

ABSTRACT

The study is connected to the theme of «Urban Soil Consumption» (and Urban Settlement Density). The importance of this theme is day by day becoming more apparent. The author's preoccupation is that the theme is generally studied neglecting the connection with transport. The study gives on this point some evaluation, namely concerning urban diffusion and private motorisation. The study highlights the problem of individuating good urban density indexes (or proxies). A particular proxy is elaborated (and discussed) comparing Agricultural and Demographic Census data.

1. GENERAL THEME OF RESEARCH. CONNECTION WITH OTHER STUDIES

1. 0. The research concerns a problem of interference between urban systems of different scales

To explain myself better I shall start by considering what I think is an acceptable schematic interpretation of the relationship between transport

systems and settlement systems, stressing above all the connection between the development of mass private transport, diffused suburbanisation and consequent extension of metropolitan systems.

This short outline will be useful in defining the terminology which I will be using in the rest of this paper.

1.1. Transport and Urban Systems. Conections

I will consider the general system of urban settlements as an aggregation of elementary poles each of which is the centre of attraction in the ambit of its own area and centre of an urban settlement (whatever may be the exact meaning of the word 'urban').

The poles of the national and regional systems are linked together (or can be linked) by a national or regional system of transport. Each pole has a power of attraction that affects the urban settlement and is proportioned to the accessibility of the pole in the regional / national (or international) system of transport (The accessibility is evaluated on some regional variables: resources, population, activities...). But the effect of the attraction is limited by the space available around the pole, and controlled according to the economical and technological possibilities of efficiently organizing local settlement and local transport.

When the settlement around a pole saturates the available space, then further settlement attracted by that pole settles itself in the nearby poles (old poles or new poles) and thus causes the growth of the metropolitan system.

If we now imagine that the population settled in the metropolitan system remains constant, it doesn't follow that the settled area and the number of the pole remain automatically constant. Whatever improvement in transport (interpole scale or local scale) has the effect of widening the system and extending the settlement area: in any case, in fact, the average value of the paths OD (origin-destination, by which we intend home-work) decreases and a certain number of citizens are thus enabled to settle further away with the same transport cost. It follows that there will be also a decrease in the average density. This result is more certain if in the

meantime, as is happening, the Destination pattern also tends to decentralize. And finally the effect of expansion is emphasized if the density decrease enables a greater number of poles to reach saturation more quickly. This occurs (above all) when the original metropolitan system is thick.

There has been a case of this kind, with the rapid improvement, general and widespread, of transport to do with the boom in private motorisation.

Private motorisation integrated public transport and made it possible to reach every part of the area and enabled a considerable number of citizens to buy a house on their own lot. The effect of this urban sprawl has moreover, as we know, also involved industries and part of the offices; this fact decreased the density to such an extent that it has resulted in a marked lessening of the receptive capacity of the area of numerous poles, thus causing the proportional extension of the metropolitan system.

To put into practice this enlargement it is not necessary to, step by step, completely saturate the pole areas. Things actually happen more gradually and in a more complicated way. Support - but also effect - in the balance between mobility transport (at different levels) and settlement density is the market of the building land; this expansion mechanism which I have just mentioned can be restudied as being dependent on the needs of expansion of supply as reply to the expansion of land demand.

1. 2. Historical evolution of transport and urban settlement systems

We may now also remember that developed countries have passed through these principal phases:

- 1) Polarization and concentration of urban settlement and contemporary building of a regional/national transport network.
- 2) Growth and extension of several metropolitan settlement systems, supported by a constant population growth and by the establishment of metropolitan transport systems.
- 3) Diffused private motorisation and suburbanisation of pole areas, further

expansion of metropolitan systems (also because of expansion of public transport network) although population grows very slowly or even decreases.

4) Growth of poles remote from major metropolitan systems, possible growth of alternative metropolitan systems.

