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MODELLING ACTIVITY LOCATION CHOICE

PAST, PRESENT AND FUTURE

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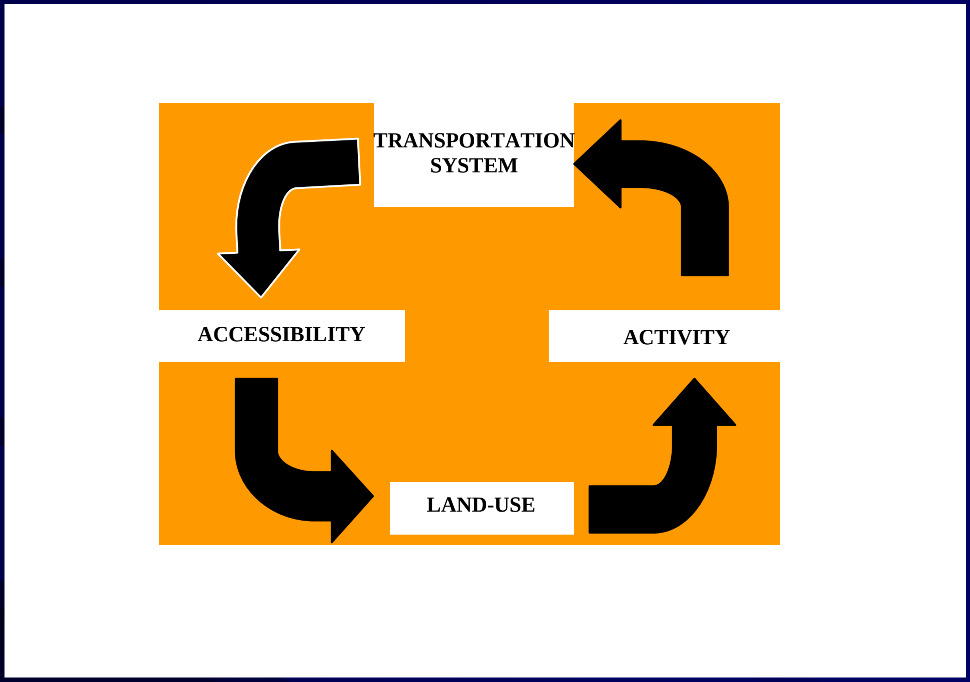
OUTLINE

- Transport and Land-Use Interaction
- Modelling approaches
- Examples of r.u. activity location choice models
- Transport impacts on location choices
- Choice set generation in location choice contexts

PAST

TRANSPORT AND LAND-USE INTERACTION



The Land-Use/Transport feedback cycle

MODELLING APPROACHES (1)

- ECONOMIC APPROACH
- SPATIAL INTERACTION APPROACH
- RANDOM UTILITY APPROACH

MODELLING APPROACHES (2)

ECONOMIC APPROACH

Urban Economy

Von Thunen (1826); Weber (1909); Christaller (1933); Alonso (1964)

OBEJECTIVE: to describe the general and aggregate behaviour of a town – more theoretical than practical approach

MODELLING APPROACHES (3)

SPATIAL INTERACTION MODELLING

Hansen (1959); Lowry (1964); Wilson (1974)

OBJECTIVE: to develop tools for direct application to planning; practical approach

MODELLING APPROACHES (4)

<u>RANDOM UTILITY APPROACH</u>

McFadden (1975); Echenique (1988); de la Barra (1989); Wegener (1999); Cascetta (2005)

OBJECTIVE: from economy a practical approach which will become the basis of Transportation Systems Theory

RANDOM UTILITY APPROACH (1)

1. User *i* in making a choice chooses among m_i avaiable alternatives which make his/her choice set I^i.

2. The decision-maker *i* assigns to each alternative *j* of his/her choice set a perceived utility or "attractiveness" U^i_j and chooses the alternative maximising this utility.

3. The utility associated with each alternative depends on a series of characteristics, attributes of the alternative itself and of the decision-maker $U^i_j = U^i(\mathbf{X}^i_j)$, where $\mathbf{X}^i_j$ is the vector of attributes relative to alternative *j* and decision-maker *i*.

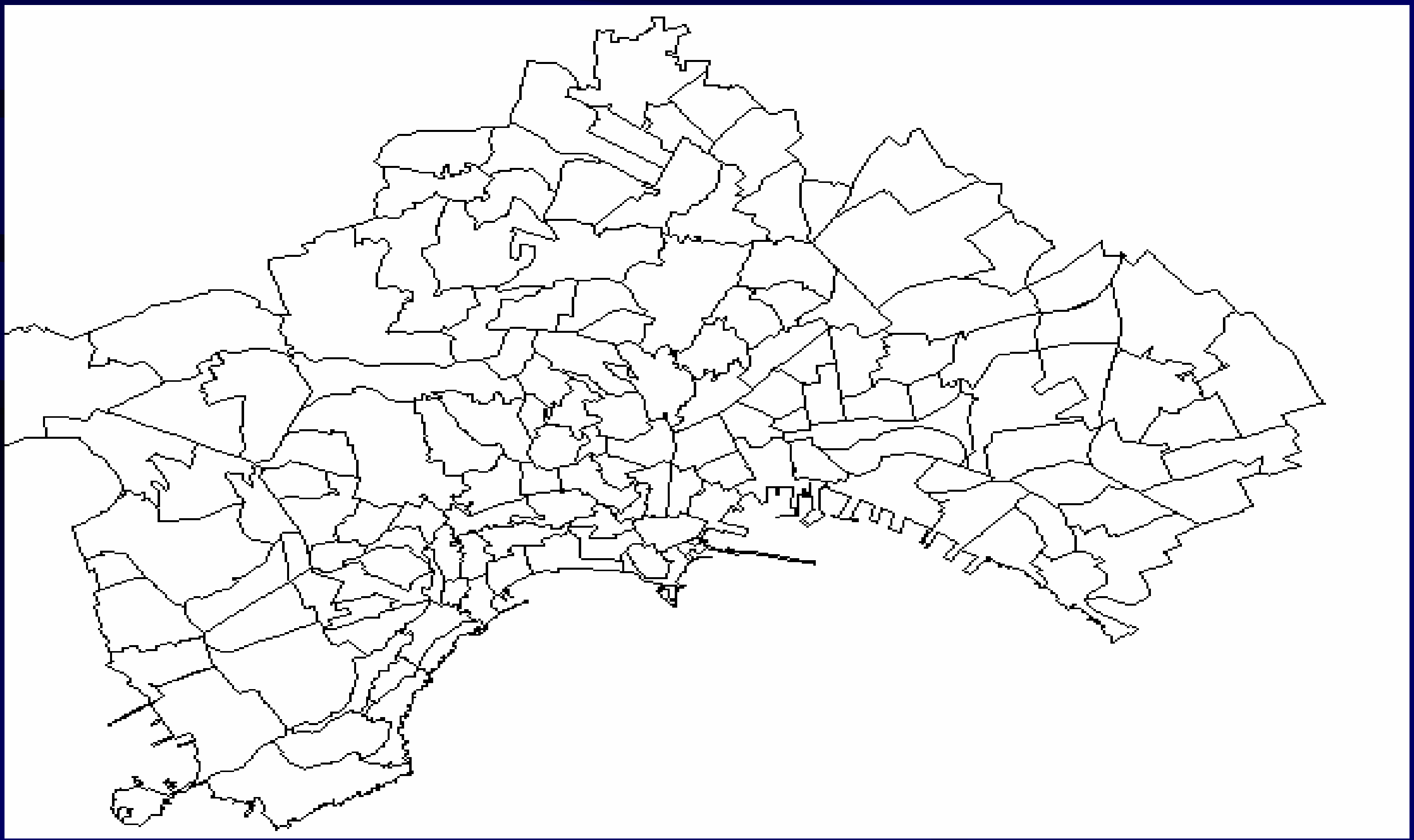
RANDOM UTILITY APPROACH (2)

4. $U^i_j = V^i_j, + \varepsilon^i_j \quad \forall j \in I^i$

The probability of choosing alternative *j* among those avaiable (1,2....*m*) $\in$ *I* can be expressed as:

$p^i(j/I^i) = Pr\,(V^i_j - V^i_k > \varepsilon^i_k - \varepsilon^i_j \;\; \forall k \neq j,\, k \in I^i)$

APPLICATION EXAMPLES (1) : RESIDENTIAL AND ACTIVITY LOCATION CHOICE MODELS



APPLICATION EXAMPLES (2) RANDOM UTILITY APPROACH

The functional specification of such models requires the identification of:

- Decision-makers
- Choice set
- Behavioural assumptions

THE CASE OF NAPLES: RESIDENTIAL LOCATION CHOICE MODEL (1)

- Decision-makers

  - employees by income (high/medium and low)

- Choice set

  - all the zones of the study area

- Behavioural assumptions

  - the probability of residing in a zone is conditional to the workplace

THE CASE OF NAPLES: RESIDENTIAL LOCATION CHOICE MODEL (2)

$$p^c(liv = i) = \sum_j p^c(liv = i, work = j)$$

$$p^c\left(liv = i, work = j\right) = p^c(liv = i / work = j) \cdot p^c\left(work = j\right)$$

$$p^c(j=work)=\frac{Workplaces^c(j=work)}{\sum_h Workplaces^c(h=work)}$$

THE CASE OF NAPLES: RESIDENTIAL LOCATION CHOICE MODEL (2)

