES

The sums agreed in the sales are extremely variable, passing from a minimum of £2.4 million to a maximum of £4 billion.

Obviously, the price per square metre of the land differs profoundly on the basis of the urban zone where it is sited as well as by the presence of any buildings (tab.3). The average price of land in zone E, without buildings is around £70 million per hectare, while if there is a habitation or outbuildings, even in a not very good state of conservation, the price rises notably, exceeding £240 million per hectare.

These values are much higher than those found in a research project in the early nineties in rural areas of the Padova plain outside the metropolitan area (Tempesta, 1995) from which emerged average prices of land without buildings of less than £50 million per hectare (in 1995 liras).

This discrepancy can be attributed mainly to high building trade earnings also affecting land classified as agricultural in the current urban plans. In fact, constraints that could in some way lessen the possibility of building (like the setting up of a park) tend to considerably reduce the value of land without buildings to less than £60 million per hectare. It can be noted, however, that exactly the opposite happens for plots with houses or outbuildings. In this case the average selling price of plots in a park area is higher than, though only slightly, that of plots without this sort of constraint.

The setting up of a protected area therefore has a basic re-distribution effect on land values, as reducing the land's building potential determines a shift in the demand for agricultural land for building purposes to the lots already built on.

The presence of a building also translates into a substantial reduction in the differential between values of areas that can be built on and those of rural land. Fig. 1 shows that the following relationship exists between the price per square metre (PM) and the cubic measure index of the buildings present (IC), expressed as m^3 per m^2:

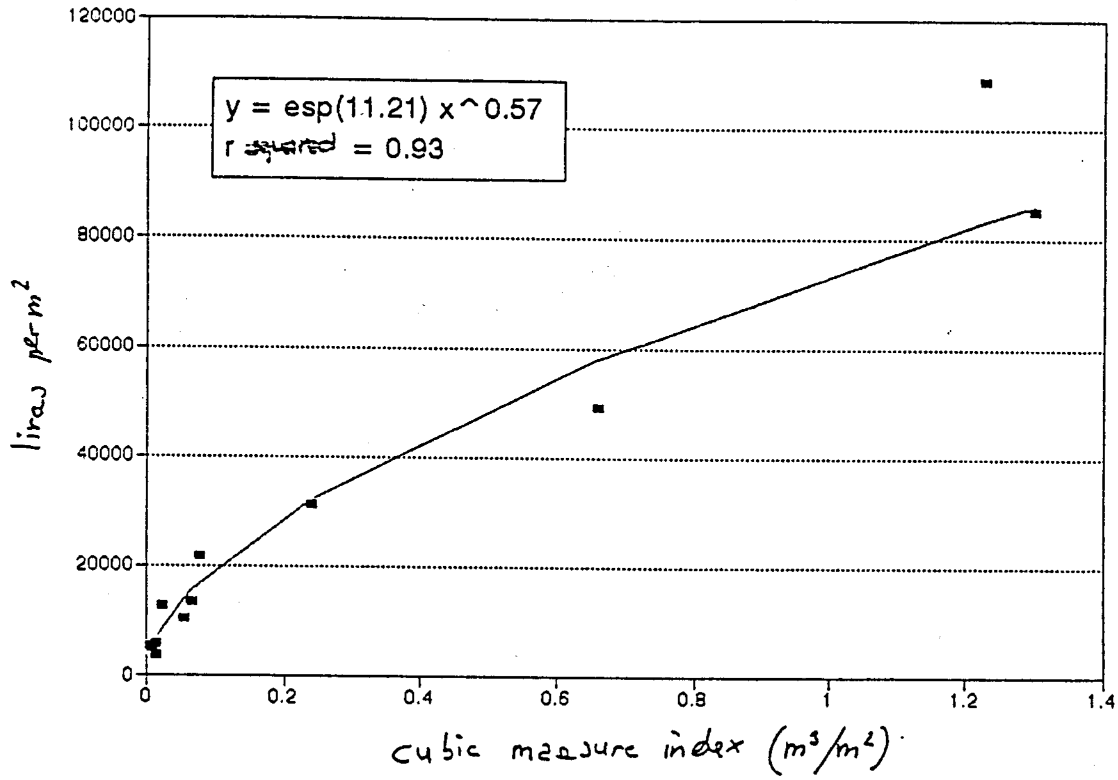
$$PM = e^{11.21} * Ic^{0.57}$$

r squared = 0.93

Therefore, the PM of a plot with an Ic between 1 and 3 m^3 per m^2, the maximum and minimum values from art.23 of R.L. 61/85 for in-filling zones, varies on average from £73 thousand to £138 thousand per m^2, the same prices as those found in the urban areas. It can therefore be inferred that the whole metropolitan area, independently of urban destination, is included in the demand for areas that can be built on.

In other terms, the market makes no distinction between urban zones, but refers only to the building possibilities of the land as defined either by the cubic measure indexes established by the M.P. or by the presence of a building.

Fig. 1. Price per m^2 and cubic measure indexes of houses and outbuildings



Moreover, renovating and extending existing buildings involves a considerable reduction in urbanisation charges which are 20% of those of new buildings. This, for many reasons other than considerations of a landscape and environmental character, can make the purchase of rural buildings particularly good value (R.L. 61/85 art.82).
The purchase of a rural plot of land with buildings can therefore be seen as good value even when the state of conservation is fairly bad, as the building itself is not bought but the building potential of the plot.
Regarding, in a more specific way, land already built on in zone E, the data acquired demonstrate that numerous other factors are able to affect the selling price.
In the first place, the values of land vary quite considerably depending on the size of the plot. In fact, the highest prices are found for dimensions of less than 3,000 m^2 (£8,441 per m^2), while larger surface areas have prices about 20% lower. This phenomenon is a consequence of the function of demand for rural plots that tends to favour small plots, the purchase of which is also possible for many small farmers who have a modest capacity for accumulating capital. This segmenting of the function of demand is attested to by the effect of the presence of buildings on the value of the land that appears relevant only for the small plots. The demand for small plots with buildings is a typically urban demand and this obviously reflects on the selling price.
The agronomic quality of the soil does not seem to influence prices very much, whilst a role of some importance seems to be the possibility of irrigating the land. In fact, irrigated plots have a value 18% above those not irrigated.
The effect of the characteristics of the owner of the rural plot of land is also fairly interesting, as the highest prices have been obtained by vendors who are not part of the rural world, demonstrating their better bargaining capability.
The presence of constraints like rights of entry does not seem to have any uniform influence on land values.
On the contrary an element of great importance in forming the price is the accessibility of the land. The plots without buildings, facing the road, have a value 70% higher than those reached by dirt tracks or across field ends. This discrepancy cannot be motivated by the lower costs for cropping operations, but more to the higher desirability for non-agricultural uses of land fronting onto the road and therefore easily reached. The road network characteristics therefore appear to assume a central role in favouring the penetration of land rent in rural areas.
In summary, analysis of this first set of agricultural production variables reveals that the typically rural nature of a plot of land does not seem to play a primary role in forming the selling price; this appears to be confirmed by the importance assumed by a variable such as the type of management of the plot, which is a decisive element in determining the value to people from outside the rural environment.
According to the models elaborated by Von Thuenen it is the presence of phenomena of demand polarisation that determines the onset of differential rents and therefore diversification of land values on a territorial basis.
It is recognised that Von Thuenen's model is an over-simplification of what actually happens since there are many factors of demand polarisation. Anyway it is very complex identifying which are the central locations capable of determining the forming of the rent differential as the demand for land is to satisfy many needs (building and otherwise) and the land market also deviates considerably from models of free competition. Therefore, with really efficient