The U.S. evolution may be considered the standard one: metropolitan systems population boom up to 1914 supported by public transport networks. An early elite suburbanisation up to 1930, then diffused suburbanisation and expansion of main metropolitan systems helped by the private motorisation boom, after 1945 the mass suburbanisation continued even if population growth in metropolitan systems stopped (in 1955 in the north-eastern Megalopolis).

Similar events occurred in England, France, Germany, and finally in Italy, where we had a population boom in the big towns - principally in the Northern-Central ones - during the 50's (and growth of the Milan metropolitan systems); then the private motorisation boom and diffused suburbanisation, plus expansion of metropolitan systems with slower population growth during the 60's, decrease in the central towns during the 70's. Things happened in a less sensible way than in the U.S., and suburbanisation density has been less extensive because it developed with lower income levels.

About 1960 the U.S. entered phase 4, which we can call "decentralisation" (De Matteis 83 b). England was already in this phase, and after 1960 one by one the C.E.E. countries entered.

1.3. Studies on urban settlements. Sensitivity problems

The polarisation effects of phase 1 have been studied by geographers according to gravitational schemes (Ravenstein 1885, as explained in Willis 74) and above all according to urban Rank-size schemes (Auerbach 1913, Chistaller 1937). Between geographers and town planners there was, at that time, practically no reason for interference. Later other geographers criticized (Berry 61) one point in the Rank-size theory, that is the supposed correlation between development and Rank-size distribution, and several

geographers at the same time studied the metropolitan area structures (Gotmann 61) when diffused suburbanisation had already started, but without taking into consideration the influence it would also have on the extension of metropolitan systems.

The effect of this diffused suburbanisation, on the other hand, was immediately felt, at the level of the individual urban pole, by U.S. town planners (Haig 26, Vernon 59) who had direct experience. The large expansion of the land market and the increase in urban soil consumption drew the attention of economists: the monopolar explanatory model of Alonso 1964 (and his Von Thünen revisitation) was proposed at that time, and connected urban soil consumption to income and mobility transport. But a multipolar and dynamic rent model has not yet been satisfactorily realized. When we entered the 4th phase the geographers were the first to understand and study "decentralisation", but they did not have the right instruments to enable them to understand exactly the connection existing between diffused suburbanisation, motorisation boom and the extension of metropolitan systems.

In fact at a regional level the shifting of metropolitan system weights and metropolitan system expansion may result in similar variations in population distribution, and that doesn't allow the correct separation of the phenomena. For instance, the distribution of population growth in the poles of a metropolitan system in expansion has a negative correlation with the demographic pole dimensions that is very similar (and more so if the whole metropolitan system's weight is growing) to the «counter-urbanisation» as defined in Fielding 82.

These problems have created a certain amount of uncertainty concerning the evaluation in decentralisation related to a regional scale (Berry 78). They denounce a lack of sensitivity concerning local level that results in the difficulty of taking into consideration local causes. Namely using total land density (DT) and not using urban settlement density (DU) we don't touch diffusion phenomena which are connected with changed motorisation level. In that way motorisation and more generally transport, is not, or not well enough, known as a possible explicative variable in the dynamics of settlement at metropolitan (and even regional) scale.

1.4. The Evolution of Studies in Europe and Italy . Transport sensitivity

In Europe, and particularly in Italy, many studies have been carried out on urban settlement decentralisation, (main ones: Garofoli 83, Cencini De Matteis Menegatti 83) but no real explicative model hypothesis has been advanced, not counting the Functional Urban Region cyclical models (Dewett 80, Cencini 83) whose methodological consistence and application scale is not perfectly clear.

It is interesting, referring to the above-mentioned lack of sensitivity, that, in order to explain urban systems evolution, transport is considered in reference to a metropolitan scale, and not to a local scale, only occasionally and implicitly.

For instance many phenomena listed in association with the «metropolitan crisis» and the «peripheral development» in De Matteis 83 on pages 108 - 111 presume there has been a change in structure, in modes, and in level of transport (say, urban land market, fiscal crisis in towns, industrial decentralisation, the trend towards a more homogeneous rural urban settlement) but there is no explicit reference to transport, while in my opinion transport evolution (above all private motorisation) is the clearest way to explain phenomena which otherwise remain unexplained.