Conditional probability of the LOGIT type:

$$p^c(liv=i/work=j)=\frac{exp(V^c(liv=i/work=j)/\theta)}{\sum_{h\in\{1,2,..,n\}} exp\left(V^c(liv=h/work=j)/\theta\right)}$$

Probability of working in zone *j* for employees of type *c*:

$$p^c(j=work)=\frac{Workplaces^c(j=work)}{\sum_h Workplaces^c(h=work)}$$

THE CASE OF NAPLES: RESIDENTIAL LOCATION CHOICE MODEL (3) MAIN ATTRIBUTES

$$V^c(liv = i/work = j) = \sum_k \beta_k X^c_{kj}(liv = i/work = j)$$

Not dependent on the Transportation system

- lnSTOCK(i)
- Price(i)
- PREST(i)
- CH(i)

Dependent on the Transportation system

- $ACA\_SER^c(i)$
- $Y^c_{work}(i,j)$

THE CASE OF NAPLES: RESIDENTIAL LOCATION CHOICE MODEL (4)

Estimation parameters: Maximum likelihood method (RP survey)

High/Medium Income

ρ^2 = 0.718	*lnSTOCK(i)*	*PRICE(i)*	*ACA_SER^c(i)*	*Y^c_{work}(i,j)*	*PREST(i)*	*CH(i)*
β	0.2106	-0.049	0.945	2.578	0.3894	-1.365
t-ratio	4.1	-1.3	1.6	11.1	2.5	-3.1

Low Income

ρ^2 = 0.1102	*lnSTOCK(i)*	*PRICE(i)*	*Y^c_{work}(i,j)*	*PREST(i)*
β	0.2806	-0.385	3.698	-2.2487
t-ratio	2.0	-2.0	5.5	-0.4

THE CASE OF NAPLES: ACTIVITY LOCATION CHOICE MODEL (1)

- **BASIC ACTIVITIES**: location derives from decisions taken at the national level (e.g. factories location, universities, …)

- NON-BASIC ACTIVITIES: location derives from decisions taken at the local level (zonal accessibility)

  Simulated sectors:

  - wholesale

  - retail

  - public and private services

THE CASE OF NAPLES:
ACTIVITY LOCATION CHOICE MODEL (2)

- Decision-makers

  - private investors (companies, etc.)

- Choice set

  - all the zones of the study area

- Behavioural assumptions

  - primary choice (not conditional)

THE CASE OF NAPLES: ACTIVITY LOCATION CHOICE MODEL (3)

- The probability of locating an activity *A* in a zone *i*:

$$p^{A}(i) = \frac{\exp(V^{A}(i))}{\sum_{j \in \{1,2,\ldots,n\}} \exp(V^{A}(j))}$$

Not dependent on the Transportation system

- lnFL(i)
- PRICE(i)
- $\text{Workplaces}^{ser}(i)$
- POP(i)
- MJUNCTIONS (i)
- CENTRE(i)
- FR(i)

Dependent on the Transportation system

- PA_POP(j)
- $\text{PA\_Workplaces}^{ret}(i)$

THE CASE OF NAPLES: ACTIVITY LOCATION CHOICE MODEL (4)

Parameters estimation: GLS method (Census data 1991)

Wholesale

ρ^2 = 0.25	$InFL^{wh}(i)$	$PA\_Work^{re}(j)$	$MJ(i)$	$CENTRE(i)$
β	0.4695	0.0003	0.1164	0.3441
t-ratio	62.6	3.3	4.3	14.2

Retail

ρ^2 = 0.68	$InFL^{re}(i)$	$PRICE^{re}(i)$	$PA\_POP(j)$	$POP(i)$	$Work^{se}(i)$	$CENTRE(i)$	$FR(i)$
β	0.3507	-0.0370	2.4358E-05	0.0780	0.1294	0.5589	0.4585
t-ratio	77.1	-8.3	12.4	53.1	24.3	20.1	25.3

Public and private services

ρ^2 = 0.92	$InFL^{ser}(i)$	$PRICE^{ser}(i)$	$PA\_POP(j)$	$CENTRE(i)$
β	0.8174	-0.0138	3.7003E-06	0.0227
t-ratio	93.1	-6.4	3.4	29.8

TRANSPORT IMPACTS ON LOCATION CHOICES (1)

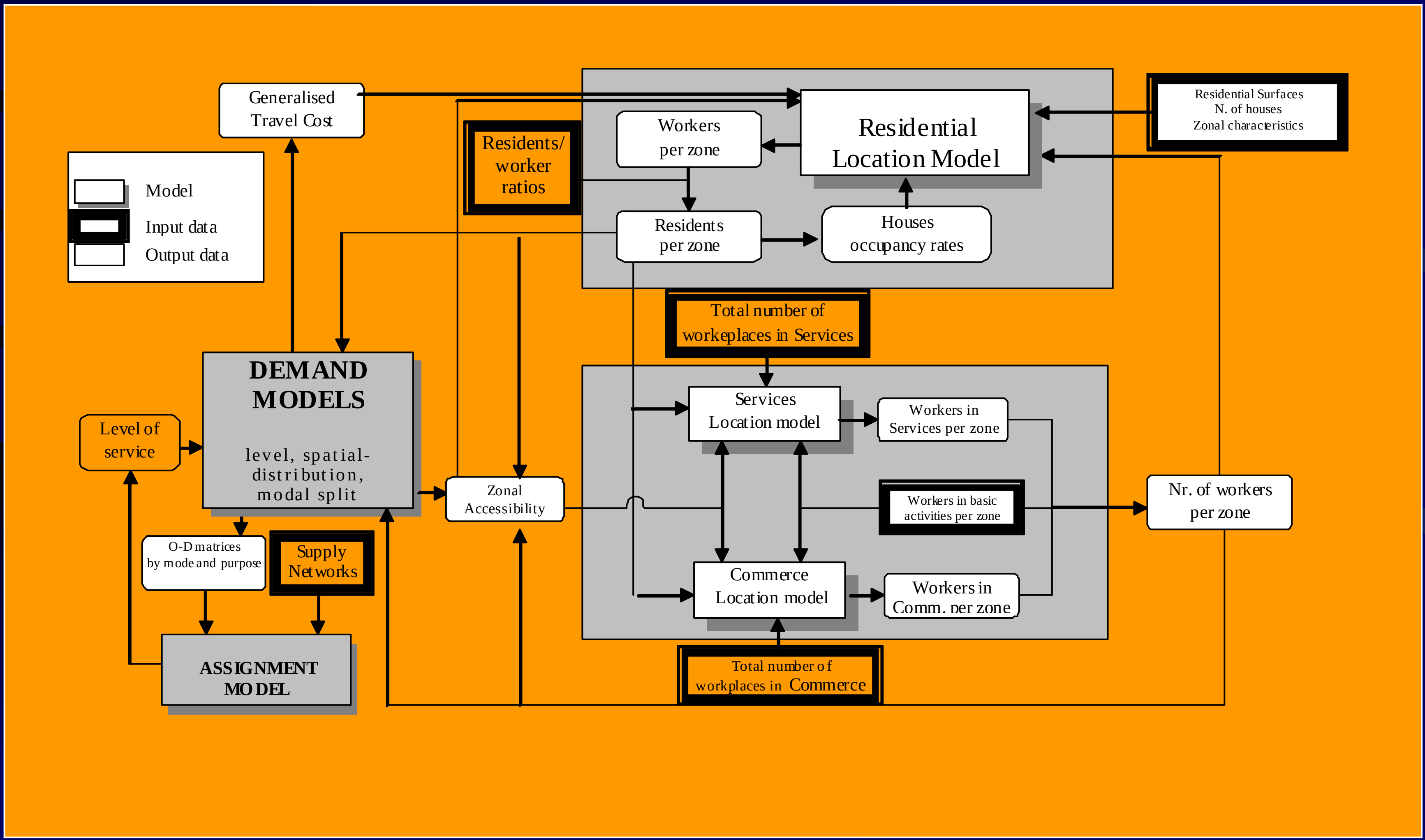
PROBLEM DEFINITION

THE IMPACTS OF A TRANSPORT INTERVENTION:

•USERS (Cascetta, 2001)
•NON USERS (externalities) (Banister, 2002; Pagliara e Preston, 2002)

- TERRITORIAL IMPACTS
- ECONOMIC IMPACTS
- SOCIAL IMPACTS
- –- ENVIRONMENTAL IMPACTS

TERRITORIAL IMPACTS (1):
THE CASE OF ROME



TERRITORIAL IMPACTS (2):
THE CASE OF ROME

The model system has been applied to the urban area of Rome to evaluate the impacts of changes in the supply system. The analysis of such impacts has been considered in terms of changes of residential and activity location.

1. The first intervention has been that of introducing Travel Demand Management policies. The study area has been divided in 4 macroareas: “Centre” which corresponds to the historical centre of the city and 3 rings.

TERRITORIAL IMPACTS (3):
THE CASE OF ROME

With respect to the basic scenario where only the central zones are subject to TDM policies (parking fare and access only to residents), the fare payment has been extended to the zones of the "First Ring".