territorial planning the phenomena of building rent would have to be very limited in agricultural areas on the plots without buildings. On the contrary, in with fairly unrestrictive territorial policies, urban land rent tends also to include agricultural land. In the latter hypothesis (more realistic) the value of agricultural land will also be affected by the presence of localities able to polarise non-agricultural demand.

It is consequently interesting to relate the values of agricultural land to some possible sources of polarisation of the demand formed either by towns of various sizes offering many types of services or else by single services. The distance from the centre of Padova does not seem to exercise any particular influence on the formation of the selling price, independently of the presence of buildings. Similarly, the distance from the city centre does not appear to affect the value of agricultural land.

At present, therefore, the formation of urban land rent is no longer due to the presence of a large central town. On the contrary, the rents are now determined by the position in respect to areas destined for particular uses or to smaller urban areas.

It is shown, for example, that the distance from the nearest commercial/industrial area influences the selling price. In particular, for plots without buildings the highest values are in the immediate vicinity (£8,148 per m^2 at less than 2 km), while they gradually lower as the distance increases, almost halving at distances above 6 km. The same can be said for distance from the nearest village. The furthest away plots cost almost £18 million per hectare less than those in the immediate vicinity.

Regarding the distance of services, the influence of the location of the plots in respect to a bank is clear, in fact for distances less than 2.5 km the selling prices of land with buildings are around £32,500 per m^2, dropping as the distance increases. The selling prices of land not built on do not fluctuate, remaining at £6-7,000 per m^2.

The distance from a school does not seem to influence the selling price of land, either with or without buildings.

A significant element in determining the price seems instead to be the distance from motorway access points. For distances of less than 5 km, taking land with or without buildings, the plots are sold at higher prices (£45,086 and £7,289 per m^2, respectively) while they diminish as the distance increases.

Passing to the landscape-environmental aspects, vicinity to areas of particular value from the nature point of view (parks, green spaces etc.) contributes to raising the prices of plots with buildings, while it appears to exercise the opposite effect on plots without buildings. This is obviously in line with what has already been observed in the ratios between landscape-environmental constraints and land value. The influence of the vicinity to rivers is clear, especially in plots with buildings, where the presence of waterways involves an increase in the value of around £8,000 per m^2.

Vicinity to dumps obviously has a negative effect, determining a notable decrease in the selling price, that drops from £27,500 to £5,400 per m^2 for plots with buildings and from £6,800 to £4,500 per m^2 for those without buildings. Vicinity to quarries is not as uniform in determining the selling price.

Tab. 3 Average selling prices of rural land

Zone where plots are sited	Average values (lire/m^2)			
	Rural plots without buildings	Frequency	Rural plots with buildings	Frequency
Zone E	7.058	37	24.204	13
Other zone	62.005	6	54.967	7
Variation of zone	25.250	6	18.114	1
Zone E k park	5.911	13	27.868	2
Zone in protected strip	6.642	4	-	5

5. AN INTERPRETATION MODEL OF LAND VALUES

The analyses done previously, being based mainly on univariate statistical approaches, give only rough indications about the factors that affect the value of land in metropolitan areas. To overcome these limits, following the proposals of other authors (Grittani, Grillenzoni, 1990), a stepwise regression analysis was done using the land values and variables given in tab. 1. Both linear and double-log models were considered. Double-log models generally interpolated the surveyed data better, having being demonstrated capable of providing an interpretative framework which is much more convincing in terms of economic theory.
Using stepwise analysis, the method allows models to be selected that can be considered optimal from the statistical point of view but not necessarily also from the theoretical one. It does not seem sensible therefore to adhere strictly to the models as they are selected by the statistical programme, but at least to try to interpret them in a wider sense, verifying any effect of exclusion or insertion of one or more of the possible predictors on the characteristics of the model.
Three models were produced referring:
A) to all the sales analysed;
B) to sales of plots situated in an agricultural zone for which there is no planned change in destination of use;
C) to sales of plots without buildings situated in an agricultural zone for which there is no planned change in destination of use.
By means of these three models (see tab. 4) it was possible to clarify the factors which could contribute to forming the prices of land in a more articulated way.
All three models show good adaptation to the surveyed data, the adjusted coefficient of determination being above 0.89.
A first piece of data emerging from the models is that the value of the plots of land tends to diminish as the surface area of the plot sold increases (figs. 2a and 2b). For example, from model C relating only to agricultural land without buildings, it can be deduced that the price per m^2 of a plot 2 km from the nearest industrial or artisan area, with good access and not situated in a park, varies from £90 to £60 million depending on whether it's dimensions are 1000 m^2 or 5 hectares, respectively. Similar results can be obtained with the other two models. As shown in figs. 2a and 2b, this effect is considerable passing from very small plots