For example: why do we come across counterurbanisation only in developed countries? We cannot overlook the fact that in developing countries transport levels - particularly private motorisation - are inferior.

Analogously: why can recent metropolitan areas (Italy) reach the counterurbanisation phase a short time after it has been reached by more ancient metropolitan areas (England) and richer ones (USA)? This can be explained if we consider that the time lag in different private motorisation booms is relatively-speaking reduced.

Finally: the 10 - year time-lag in developing private motorisation probably explains the different speed in demographic evolution between the Southern metropolitan areas and Northern and Central ones that has been noted in Cencini 83, p. 101 and in De Matteis 83a, p. 129.

1.5. Urban Soil Consumption

There has been much more interest taken in recent years in *urban settlement densities* (DU) or more precisely in their inverses: *urban soil* (pro capite) *consumption*; individuation of urban densities is much more difficult to treat than total land densities (DT) it is also more important in order to go deeper into the matter of urban dynamics, and to get normative indications concerning urban management.

After several general studies (Carozzi Mioni Rozzi 76, Carozzi Rozzi 80) a study on the situation in Lombardy has recently been produced (Mioni Tarulli 83) (The study treats the problem from the point of view of consumption).

But also in these studies, which should have a historical reference the Alonso Model, transport is again neglected.

We can finally observe that transport, on the one hand hides behind many other variables, and so it ends up like the forest that cannot be seen for the trees, on the other hand it propagates quickly toward an isotropic distribution; which doesn't result in relevant differences from point to point in a synchronic cross-section (of a homogeneous region), but, in a dynamic study, transport cannot be overlooked because of the big change caused in the whole system.

2 . WORKING HYPOTHESIS

From what is said above emerges, first of all, the need to take into account also transport variables in order to analyse urban settlement dynamics. In the second place the need to refer to *Urban Settlement Densities DU* (instead of *Total Land Densities DT*) as better connected with transport evolution.

The aim of this research has been to study this connection, based on this first working hypothesis: that, as a consequence of the private motorisation boom (and also of public transport improvement) *DU has decreased everywhere, even when DT has increased.*

The most difficult problem then is to find an acceptable proxy D'U of the measure of DU.

Unfortunately, in fact, it is quite impossible to find DU series that suit synchronic and diacronic comparison on a large scale. In Italy the only possible way could be to use Agricultural Census data (61, 70, 82), even if there are possibilities of biases. So a consequent second working hypothesis is that Proxies of DU, which we have elaborated using Agricultural Census data, are reliable or at least that *it is possible, using A.C. data, to elaborate (other) acceptable proxies.*

So in the rest of the paper we give a very synthetic account of the principal work we have done and of the results we have reached.

Some are good; and we have managed to minimize the risk, which is nevertheless present, of being involved in a tautological loop with the two hypotheses, that is: we may say that the cake is good using proofs that we in turn judge good because they prove that the cake is good.

3. DECREASE OF FARMLAND (DSTA) AND URBAN SOIL CONSUMPTION

3.1. Comprehensive data comparison between Italy and US.

Here we'll give the conclusion of our elaboration for Italy:

TAB 3.1. DECREASE OF FARMLAND IN ITALY: URBAN SOIL CONSUMPTION	Period	Annual mean variation STA (1000 ha)	% var.	Procapite annual var. (ha)	For urban use *
	1961 - 70	-158.7	- 0.60	- 0.003	0.00174
*The last column gives data estimated with the par. 8 regression.	1970 - 82	- 123.7	- 0.49	- 0.002	0.00164

There are many different opinions on U.S. farmland conversion into urbanised land. After having considered the Soil Conservation Service

SCS data, as used in NALS 81, and the Economics and Statistics Services ESS (Demographic Census) data, as discussed in Fisher 82, Simon and Sudman 82, Borwn Brewer Boxley and Beale 82, we have concluded with these rough approximated data:

Annual percentual variation of Farmland (67 - 77): -0.2% (to be compared with -0.49 for Italy), annual pro capite variation 0.0053 of which 0.0026 shift to urban uses (to be compared with 0.002 and 0.00164). That correponds to the fact that nowadays in Italy there is relatively more abandoned farmland than in the U.S., and to the fact that the Italian urban expansion is less extensive than the U.S. one.