2. The introduction of a new underground line and the extension of the existing ones has been considered.

TERRITORIAL IMPACTS (4):
THE CASE OF ROME

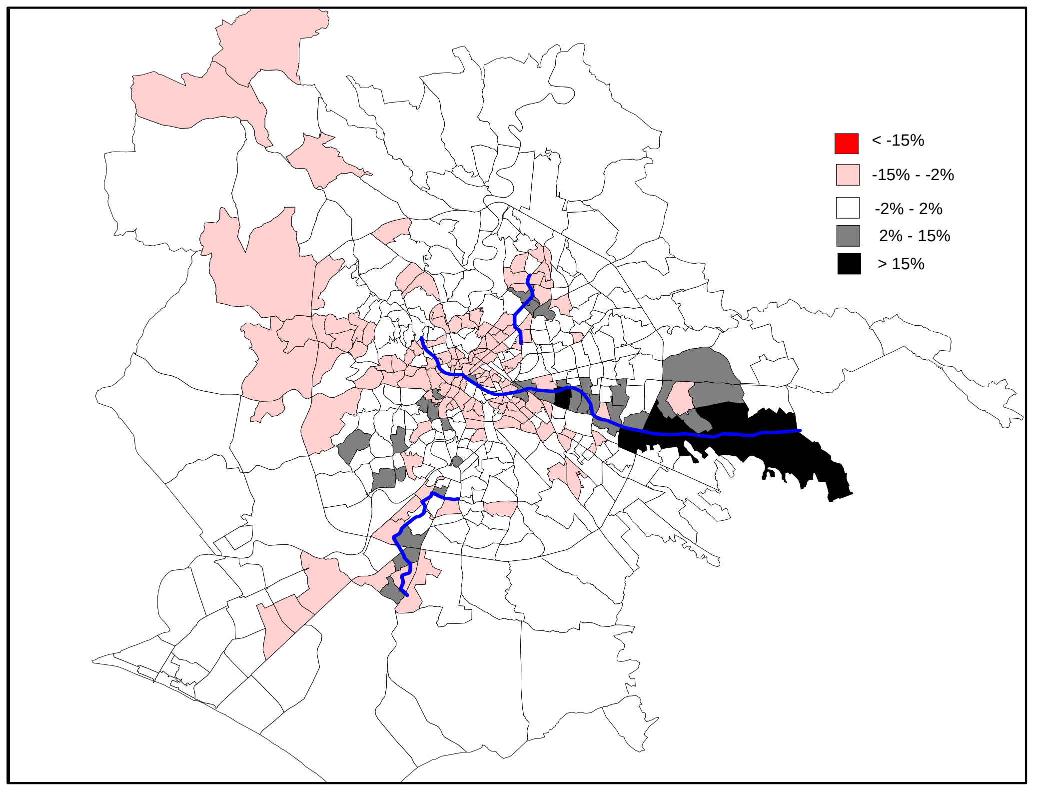
The introduction of parking fares determines:

An increase in the number of residents and a decrease in the number of activities. Parking fares increases the generalised travel cost towards *i* and determines a reduction of the passive accessibility of *i*. People working in *i* (i.e. the zones subject to new parking fares) tend to move residence towards these zones to minimise the effect of the increased generalised travel cost to their workplaces. On the other hand, consultants, banks and other private investors tend to locate their activities in other zones which result more attractive for potential clients, having a higher accessibility.

	Residents	*Employed in commerce*	*Employed in services*
Centro	3%	5%	8%
Ring 1	9%	-7%	-10%
Ring 2	-4%	3%	7%
Ring 3	-2%	2%	5%

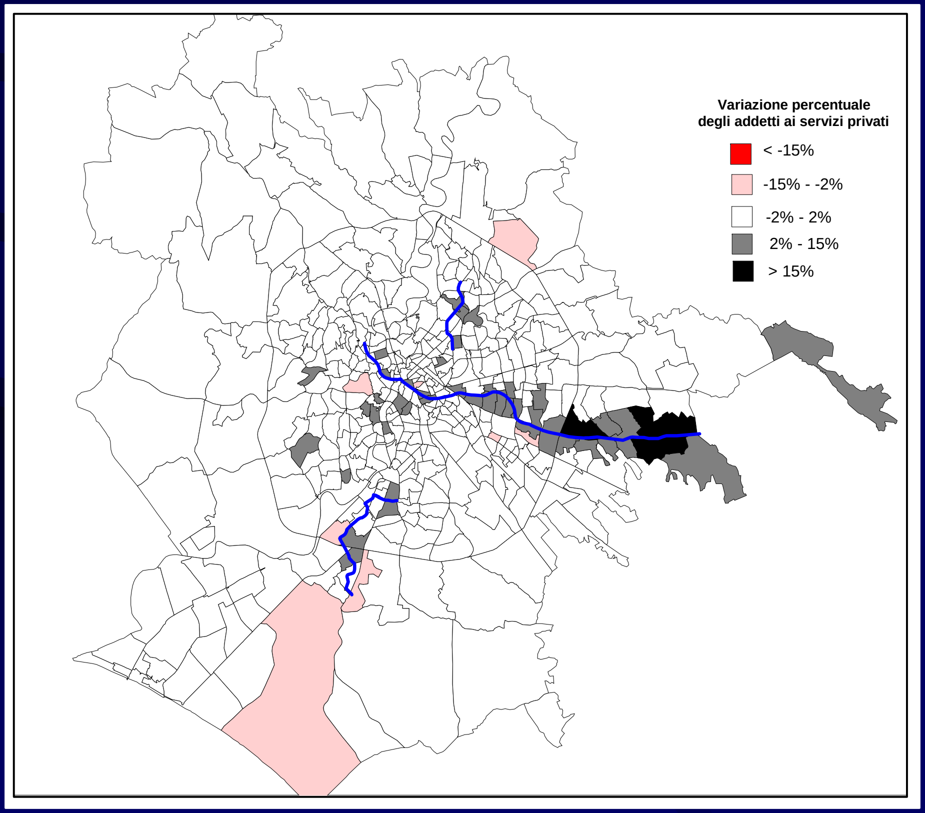
TERRITORIAL IMPACTS (5):
THE CASE OF ROME

Residential percentage change within the study area due to new underground lines (reported in blue). Increase in the number of residents in the zones served by the new line. It is higher in the peripheral zones where the increase of accessibility is higher.



TERRITORIAL IMPACTS (6):
THE CASE OF ROME

Services percentage change within the study area due to new underground lines.



ECONOMIC IMPACTS (1):
THE OXFORDSHIRE CASE STUDY

The DfT funded a project (Jan2002-Jan2003) based at TSU of the University of Oxford:

To assess the extent to which transport policy decisions impact on house prices

Methodology of the study
- Model estimation
- Model application

ECONOMIC IMPACTS (2):
THE OXFORDSHIRE CASE STUDY
Model estimation (1)

-Two Stated Preference (SP) experiments have been undertaken in Oxfordshire (Pagliara et al., 2002).

- These surveys suggested that householders place high values on transport times and costs but also value low density developments, access to high quality schools, low noise levels and developments in small towns/rural areas.

ECONOMIC IMPACTS (3):
THE OXFORDSHIRE CASE STUDY

Model estimation (2)

Coefficients estimates for experiment 1 (*t-statistics in brackets*)

Variable	Full data set	Movers	Non-Movers less than 10 yrs	Non-Movers more than 10 yrs
$HPrice_i$	-0.720-05	-0.935-05	-0.115-04	-0.175-05*
	(*-3.241*)	(*-2.944*)	(*-2.862*)	(*-0.752*)
$TTWork_{ij}$	-0.462-01	-0.367-01	-0.644-01	-0.496-01
	(*-8.087*)	(*-4.539*)	(*-6.547*)	(*-4.211*)
$TCWork_{ij}$	-0.667-02	-0.381-02*	-0.504-02	-0.135-01
	(*-5.000*)	(*-1.950*)	(*-2.211*)	(*-4.480*)
$MDENS_i$	-0.393	-0.591	-	-0.453
	(*-3.724*)	(*-3.681*)		(*-2.019*)
$HDENS_i$	-0.943	-1.247	-0.315	-1.250
	(*-7.143*)	(*-5.688*)	(*-2.098*)	(*-4.670*)
$CITY_i$	-0.274	-0.463	-0.325	-
	(*-3.596*)	(*-4.105*)	(*-2.678*)	
$DETACH_i$	0.274	0.742	-	-
	(*2.188*)	(*4.233*)		
No. of observations	1536	672	528	336
L(*)	-1576	-664	-536	-331
L(0)	-1687	-738	-580	-369
ρ^2	0.07	0.10	0.08	0.10

* Not significant at the 5% level

ECONOMIC IMPACTS (4):

THE OXFORDSHIRE CASE STUDY

Model estimation (3)

Coefficients estimates for experiment 2 (*t-statistics in brackets*)