to those of 2-2.5 hectares, above which the values remain much more stable. It is therefore confirmed that the dimensions of the plots play an important role in forming land values as they determine a net separation of the different sections of demand in the land market.
Analysis of the three models shows, secondly, that the factors that mainly influence the formation of the value of land in the metropolitan area of Padova are those given in the above paragraph. Model A clearly emphasises the importance of the urbanistic choices in forming land rents. The other factors being equal, the change of destination of use determines an increase of 2.5 to 9 times in the land value depending on the type of urban zone planned. The biggest increases are in areas of residential expansion and in-filling while those in the artisan and commercial areas are less. It is also interesting how plans for change of destination of use backed by an urban variant in progress have considerable effects on the values, although much less than those found once that variant has been approved.
It must be emphasised that this is a question of indications that are clearly affected by the characteristics of the plots surveyed since, as seen before, sales relating to land in non-agricultural areas have reduced. Notwithstanding this the model provides an orientative order of size of the possible effects of urban choices on the price of land allowing the estimate obtained through analysis of average market values alone to be refined.
All the models emphasise the importance of access to the land in the formation of the price. The regression coefficient of the access variable is also very similar in all the models. The plots sited along major roads or local roads cost 55-60% more than those with poorer access. Once again it appears that the road network is in many ways the principal way that urban prices penetrate into agricultural areas.
Another element that appears in all three models is the vicinity to industrial and commercial zones that appear to be the central locations able to generate phenomena of rent (figs. 3a and 3b). The three models show that the elasticity of price to distance varies from -0.18 to -0.14 tending to reduce for model C in which the more properly urban areas and plots with rural buildings were not inserted. It is clear that the phenomenon of rent generated by non-agricultural production areas advantages houses, either of the urban type or scattered rural housing. In many ways it can be retained that the true receiver of the benefits that lead to price formation in metropolitan areas is housing.
It must be stated that, although in all the models the commercial and industrial areas have resulted as better correlated to the price variable than the distance from other localities or from particular services, the phenomenon is much more complex in reality. Since the distances between different types of urban areas or possible services are often correlated, because of the possible cropping up of phenomena of colinearity, the models have favoured the best correlated variable. This, obviously, does not mean that the forming of the rent can be attributed solely to the distance from non-agricultural production zones. It is, in fact, particularly complicated to overcome the problem of colinearity within regression analysis and therefore obtaining a model that can take into account the role of all the factors able to generate rents is problematical. In many ways it can therefore be retained that the regression coefficient obtained tends to over-estimate the real role played by industrial and commercial zones in forming land prices in the metropolitan area of Padova. However, it cannot be ignored that they play an important though difficult to define role.
The two models relating to the sales of land with buildings (A and B) always include the cubic measure index, that has been revealed as one of the variables that most influence the value of land. The phenomenon is particularly evident in sales of fairly small plots that, the

cubic measure index being equal, generally present values very similar to those of urban land. For example, the value of a plot in an agricultural area with buildings with a cubic measure index equal to 1 m^3/m^2 is 6.4 times that of a plot in the same conditions but without buildings. This coefficient is very similar to that identified in model A, for zones B and C.

Taking lastly model C, relating to agricultural land without buildings, it is surprising that the true agronomic variables haven't entered the model. Even in the more properly agricultural plots it is the variables that can influence the possibility of building that are better correlated with the selling price. As well as the effects of access and distance from industrial and commercial zones, it has emerged that two further factors capable of holding down the value of agricultural land are nearness to dumps or being situated in park areas (figs. 3a and 3b). Vicinity to a dump has a greater effect than that of poor access. It is clear in fact that being close to dumps eliminates the building suitability of the land almost totally, at least from an urban residential point of view. This allows the effect of the urban land rent on agricultural land in metropolitan areas to be estimated. If the value of a 2 ha plot of land, sited near an industrial or commercial area and with good access, is estimated with model C at around £77 million per hectare, that of a plot of the same size situated 9 km away, near a dump and access by dirt track or across the end of a field would be about £28 million per hectare. While not disregarding the fact that vicinity to a dump and lack of easy access can also lower the agricultural value of the land, it can be estimated that the maximum value of the urban land rent would be around £40-50 million per hectare and tend to decrease as the distance grows from some central localities, such as non-agricultural production zones or with poorer access. Regarding this, the value of the land rent consequent to a value of £28 million per hectare of farming land corresponds to an amount varying between £550 and £850 thousand per hectare per year, assuming an interest rate of 2 or 3%, and this can be considered very consistent with the real earnings of main field crops on small farms in the area.

Lastly, it must not be forgotten that in the models obtained through stepwise regression variables relating to the main factors able to affect farm produce earnings, such as agronomic quality, availability of irrigation water or the existence of constraints are absent. This doesn't mean that these variables cannot have some role in the forming of the price of agricultural land. Their absence from the proposed models indicates that they can only contribute towards explaining a small fraction of the price variability, therefore the method of selecting the variables of the multiple regression function tends to exclude them in favour of the variables that are better correlated statistically.

6. LOCATION AND LAND VALUE: AN INTERPRETATION THROUGH FACTORIAL ANALYSIS.

The models illustrated above, whilst giving a reliable interpretation of reality, are not sufficiently thorough in explaining the rent in terms of the variables linked to the distance from other localities or particular services. As mentioned above, in fact, the parameter best correlated to the variable price of land was, in all the models, the distance from commercial and industrial areas; in reality this situation can probably be related to the appearance of

phenomena of colinearity, as the variables that represent the other distances are often correlated.
In an attempt to overcome these limitations, a factorial analysis was done which can isolate a single factor to interpret contemporarily the different level of variation explained by the single site predictors.
The first problem is the choice of variables from which to extrapolate the factors. Given the finality of the singling out of the factors, the variables that form it must all take a positive "score". Assuming that a_i are the regression coefficients of the factor (or factorial points) the condition $a_i>0$ must be verified. Alternatively, as the factor is negatively correlated with the value of the land, the distances with $a_i<0$ would be positively correlated with the same value and this would be in contrast to the theories of land rent.
Consequently, the choice falls on the variables that are better correlated with the price variable, excluding those that appear strongly correlated between each other and those that had a negative score in the formation of the factor.
Such a factor, therefore, is formed by a linear combination of the following variables: distance from the nearest inhabited centre, nearest hospital, nearest commercial/industrial area and lastly, the nearest motorway access point, expressed in logarithmic form. The contribution of each variable in the forming of the factor is as follows:

FACTB=0.1314*KMCAB1 + KMH1*0.3940 + KMINDU1*0.3623 + KMAUTS1*0.3830

As regards the amount of variability explained by the single variables (tab.5), it can be observed that most of the variance can be attributed to the distance from the nearest inhabited centre, associated, to a lesser extent, with the situation in regard to a commercial area[3].

Tab,5 Percentage of variability explained by the variables that make up the factor (FACTB).

Variable code	**Variable description**	**Variance perc.**	**Cumulative perc.**
KMCAB1	log. nat. distance from the nearest inhabitated centre (km+1)	55.5	55.5
KMINDU1	log. nat. distance from the nearest comm./artisan centre (km+1)	24.8	80.3
KMH1	log. nat. distance from the hospital (km+1)	12.8	93.1
KMAUTS1	log. nat. distance from the nearest motorway access point (km+1)	6.9	100.0

[3] For a more complete treatment of factorial analysis see the texts cited in the reference list (Hair, Anderson, Tatham, Black, 1992).