3.2. Correlation between DSTA and urban expansion, and abandoned farmland

Comparing farmland variation correlations with indexes that we suppose can approximate urban expansion (index: variation in number of rooms) and abandoned farmland (decrease of farm-workers), we may conclude that urban use is everywhere more than 50% of DSTA. And the percentage is clearly higher in the 25 more urbanised «province» (Urbanisation Index 1971 from Vitali 83, p. 231).

4. GENERAL PROBLEMS IN DEFINITION AND MEASUREMENT OF URBAN SETTLEMENT DENSITY DU

- We have many methodological problems in chosing the right density, and after that defining, and then measuring.
- This part of the research has been developed in a long systematic discussion.
- The problems are above all in the individuation of urban settlement area AU, which can be done in many different ways; and obviously you have as many DU as AU. But DU also changes with graphic definitions and with settlement rate of dispersal. And if DU change the time trends and cross-section variations also change. (You may even have situations in which

studying the evolution of a settlement DU you can find an increase in spite of a decrease in connection with different DU definitions) . (Nevertheless it is possible to use DU correctly).

5. DISCUSSION ON THE RELIABILITY OF PROPOSED PROXIES ELABORATED USING AGRICULTURA CENSUS DATA

The principal proxy D'U proposed is an «urban settlement density» measured considering: urban area = total area - farmland area. We find it has a relevant possibility of bias if it is used to study density in a single «comune» area for the particular way the datum is defined by the Agricoltura Census services. But there is, of course, a greater bias possibility if this proxy refers to a «provincia» or else a «regione» because there is a growing risk of treating abandoned farmland like urbanised land.

The most correct way to use D'U is to use it at «provincia» (or minor aggregation of a certain number of "comuni") level, and the more urbanised the «provincia» is, the more reliable the proxy is.

Another proxy (fringe density) is not considered reliable, unless the elaborations proposed in par. 8 will give, in future, good results.

6. RELATION BETWEEN TOTAL LAND DENSITY DT AND URBAN SETTLEMENT DENSITY

(See Tab. and Fig. 6.1, 6.2, 6.3)

The first working hypothesis has been confirmed: The higher the historical (61) DT of the settlement is there more D'U decreases in time (61-71).

D'U *ever* decreases, even when DT increases greatly (see figure 6.1.)

Year by year, in connection with the same DT value, we register lessening of D'U values (as a system moves toward urbanisation) (we can also say that land occupation increases - and so the slope of DT-DU curve becomes nearer to one - even when DT does not increase or increases very slightly) (see fig. 6.2, 6.3).

In fig 6.3 several curves are drawn which represent schematic interpretations (to be confirmed with a more accurate test) of the results, in order to explain the