Variable	Full data set	Movers	Non-Movers less than 10 yrs	Non-Movers more than 10 yrs
$HPrice_i$	-0.145-05*	-0.193-04	-0.710-05	0.290-05*#
	(*-1.120*)	(*-5.466*)	(-2.061)	(*1.495*)
$TCShop_{ij}$	-0.221-02*	-	-0.580-02	-0.842-02
	(*-1.885*)		(-2.897)	(*-3.427*)
$MQSCH_i$	0.496	-	-	1.352
	(*3.825*)			(*4.143*)
$HQSCH_i$	1.270	0.954	0.520	1.870
	(*9.557*)	(*7.455*)	(3.764)	(*5.738*)
$MNOISE_i$	-0.728	-0.641	-1.112	-0.450
	(*-8.937*)	(*-5.165*)	(-7.785)	(*-2.702*)
$HNOISE_i$	-2.487	-2.313	-3.142	-1.936
	(*-11.333*)	(*-6.554*)	(-7.908)	(*-4.964*)
$DETACH_i$	0.355	0.951	-	-
	(*2.881*)	(*5.459*)		
No. of observations	1536	672	528	336
L(*)	-1332	-533	-449	-299
L(0)	-1687	-738	-580	-369
ρ^2	0.21	0.27	0.22	0.19

* Not significant at the 5% level # Incorrect sign

ECONOMIC IMPACTS (5):
THE OXFORDSHIRE CASE STUDY
Model application (1)

The area under study is the corridor Kidlington-Oxford-Abingdon

Kidlington OX5
Oxford OX1, OX2, OX4
Abingdon OX13, OX14

ECONOMIC IMPACTS (6):
THE OXFORDSHIRE CASE STUDY
Model application (2)

The choice models developed from the Stated Preference experiments have been used in conjunction with data on house prices to produce an hedonic pricing model

Four different scenarios have been examined These are:

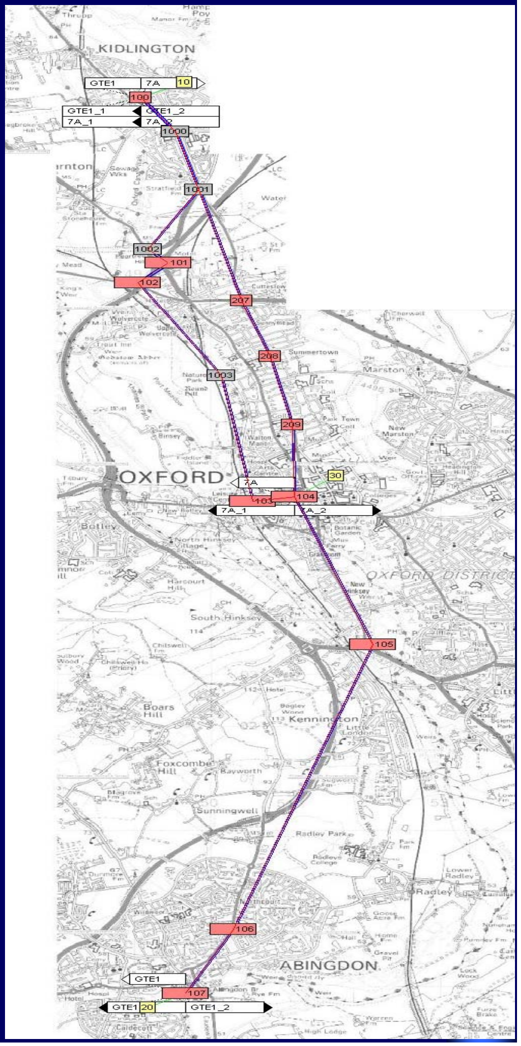
1. Road User Charge
2. Fuel Duty Increase
3. Fuel Duty Decrease
4. Introduction of the GTE System

ECONOMIC IMPACTS (7):
THE OXFORDSHIRE CASE STUDY
Model application (3)

4. Introduction of the GTE System (1)

This system will serve the Kidlington-Oxford-Abingdon corridor.

Oxford GTE is a proposal for a guided busway to allow an express bus network to connect the City Centre to key Park and Ride sites and surrounding towns.



ECONOMIC IMPACTS (8):
THE OXFORDSHIRE CASE STUDY
Model application (4)

4. Introduction of the GTE System (2)

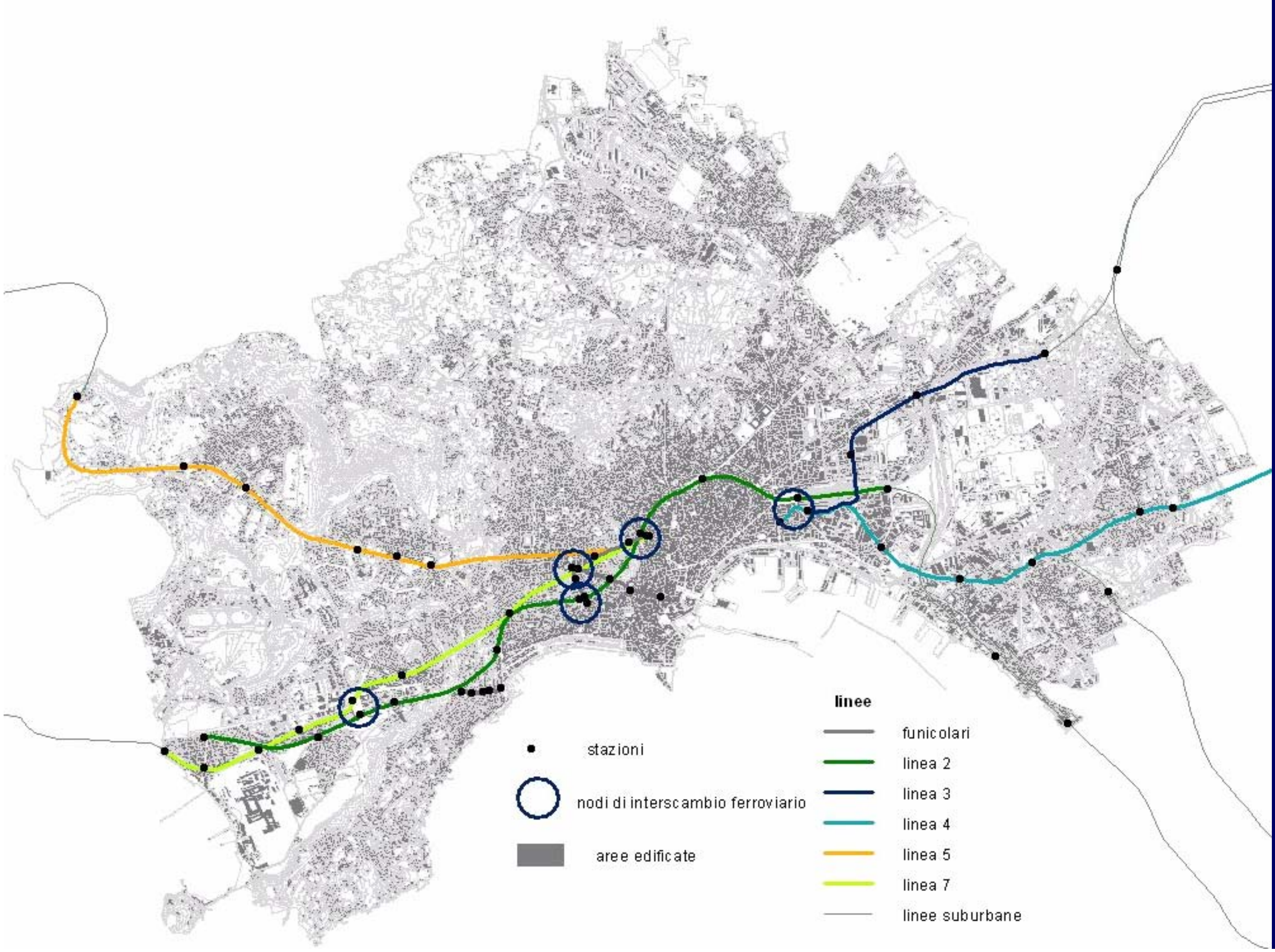
Travel times and costs change. It is supposed that this system will have fares around 10% higher than competing bus services and will reduce travel times between the areas directly served by the route.

The increase in house prices varies between 1% and 7%.

The biggest increases in central Oxford (OX1), Kidlington (OX5) and Abingdon (OX13 and OX14). This is broadly consistent with the RICS (2002) survey.