The models were therefore re-estimated substituting the value of the factor FACTB for the variable logarithm of distance from the nearest commercial area. These models, reported in tab.6, have allowed the factors forming the prices of land to be determined in a thorough manner.

Also in this case the models can interpret the data well, with an adjusted coefficient of determination of above 0.89, the price variable is also substantially influenced by the same parameters that appear in the previously estimated models.

It can be observed that in these models also, the value of the plots of land tends to diminish with the increase of the surface area of the plot (figs. 4a and 4b). Taking model F, relating only to agricultural land without buildings, it is noted that a plot with a reasonably central position in respect to the different areas and services, with good access and not sited in a park, has a price per hectare that varies from £115 million to £79 million when considering dimensions of 1000 m^2 and 5 ha, respectively.

Once again the models show the importance of urban choices in forming land rent in the Padova metropolitan area, since a change in destination of use (model D), all other factors being equal, determines a 10.5 to 2.5-fold increase in the value of the land. As in the preceding section, the biggest increases are in areas of residential expansion and in-filling, while the lower ones are in artisan and commercial areas (fig. 6).

Access to the land is confirmed as the only agronomic variable that can influence the price of land, seeing that the presence of a local or provincial road doubles the value of the land compared to plots with poorer access.

With the aim of better comprehension, factor F has been represented in figs. 5a and 5b as a centrality index, a parameter that can concisely explain the vicinity to all different location considered in the estimation of the factor. This index was obtained by standardising factor F with respect to the maximum value.

All the models show the importance of siting with respect to the different centres and services (figs. 5a and 5b), the flexibility of price to centrality index being higher on average than that estimated in the previous models (-0.20 against -0.14/-0.18). Recourse to factorial analysis has anyway highlighted the importance of a house and the presence of a whole series of services in explaining the rent phenomenon.

The presence of buildings is confirmed once again as one of the variables that influence the formation of the price of land most, as the difference between the value of a plot with buildings and one without remain on similar levels to those estimated in the previous section (models A and B).

Lastly, model F (figs. 5a and 5b) differs from the corresponding model C only by the inclusion of a variable linked to the landscape value, particularly nearness to a river, that makes the purchase of a plot much more appealing. Therefore, if the value of a plot of 2 ha, with good access and a central position near a river, can be estimated with model F as around £127 million per hectare, then one of the same size, sited in a less central position, near a dump and with access by dirt track would be around £19 million per hectare. In this way it can be estimated that the maximum value of the urban rent would be around £100 million per hectare, with a tendency to diminish as the distance from the central areas increases.

7. CONCLUSIONS

The research has given insight into the mechanisms that form agricultural land prices in metropolitan areas. The availability of a wide and composite sample of land sales characterised by different situations from the urban, agronomic and territorial viewpoint has allowed the effect on the selling price of a wide range of factors to be analysed. The picture that has emerged is in some way surprising. In fact, using both simple approaches of univariate analysis and stepwise regression methods, all the metropolitan agricultural areas are included in phenomena of urban land rent.

Access to rural land, the presence of buildings and distance from non-agricultural production areas have resulted as the factors mainly contributing to the formation of prices of agricultural land. They are, understandably, elements that spotlight the prevalently urban nature of the demand for land in metropolitan areas. This is bolstered by the fact that all the factors that can decrease the possibility of building (for example the presence of regional parks, strips of protected land bordering rivers and graveyards, etc.) contribute to markedly reducing the price in these areas.

This emphasises firstly the total inadequacy of the current urban instrumentation in the defining of a net separation in the destinations of use of the territory. In Veneto, the regulations on rural building mean that in agricultural areas people unconnected with farming are able to build. According to Veneto legislation, in fact, it is enough to buy a surface area of six hectares of arable land to be able to construct a house of 600 m^3 with outbuildings that can in theory cover up to 3000 m^2.

Moreover, many rural buildings are now obsolete and excess to the needs of cropping or livestock rearing.

The same urban procedures of most of the Veneto communes, centred on the systematic recourse to variants of the territorial plans and on creating areas of residential or production expansion (zones C and D) in practically all districts of the commune, have further increased the expansion of urban land rent in the territory.

Lastly, the scattering over the countryside of houses occupied by people working in non-agricultural sectors or of commercial areas has led to a considerable demand for infrastructuring the rural area itself. The systematic improvement of the road network in agricultural areas has been shown to be a powerful instrument for the penetration of urban land rent into cultivated areas, by reducing the journey times necessary to reach areas with urban type services.

Currently, within metropolitan ambits, it can be confirmed that the market has decreed the definitive disappearance of what was at one time defined as the dualism between town and country. In many ways in central Veneto there is now a sort of "rural town" or "town scattered over the territory" in which many factors can influence the value of the areas. It follows that land values can undergo sudden changes even in neighbouring plots of land. Evidence of this is that the central areas in a strict sense (for example the main city of the province the local town, etc.) are no longer alone in determining the increasing of the rent differential, but rather, and maybe to a greater degree, the numerous small urban centres like the villages and districts with some basic services or the industrial, commercial and artisan areas.

Which instruments might allow the governing of a territory within this type of context and what objectives must be pursued with their use? It seems certain that the usual urban instruments do not appear, or only marginally, to influence development of the territory building-wise. There is also now a doubt that it is possible to control, with traditional urban instruments, the evolving of such a scattered town which is subject to sudden technological change. It is fundamental that the definition of new instruments passes through an attentive defining of the intended objectives in management terms. Regarding this it is clear that, beyond the sterile and out-dated ideological counterpositions, urban area management must be restored to the maximisation of community well-being and sustainability of the territorial changes.

Recourse would be useful to the conceptual instruments typical of environmental economy with which, at least within set limits, rather than looking for every way of resisting the forming of rent with ever-more complex systems of constraints, it would be controlled according to the standards of the non-profits which benefit those who generate negative externalities against the community. Within this context, clearly defined property laws and an adequate tax system could favour a redistribution of the rent amongst the entire community, reducing the more negative aspects at the same time.

Tab. 4 Interpretative models of the factors that form land values in the Padova metropolitan area.