FIGURE 6.1

RELATION BETWEEN TOTAL LAND DENSITY DT AND URBAN SETTLEMENT DENSITY (PROXY) D'U - "REGIONI" SAMPLE

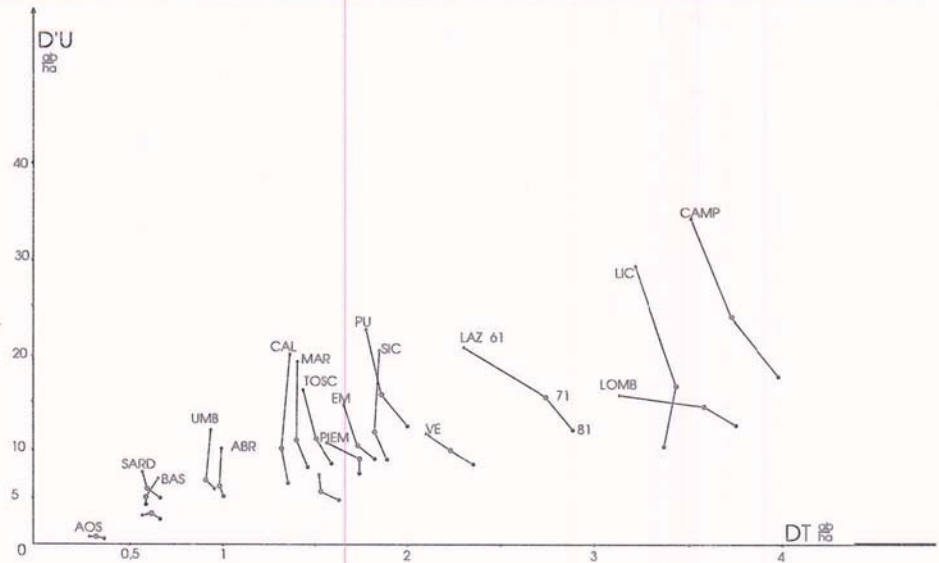


TABLE 6.2.

		1961	1971	1981
EVOLUTION OF RELATION BETWEEN TOTAL LAND DENSITY DT AND URBAN SETTLEMENT DENSITY (PROXY) D'U. «REGIONI» SAMPLE.				
All (19)	R	0.825	0.899	0.908
	Slope	7.78	4.84	3.42
	Interc.	2.59	2.00	1.81
North (12)	R	0.789	0.909	0.912
	Slope	6.85	4.26	3.05
	Interc.	2.42	2.03	1.93
South (7)	R	0.962	0.979	0.964
	Slope	9.6	6.2	4.17
	Interc.	2.73	1.58	1.58
	D'U mean	14.2	10.6	8.6
	DT mean	1.68	1.80	1.87
			(+ 7.1%)	(+ 3.9%)