PRESENT

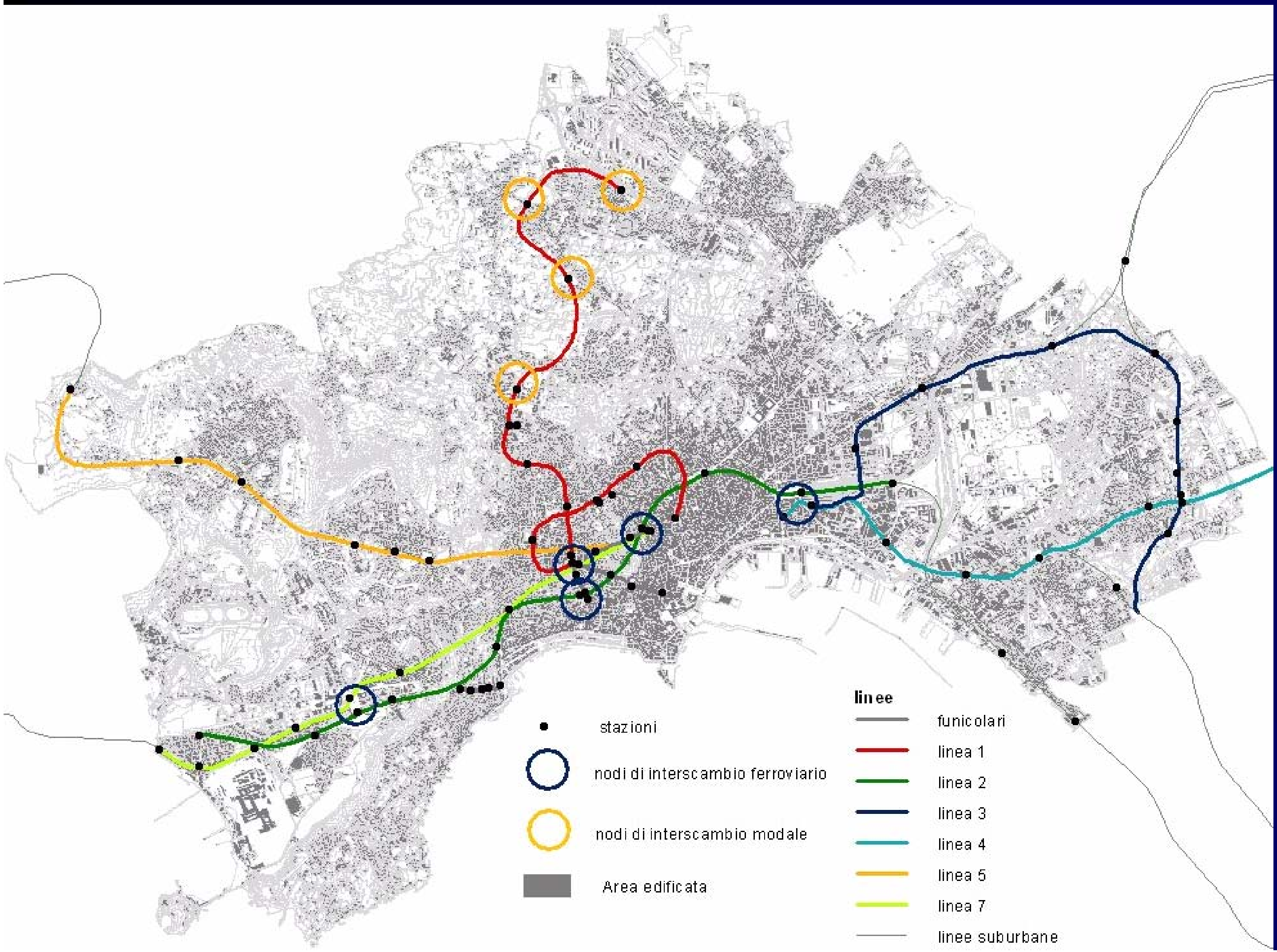
THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (1)



The 1991 network

- **5 underground lines**
- **4 funiculars**
- **43 stations**
- **5 rail exhange nodes**

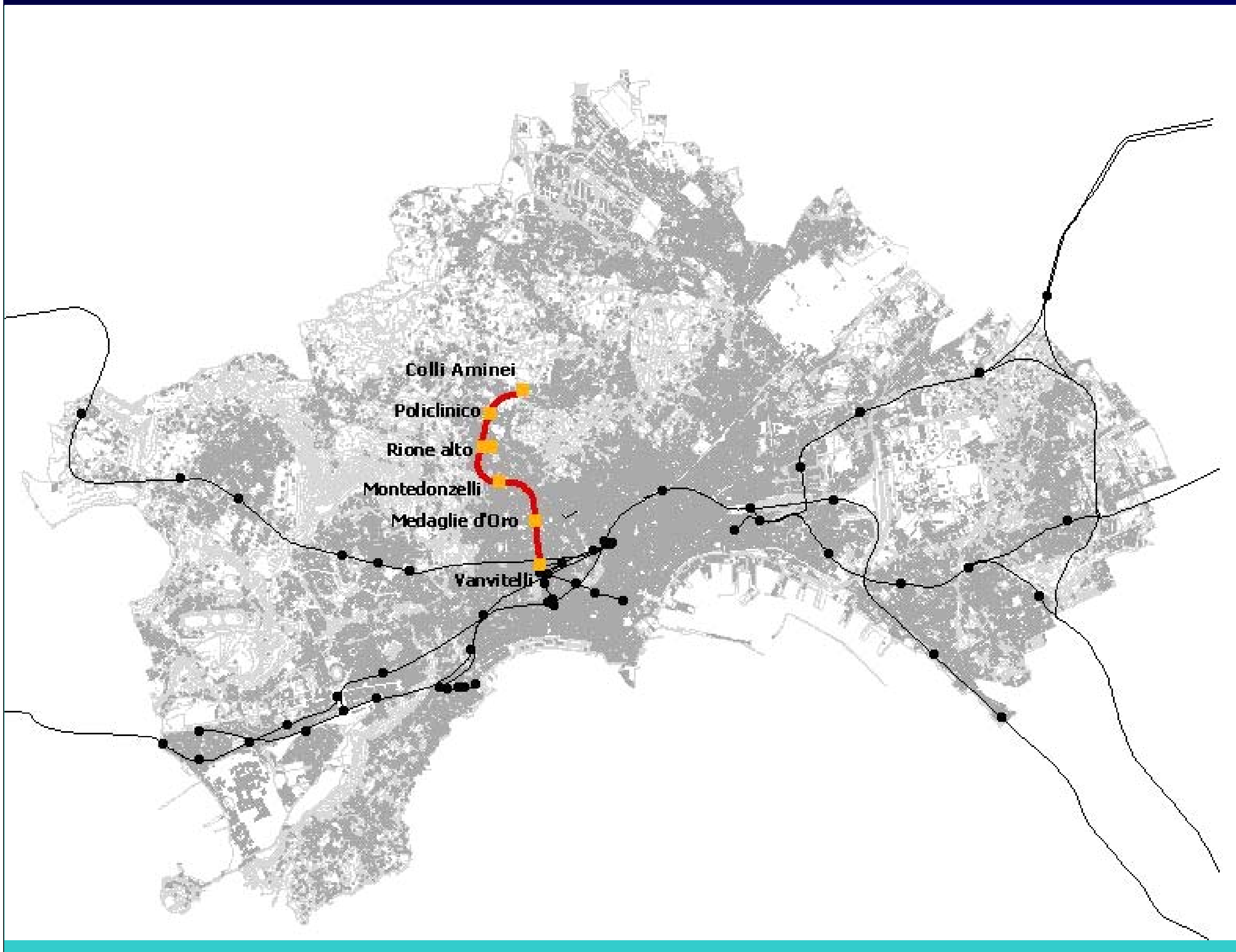
THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (2)



The 2004 network

- **6 lines**
- **4 funiculars**
- **57 stations**
- **8 rail exchange nodes**
- **4 mode exchange nodes**

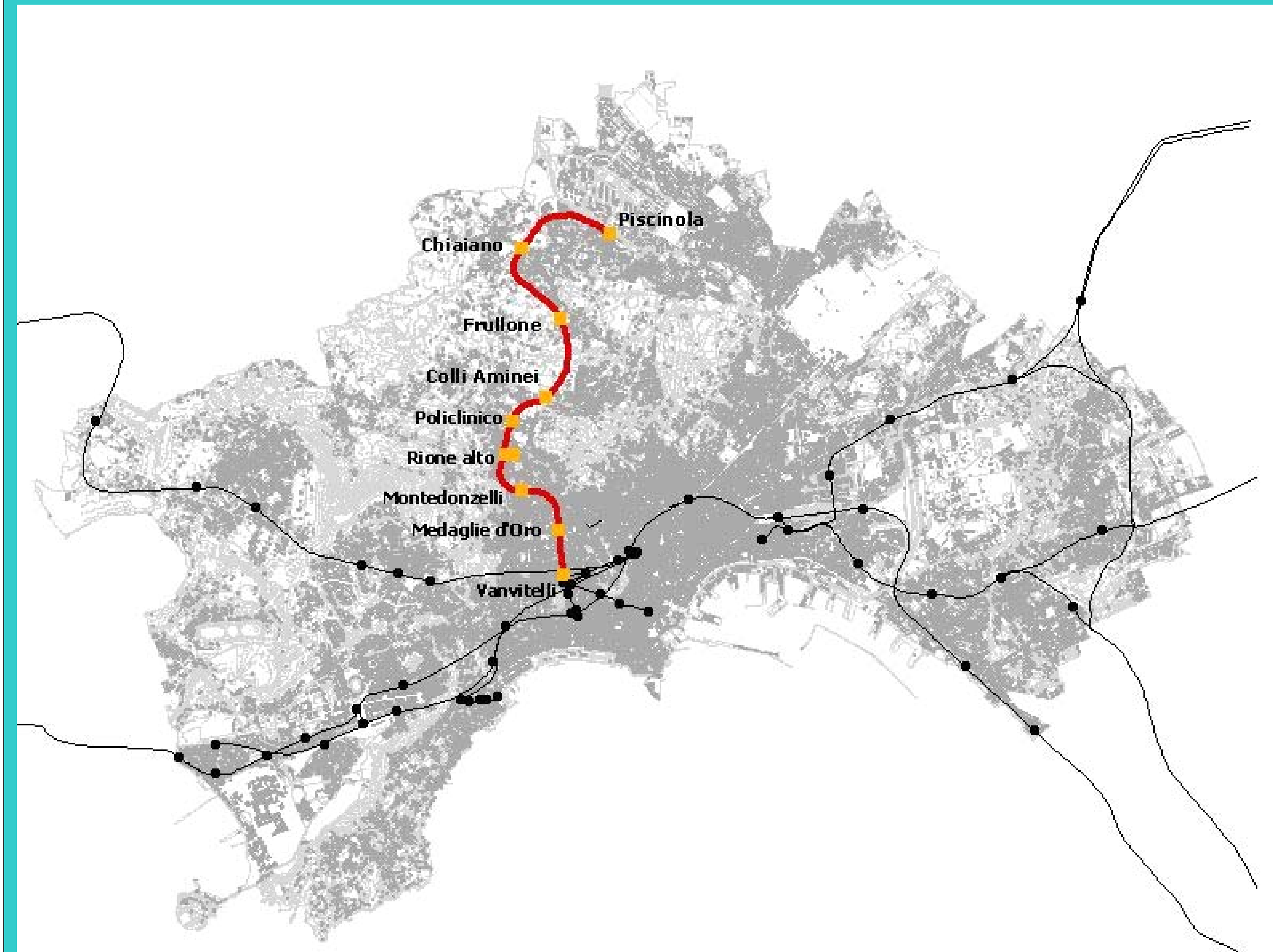
THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (3)