Model A: total sales analysed

$$LNVALORE = \underset{***}{0.9139}\ LNSUP + \underset{***}{2.6353}\ LNINCOP + \underset{***}{2.2513}\ ZTOC + \underset{***}{1.8909}\ ZTOB +$$

$$+ \underset{**}{0.8598}\ ZTOD + \underset{***}{0.9133}\ VARZTOC + \underset{***}{1.8909}\ ACCESS1 - \underset{***}{0.1812}\ KMINDU1 + \underset{***}{9.4413}$$

adjusted R^2 0.89 F=88.800

Model B: sales of plots in agricultural areas in which no change of destination of use is planned

$$LNVALORE = \underset{***}{0.9132}\ LNSUP + \underset{***}{2.7007}\ LNINCOP + \underset{***}{0.4984}\ ACCESS1 - \underset{*}{0.1652}\ KMINDU1 +$$

$$+ \underset{***}{9.4067}$$

adjusted R^2 0.89 F=134.73

Model C: sales of plots in agricultural areas in which no change of destination of use is planned and without buildings.

$$LNVALORE = \underset{***}{0.8875}\ LNSUP + \underset{***}{0.4905}\ ACCESS1 - \underset{***}{0.6529}\ DISCAR - \underset{**}{0.1444}\ KMINDU1$$

$$- \underset{*}{0.1904}\ PARCHI + \underset{***}{9.6639}$$

adjusted R^2 0.93 F=154.47

*** coeff. significant at 99%; ** coeff significant at 95%; * coeff. significant at 90%

For the significance of the variables see Tab.1.

Tab. 6 Interpretative models of the factors that form land values in the Padova metropolitan area through factorial analysis.

Model D: total sales analysed

$$\text{LNVALORE} = \underset{***}{0.9261}\ \text{LNSUP} + \underset{***}{2.5214}\ \text{LNINCOP} + \underset{***}{2.3669}\ \text{ZTOC} + \underset{***}{1.7977}\ \text{ZTOB} +$$

$$+ \underset{**}{1.0115}\ \text{ZTOD} + \underset{***}{0.8996}\ \text{VARZTOC} + \underset{***}{0.4783}\ \text{ACCESS1} - \underset{***}{0.2122}\ \text{FACTB} + \underset{***}{9.5503}$$

adjusted R^2 0.89 F=85.600

Model E: sales of plots in agricultural areas in which no change of destination of use is planned

$$\text{LNVALORE} = \underset{***}{0.9308}\ \text{LNSUP} + \underset{***}{2.6166}\ \text{LNINCOP} + \underset{***}{0.5262}\ \text{ACCESS1} - \underset{*}{0.2037}\ \text{FACTB} +$$

$$+ \underset{***}{9.4653}$$

adjusted R^2 0.89 F=133.71

Model F: sales of plots in agricultural areas in which no change of destination of use is planned and without buildings.

$$\text{LNVALORE} = \underset{***}{0.9048}\ \text{LNSUP} + \underset{***}{0.5115}\ \text{ACCESS1} - \underset{***}{0.6810}\ \text{DISCAR} - \underset{**}{0.2182}\ \text{FACTB}$$

$$- \underset{*}{0.3475}\ \text{PARCHI} + \underset{***}{0.1950}\ \text{FIUMI} + 9.7480$$

adjusted R^2 0.93 F=134.69

*** coeff. significant at 99%; ** coeff significant at 95%; * coeff. significant at 90%

For the significance of the variables see Tab.1.

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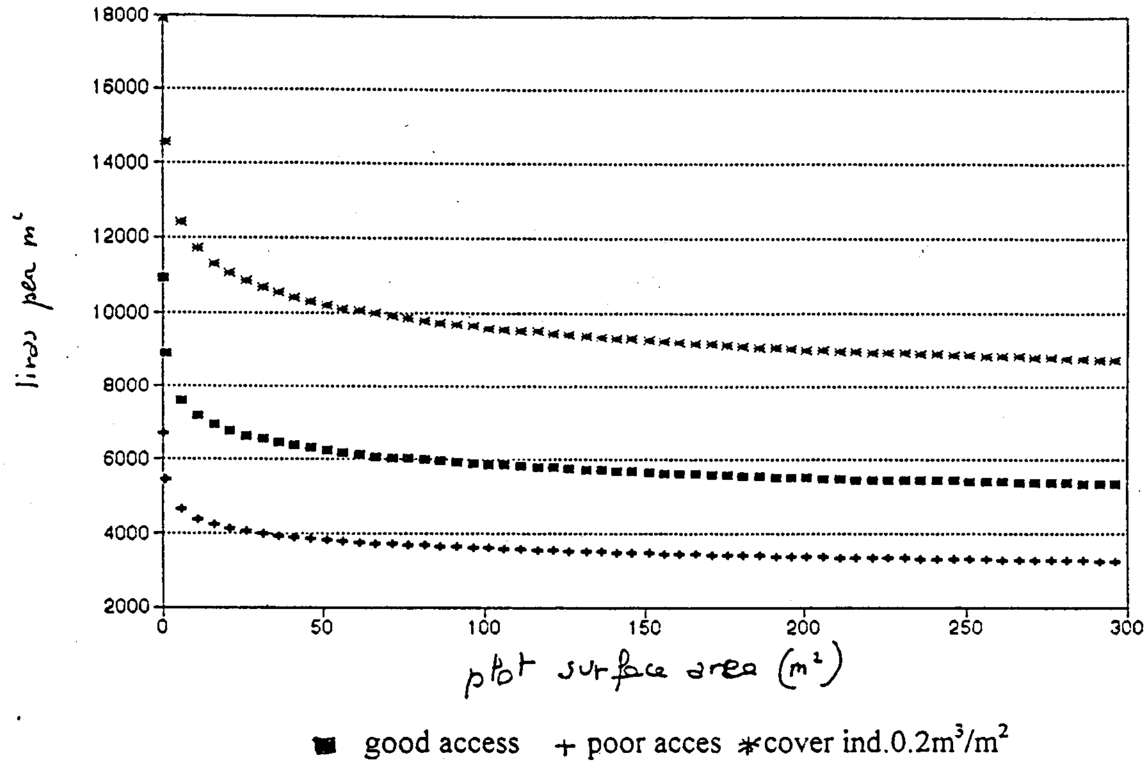
Fig. 2 Land values and plot sizes with the varying of access and cover index of buildings. Distance from nearest industrial or commercial area 2 km.

2a Plots with and without buildings



2b Plots without buildings.