FIGURE 6.2

EVOLUTION OF RELATION BETWEEN TOTAL LAND DENSITY DT AND URBAN SETTLEMENT DENSITY (PROXY) D'U. "REGIONI" SAMPLE

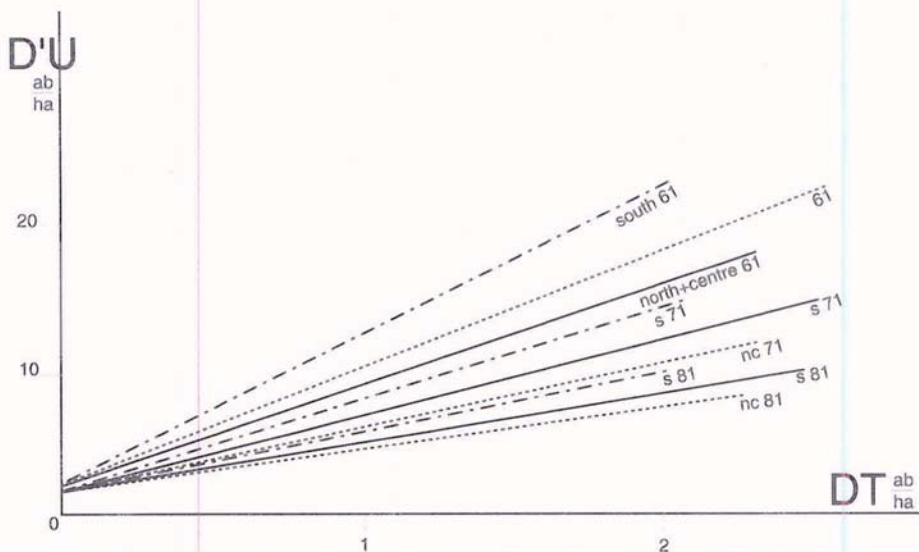


FIGURE 6.3

EVOLUTION OF RELATION BETWEEN TOTAL LAND DENSITY DT AND URBAN SETTLEMENT DENSITY (PROXY) D'U. "REGIONI" SAMPLE

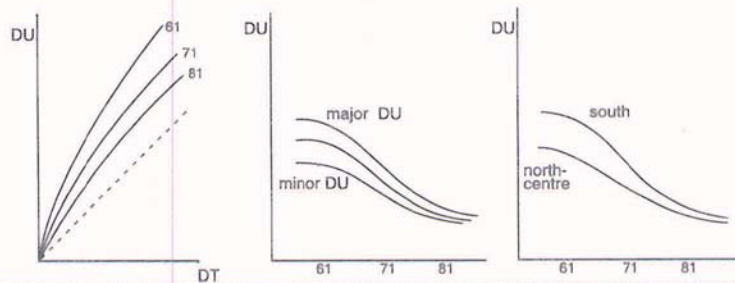
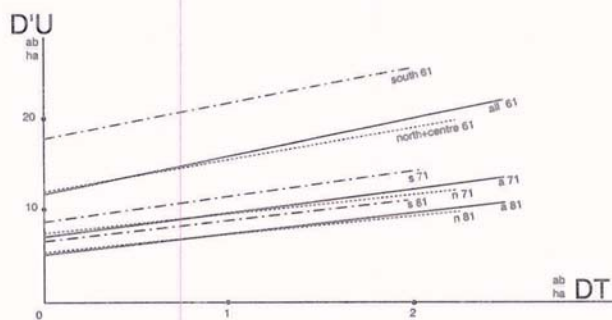


FIGURE 7.1

RELATION BETWEEN URBAN SETTLEMENT DENSITY (PROXY) D'U AND MOTORISATION INDEX M-"REGIONI" SAMPLE

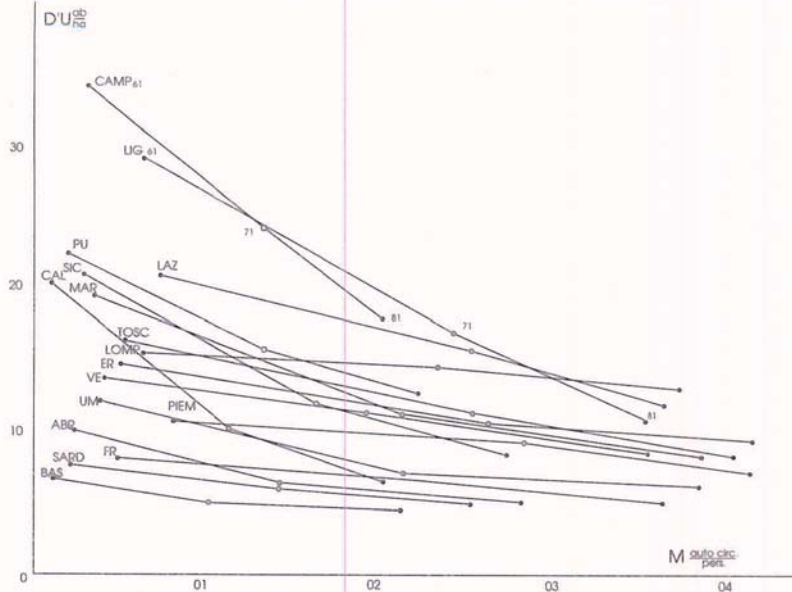
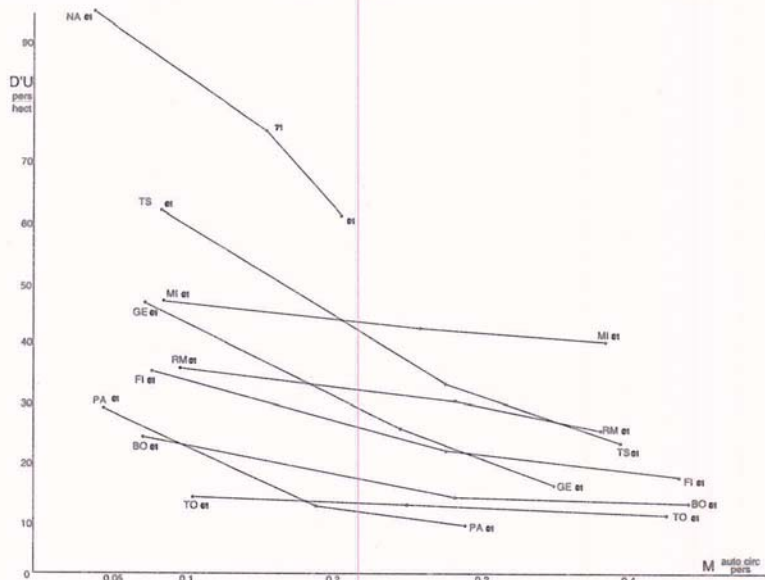