Line 1 at 1993

The first 4 chilometers section Vanvitelli-Colli Aminei has been opened in July 1993 6 stations

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (4)



Line 1 at 1995

In 1995 the section Aminei-Piscinola has been opened
+ 3 stations

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (5)

Line 1
2001-2004

In 2001 Cilea, Salvator Rosa and Museo stations were opened.

In 2002 Dante station was opened.

In 2003 Materdei station was opened.

Today line 1 is made up of 14 stations.

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (6)

TERRITORIAL IMPACTS:

Measure of the population change in the influence area *i* of the stations within the period 1991-2004

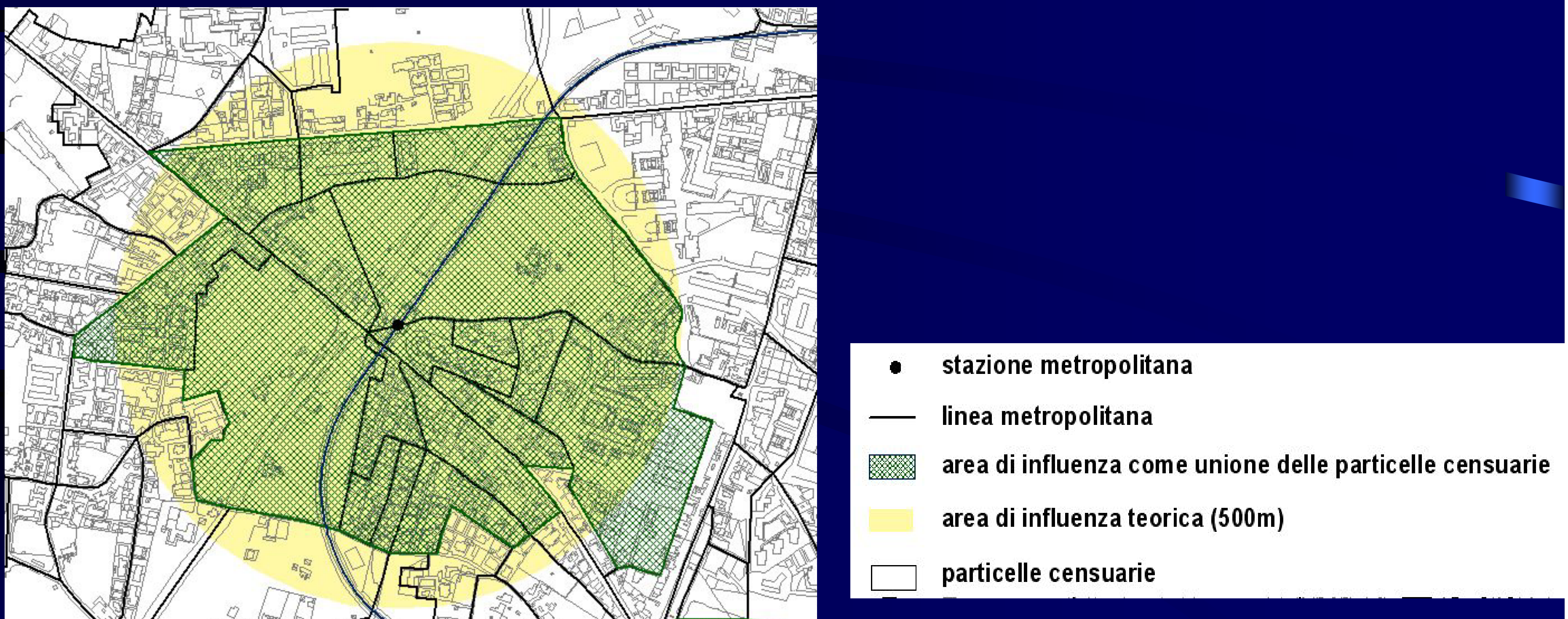
$$\Delta\% res_i = \sum_{k=1}^{p} \frac{res_{2004k} - res_{1991k}}{res_{1991k}} \cdot 100$$

***p* = number of Census parcels *k* belonging to the influence area *i*.**

Source: Census 1991, 2001 (per parcel); 2004 (per proportion per parcel).

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (7)

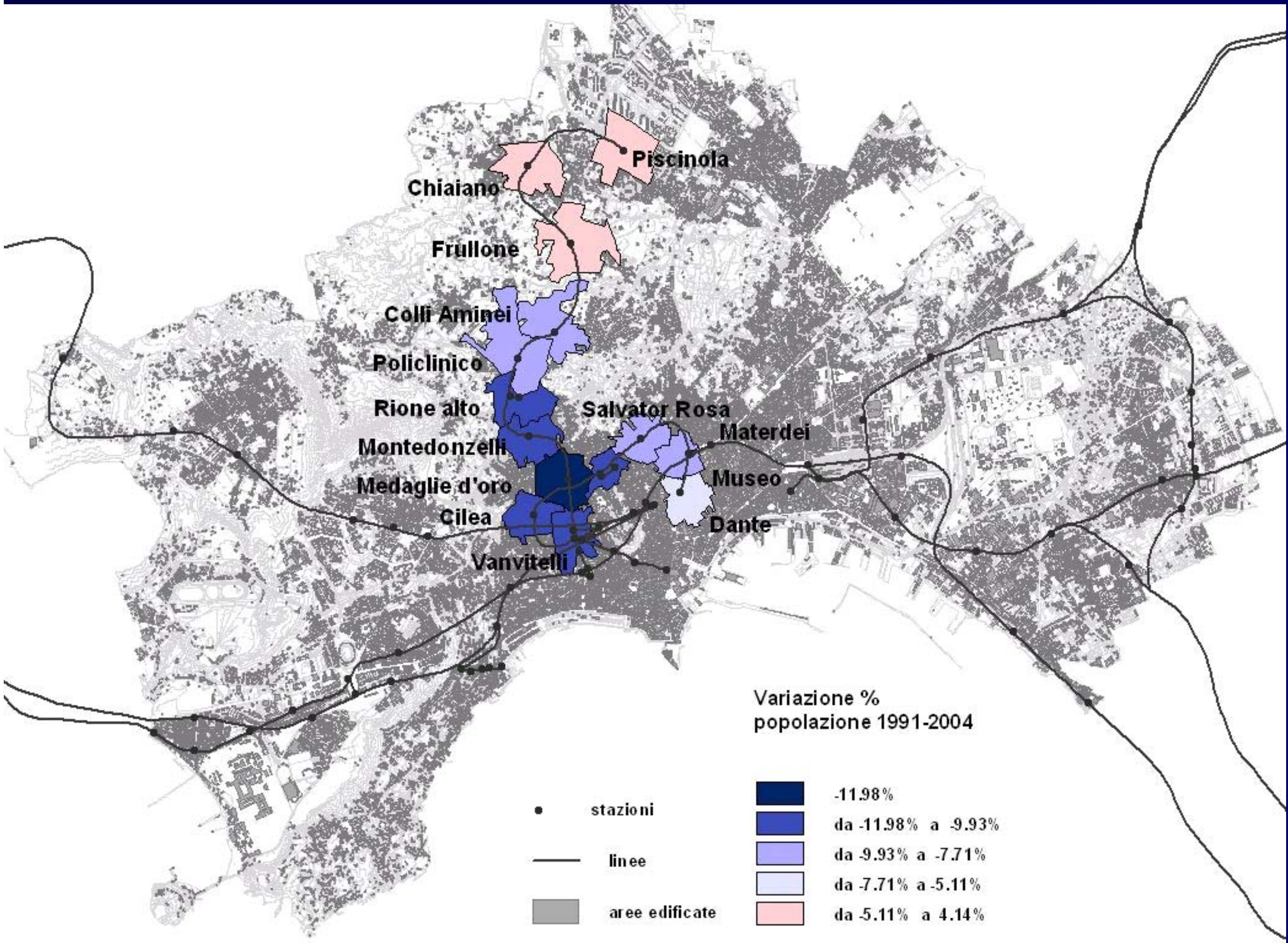
Influence area *i* definition: join of the Census parcels *k* with a distance less than 500 meters from the station



THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (8)

Average change in Naples:
-6,76%

Population change



Stations Line 1	Δ% population 1991-2004	Δ % population 1991-2004 with respect to Δ% average of the city of Naples
Piscinola	+2,85	-0,42
Chiaiano	+0,50	-0,07
Frullone	+4,14	-0,61
Colli Aminei	**-8,90**	+1,32
Policlinico	**-7,95**	+1,18
Rione Alto	**-10,63**	+1,57
Montedonzelli	**-9,93**	+1,47
Medaglie d'Oro	**-11,98**	+1,77
Vanvitelli	**-10,51**	+1,55
Cilea	**-10,97**	+1,62
Salvator Rosa	**-11,13**	+1,65
Materdei	**-7,71**	+1,14
Museo	**-9,28**	+1,37
Dante	-5,11	+0,76
average line 1	-6,90	+1,02
average Naples	-6,76	1,00

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (9)

It follows:

A general decrease of the population within the city of Naples (-6,76%);

•A reduction of population in the areas of the new stations located in the central areas inferior (e.g. Dante - 5,11%) or superior to the average value of the city of Naples (e.g. Vanvitelli - 10,51%);

• An increase of population in the peripheral areas (e.g. Piscinola +2,85%, Chiaiano +0,50% e Frullone +4,14%).

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (10)

ECONOMIC IMPACTS:

Measure of land value changes in the influence area *i* of the stations for different destination uses *t* within the period 1991-2004:

$t = \begin{cases} \text{Houses} \\ \text{Shops} \\ \text{Offices} \end{cases}$

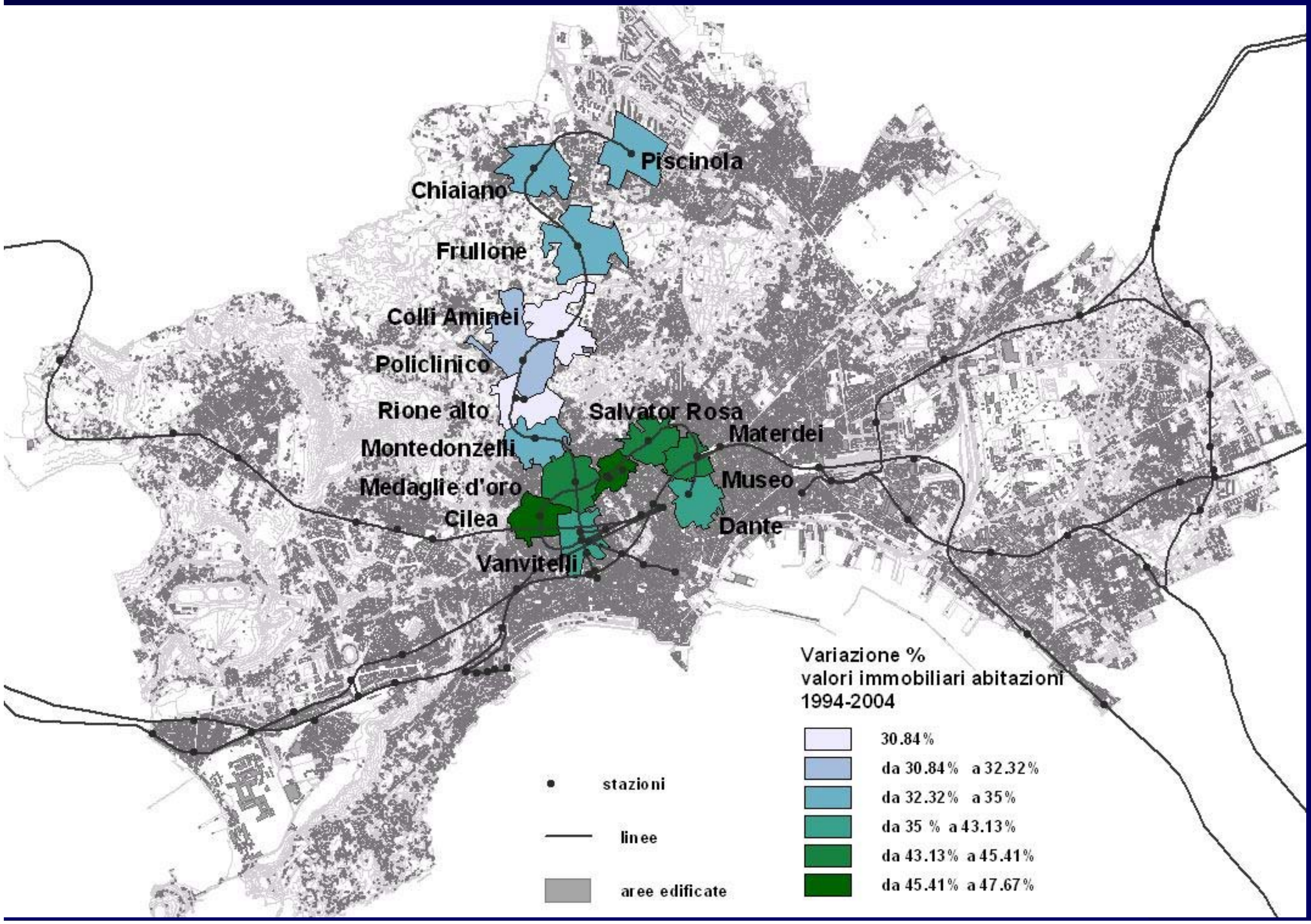
$$\Delta\%val_{it} = \sum_{k=1}^{p} \frac{val_{2004kt} - val_{1991kt}}{val_{1991k}} \cdot 100$$

Source: Agenzia del Territorio.

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (11)

Average change in Naples: +33,68%

Land value change (Houses)

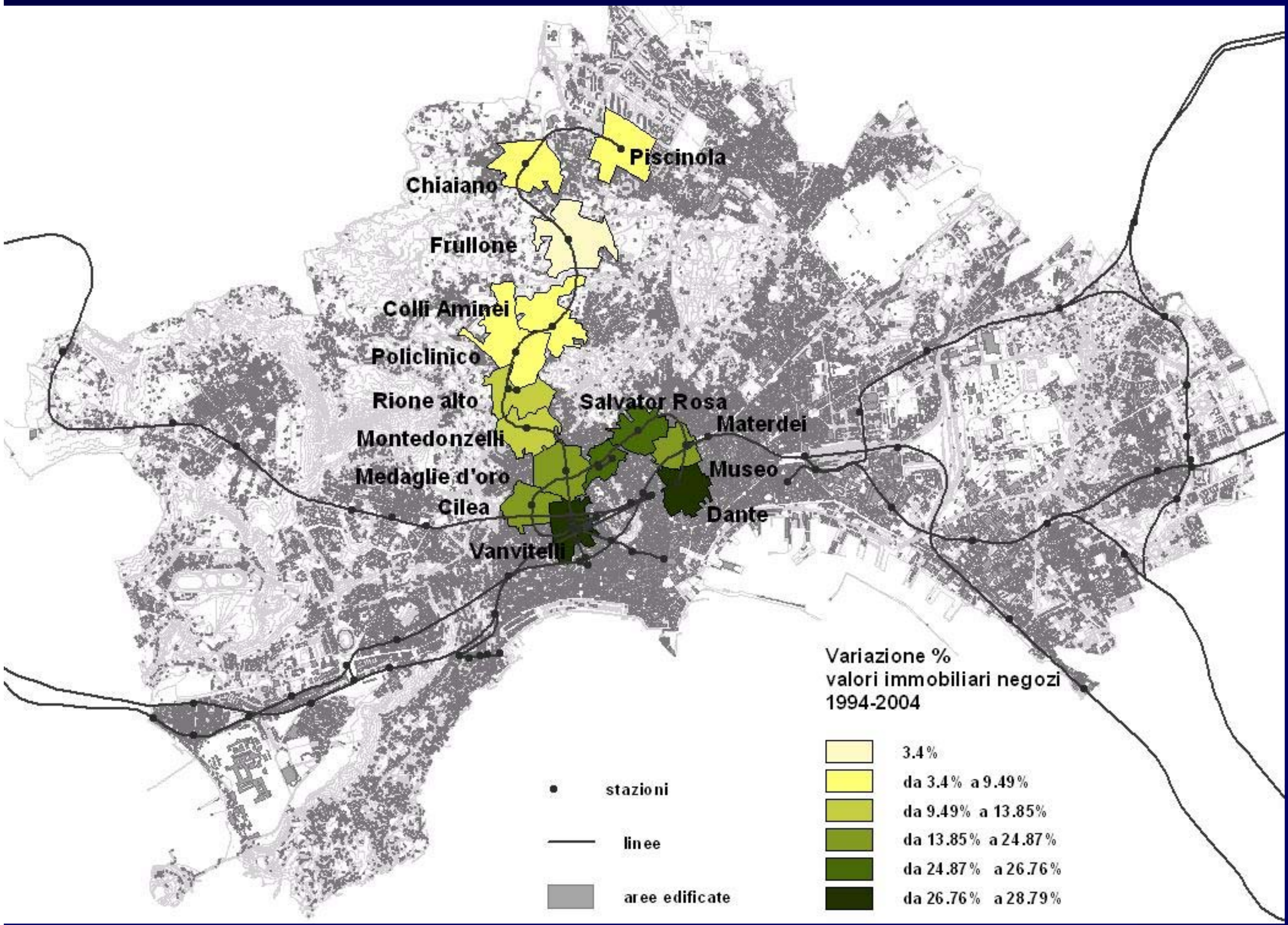


Stations line 1	Δ% land value (houes) 1991-2004	Δ % land value with respect to Δ% average of the city of Naples
Piscinola	**+34,40**	+1,02
Chiaiano	**+33,60**	+1,00
Frullone	**+34,53**	+1,03
Colli Aminei	+30,84	+0,92
Policlinico	+32,32	+0,96
Rione Alto	+30,84	+0,92
Montedonzelli	**+35,00**	+1,04
Medaglie d'Oro	**+44,14**	+1,31
Vanvitelli	**+43,13**	+1,28
Cilea	**+46,23**	+1,37
Salvator Rosa	**+47,67**	+1,42
Materdei	**+45,41**	+1,35
Museo	**+45,27**	+1,34
Dante	**+41,62**	+1,24
average line 1	+38,93	+1,16
average Naples	+33,68	1,00