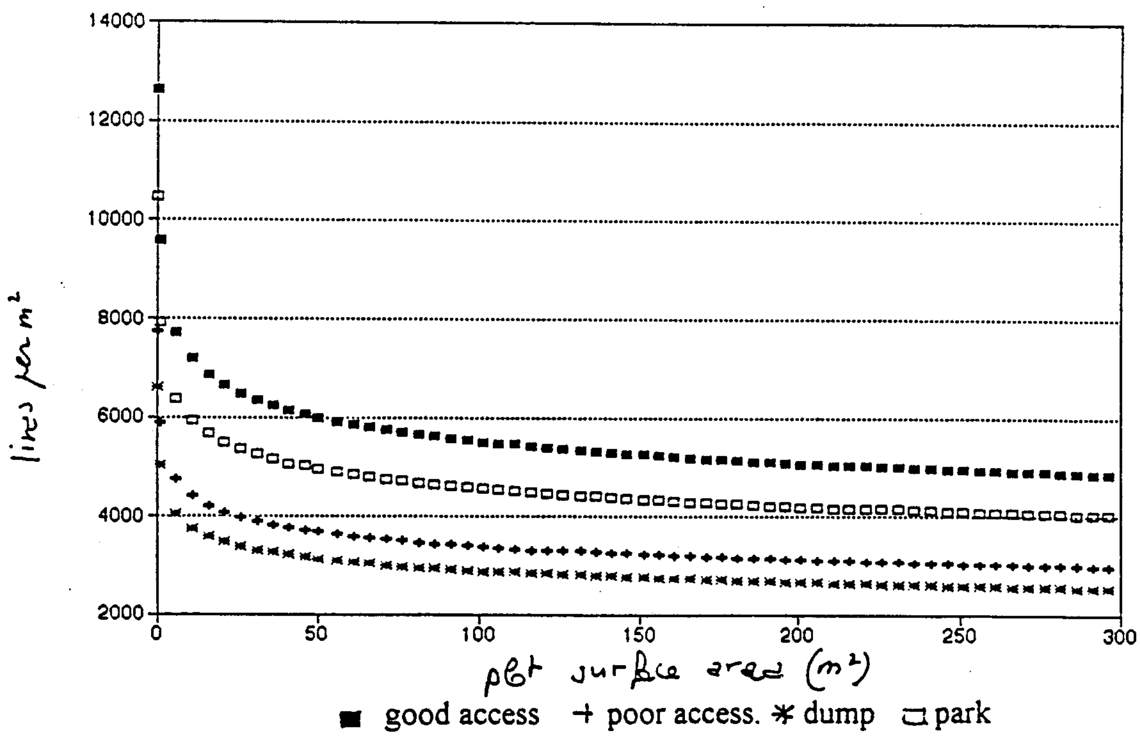
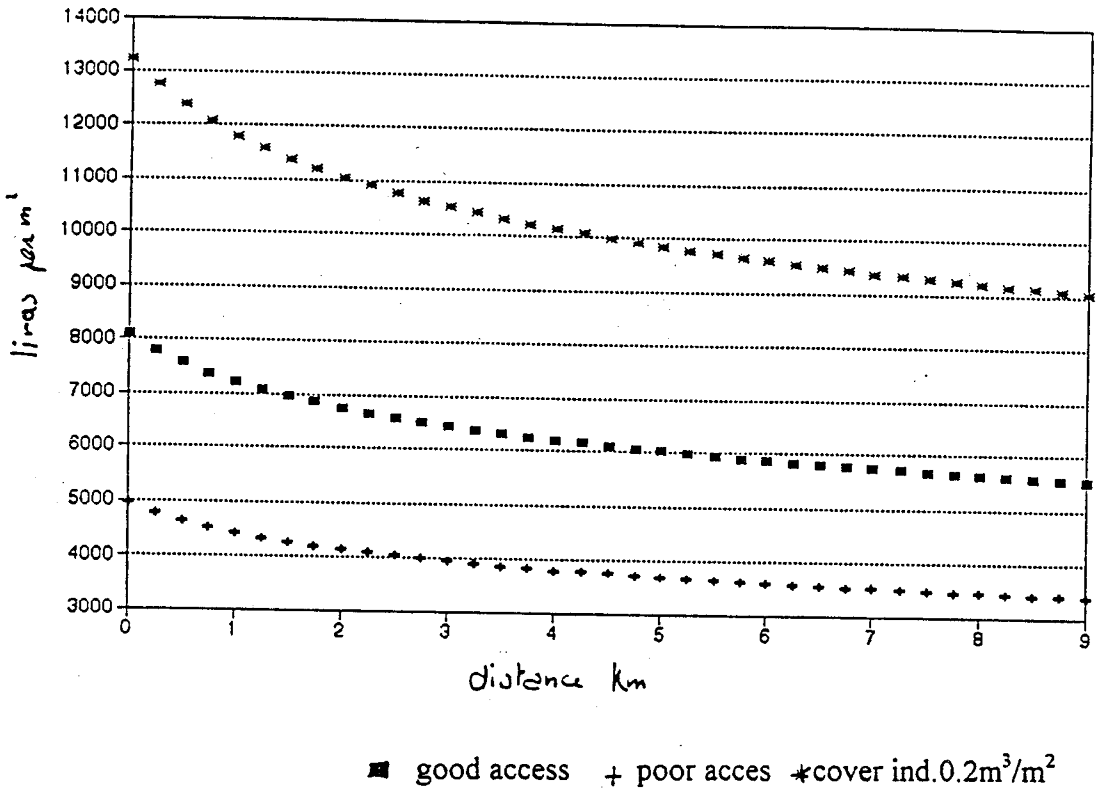


Fig. 3 Land values and distance from nearest industrial or commercial area with the varying of access and cover index of buildings. Size of the plot sold 2 ha.

3a Plots with and without buildings



3b Plots without buildings.