FIGURE 7.2

RELATION BETWEEN URBAN SETTLEMENT DENSITY (PROXY) D'U AND MOTORISATION INDEX M-URBANIZED "PROVINCE" SAMPLE



average behaviour of DU.

The decrease in time is notable: DUs move towards final asymptotic values which are lower and more homogeneous than the historical (61) ones. DU is decreasing in the South urban system with a certain time lag compared with Northern-Central urban system, but it is decreasing more quickly.

Correlation Coefficients are very good.

The risk of tautology (see par. 2) is partially reduced because correlation is tighter and hypothesis better confirmed in the sample of 25 more urbanised «Province» (where D'U works better, see par. 5).

The DU evolution appears to be well connected with transport evolution. It seems to me that changes in motorisation can be considered necessary but not sufficient conditions to determine urban diffusion.

7. COMPARISON BETWEEN MOTORISATION (CIRCULATING CARS PRO CAPITE) AND URBAN SETTLEMENT DENSITY

Results are shown in fig. 7.1 and 7.2.

A logistic curve could be a good approximation; with analogous characteristics as the case in fig. 6.3 : (Variation of DU in relation to time).

- Studying variation of correlation coefficients between D'U and motorisation, we find of course very little Correlation Coefficient value, but it is interesting that in an urbanized context (Province) the trend is from a positive towards negative correlation.

The explanation is partially connected with the urban diffusion of metropolitan peripheries, but also partially connected with the demotorisation of metropolitan centres.

8. NEW PROPOSITION OF PROCEEDING TO ESTIMATE GOOD DU VALUES (MEAN VALUES)

We have individuated a list of possible new uses for farmland which shifted

from farm use (DSTA).

These uses should be exhaustive for the total DSTA (we have proposed a possible list of 5:6 uses, which, in this first experiment, we have reduced to 3: residential, abandoned land, other urban uses). It should also be possible to associate to every single use a reliable proxy variable (we propose: for residential use the increase of rooms, for abandoned land the decrease of farm-workers).

Then we have operated with a normal multiple regression analysis, considering DSTA the dependent variable, and finally we have estimated the mean national value starting from the series of «regioni» values, and the mean value for urbanised «province» (and it would be possible to proceed in the same way to estimate mean value starting from series of «comuni» values).

The coefficients of several independent variables (of instance residence, but it could be industry, or offices) which result from the regression analysis, can be considered inverses of urban settlement densities.

Final result (see tab. 8) seem to be reliable and they agree with other results of this study (also if statistic indexes, good for the «regioni» sample, are not good for «province» sample).

ESTIMATION OF % EXTENSIONS (AND DENSITY) OF NEW USES FOR THE EX-FARMLAND AREA DSTA (MEAN VALUES).		R square (corrected)	Sample	Period	New uses %			DUF		DU+
					Abandoned	Residential	Other	rooms ha	persons ha	
0.470	«Regioni»	0.470		61-71	35.6	23.8	41.4	48	45	18
				71-81	18.1	48.3	33.5	38	28	14
0.104	Urbanized «Province»	0.104		61-71	31	23.	46	70	71	24
				71-81	0	64.	36	41	33	21

DUF = Residential Fringe Density (in residential area)
 DU* = Urban Settlement Density (withouth abandoned area)

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