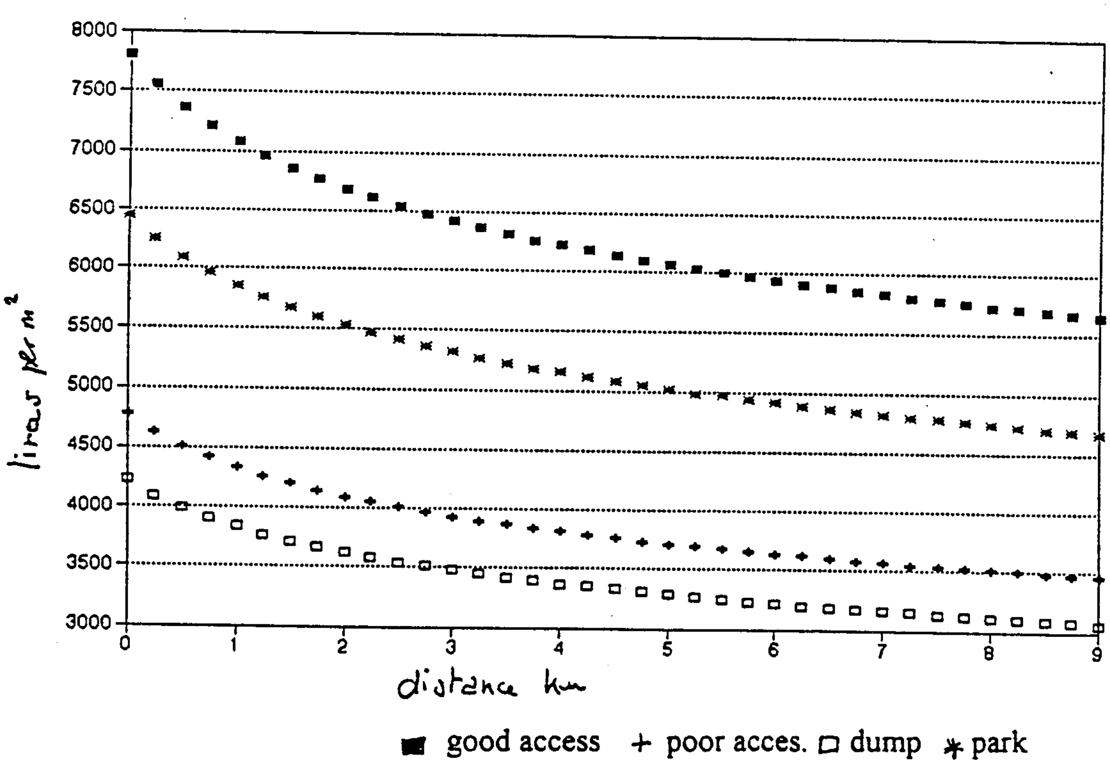
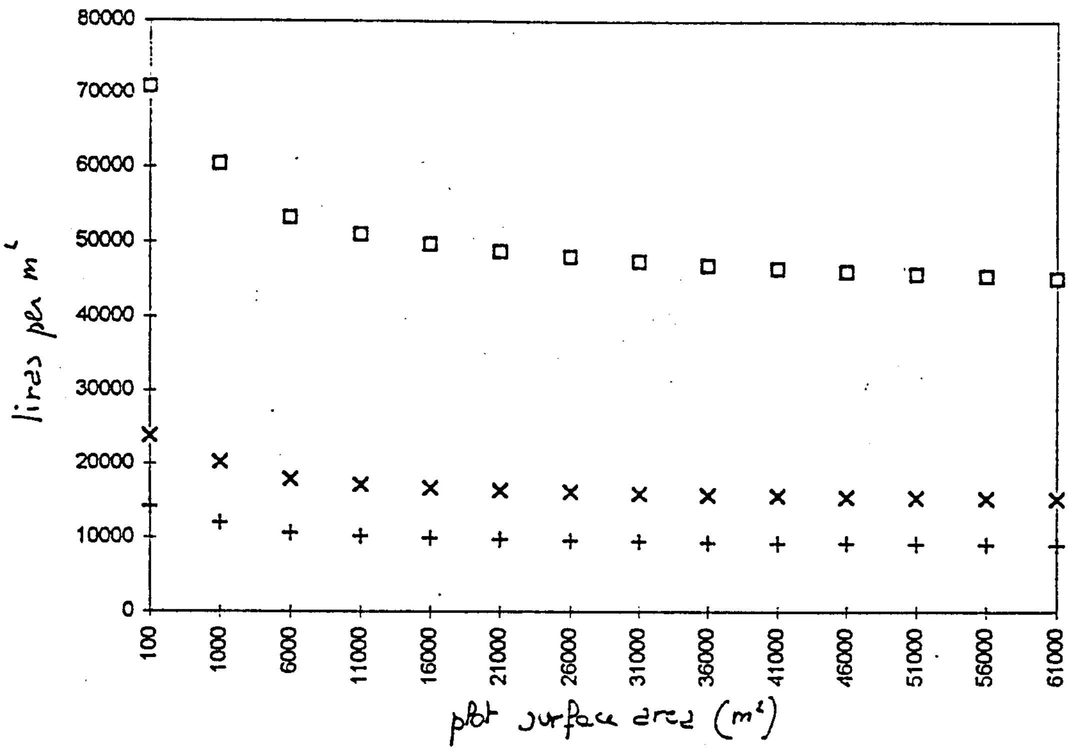


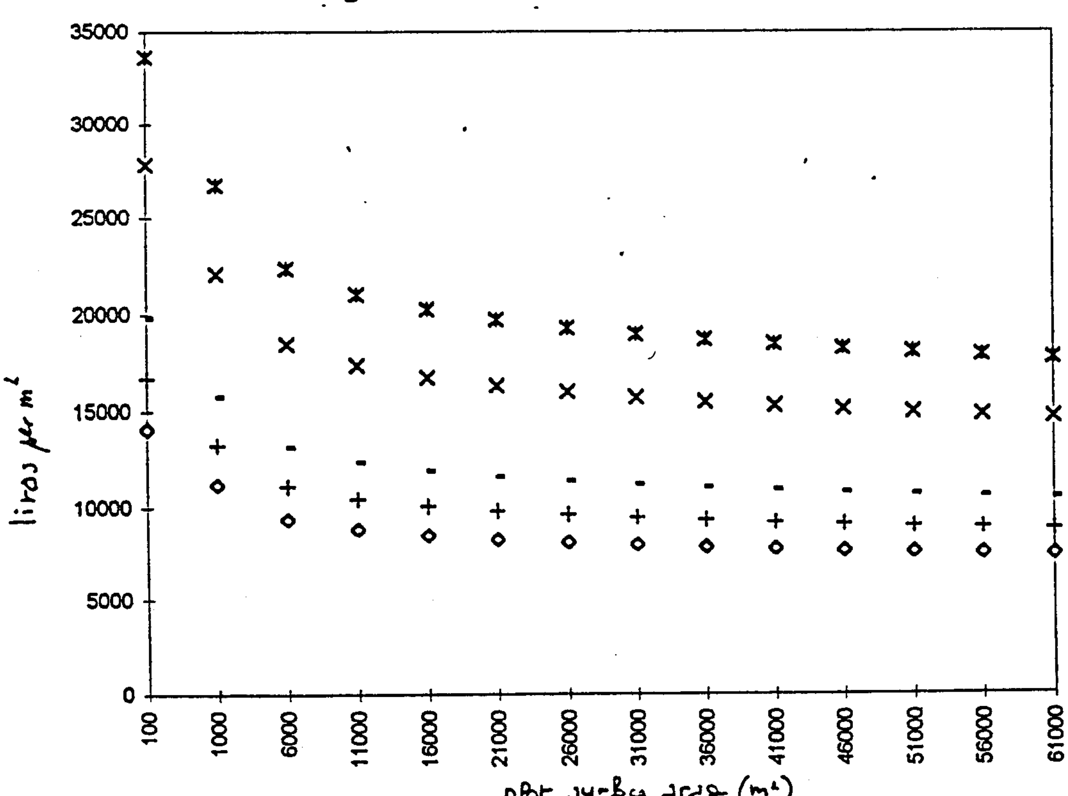
Fig. 4 Land values and plot sizes with the varying of access and cover index of buildings. Distance from nearest industrial or commercial area 2 km.

4a Plots with and without buildings



× good access + poor acces □ cover ind.0.2m^3/m^2

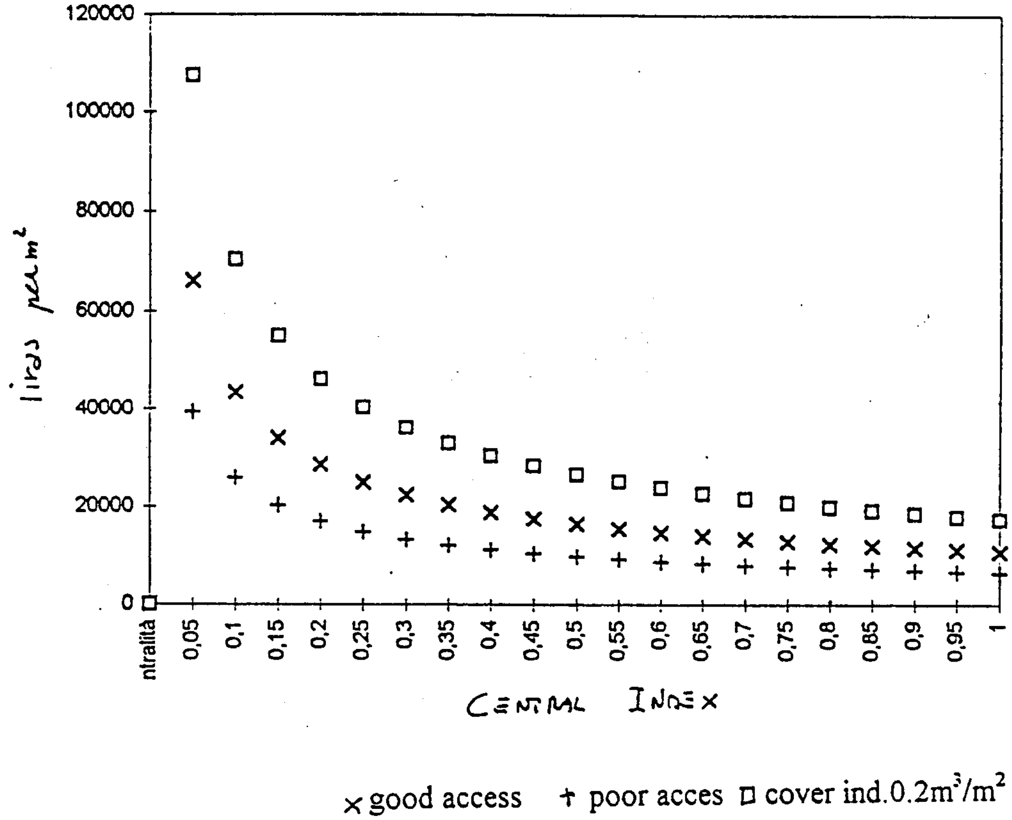
4b Plots without buildings.



× good access + poor access. ◇ dump – park ✱ river

Fig. 5 Land values and location (central index) with the varying of access and cover index of buildings. Size of the plot sold 2 ha.

5a Plots with and without buildings



5b Plots without buildings.

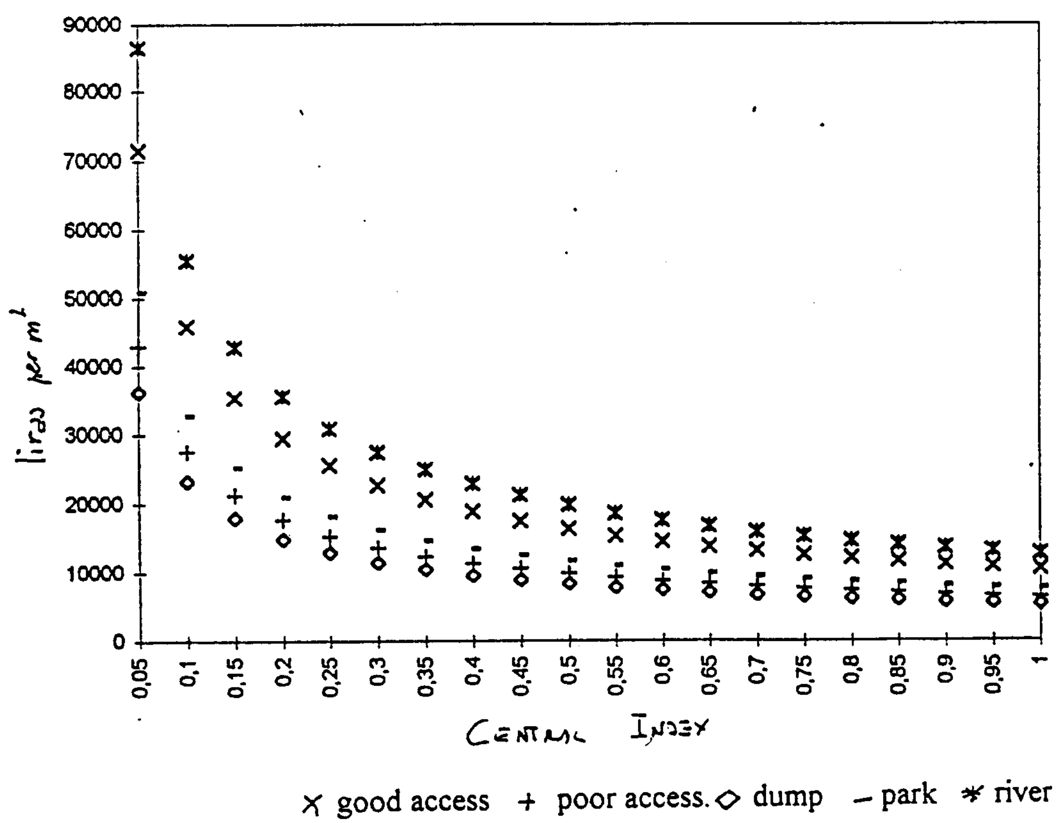


Fig. 6 Land value and urban destination of use.