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (12)

Average change in Naples: +14,82%

Land value change (Shops)

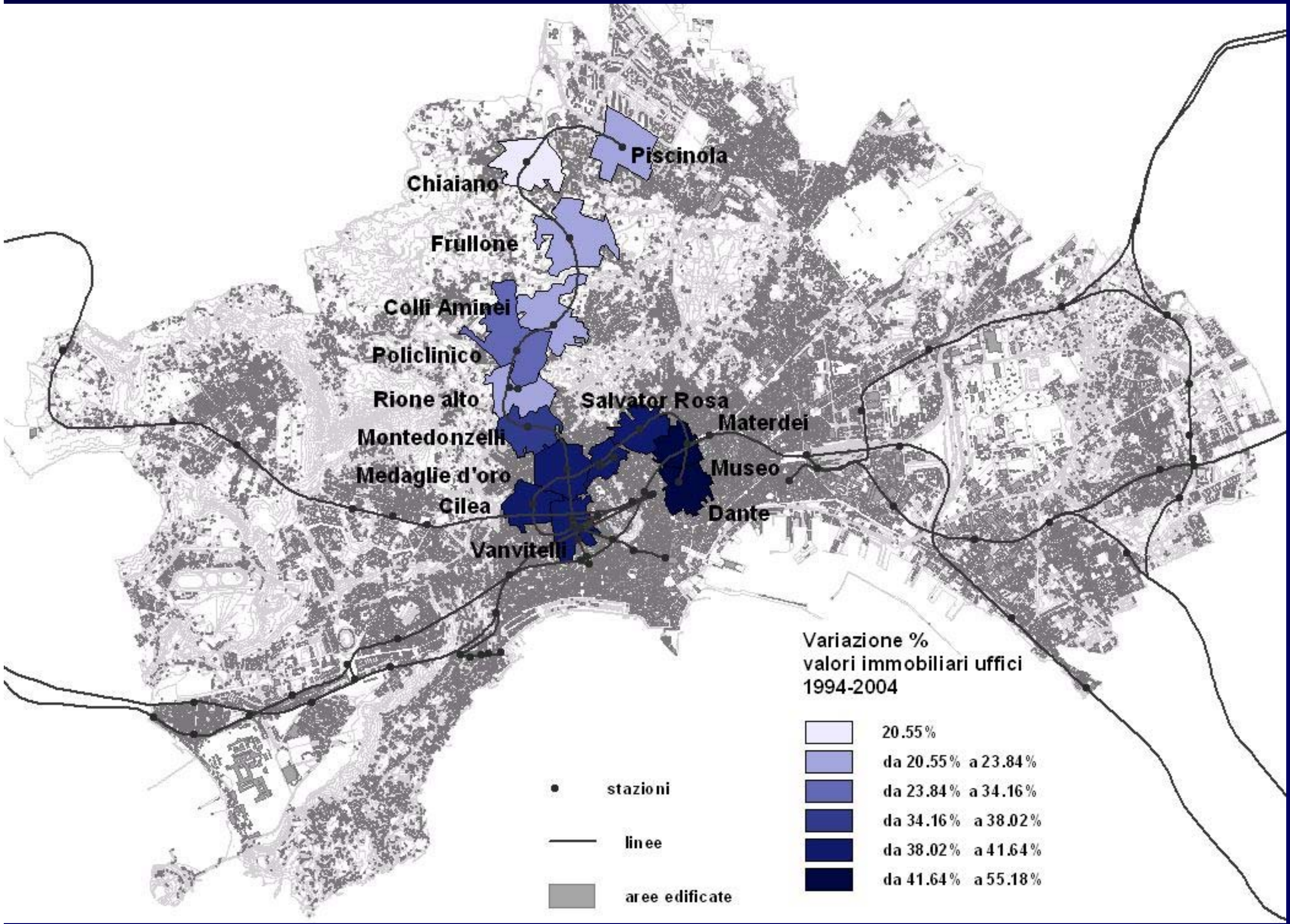


Stations line 1	Δ% land value (shops) 1991-2004	Δ % land value with respect to Δ% average of the city of Naples
Piscinola	+6,27	+0,42
Chiaiano	+6,42	+0,43
Frullone	+6,40	+0,43
Colli Aminei	+7,26	+0,49
Policlinico	+9,49	+0,64
Rione Alto	+12,26	+0,83
Montedonzelli	+13,85	+0,93
Medaglie d'Oro	**+24,47**	+1,65
Vanvitelli	**+28,79**	+1,94
Cilea	**+24,87**	+1,68
Salvator Rosa	**+26,76**	+1,81
Materdei	**+25,99**	+1,75
Museo	**+24,59**	+1,66
Dante	**+27,68**	+1,87
media linea 1	+17,50	+1,18
media comunale	+14,82	1,00

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (13)

Average change in Naples: +23,42%

Land value change (Offices)



Stations line 1	Δ% land value (offices) 1991-2004	Δ % land value with respect to Δ% average of the city of Naples
Piscinola	+22,27	+0,95
Chiaiano	+20,55	+0,88
Frullone	+22,56	+0,96
Colli Aminei	+22,84	+0,98
Policlinico	+34,16	+1,46
Rione Alto	+23,84	+1,02
Montedonzelli	+38,02	+1,62
Medaglie d'Oro	+41,64	+1,78
Vanvitelli	+41,20	+1,76
Cilea	+41,60	+1,78
Salvator Rosa	+41,40	+1,77
Materdei	+43,00	+1,84
Museo	+55,18	+2,36
Dante	+54,08	+2,31
media linea 1	+35,88	+1,53
media comunale	+23,42	1,00

THE CASE OF THE UNDERGROUND OF THE CITY OF NAPLES (14)

It follows:

- **In the areas of the central stations there is a decrease of population due to an increase of land values for different destination uses greater than the average value of the city of Naples;**
- **In the peripheral areas there is an increase of population and an increase of land values equal or less than the average value of the city of Naples.**

FUTURE

CHOICE SET GENERATION (1)

- Importance of properly specifying the choice set in destination choice modelling applications to avoid model parameter bias.

- The number of elements in the universe of alternatives makes it hard to assume beforehand that the individual is able to evaluate each and every one of them and then make an educated decision. The task of the analyst is to try to capture at best the extent of the true choice set.

- The traditional approaches consist of delineation based on a restricted list of deterministic criteria selected by the analyst. This opens the door to likely mis-specification of choice sets and, in turn, it can lead to an incorrect setting of the parameters of the utility function and incorrectly predicted choice probabilities.

CHOICE SET GENERATION (2)

- In order to improve the model reproducing ability a procedure is proposed to make all the alternatives perceived at the same time.
- The approach considers the simulation of an alternative, within the full set, together with its availability/perception (Cascetta and Papola, 2001). For example if using a MNL model:

$$p[j] = \frac{\exp(V_j)}{\sum_h \exp(V_h)}$$

$$V_j = \sum_n \beta_n X_{jn} + \sum_k \gamma_k Y_{jk}$$

CHOICE SET GENERATION (3)

•The innovative aspect consists of specifying the perception variables through the concept of dominance, used in the context of comparison methods for alternative transport projects (Haimes and Chankong, 1985) and introduced for the first time by Cascetta and Papola (2005) for the choice set generation in the case of non-systematic trip purpose destination choices.

•The novelty of the research proposed is to extend this methodology to residential location choices (never applied in the literature before).

•It is assumed that the resident chooses a zone on a map made up by perceived zones.

CHOICE SET GENERATION (4)

- The development of the dominance information is derived by comparing all the zones (alternatives) in terms of their utility through the definition of some rules.

- To each residential zone a dominance variable is assigned. A dominance list will be provided within which the place occupied by the zones is defined by the number of alternatives dominating the zone. The first places will be occupied by the zones with a greater number of dominations and, in turn, the model will give them a lower probability of belonging to the choice set. The last places will be occupied by the zones with lower dominations and, therefore, by those better perceived by the resident.

CHOICE SET GENERATION (5)

•All dominated alternatives (perhaps with a dominance degree greater than a given threshold) can be deterministically excluded from the choice set or

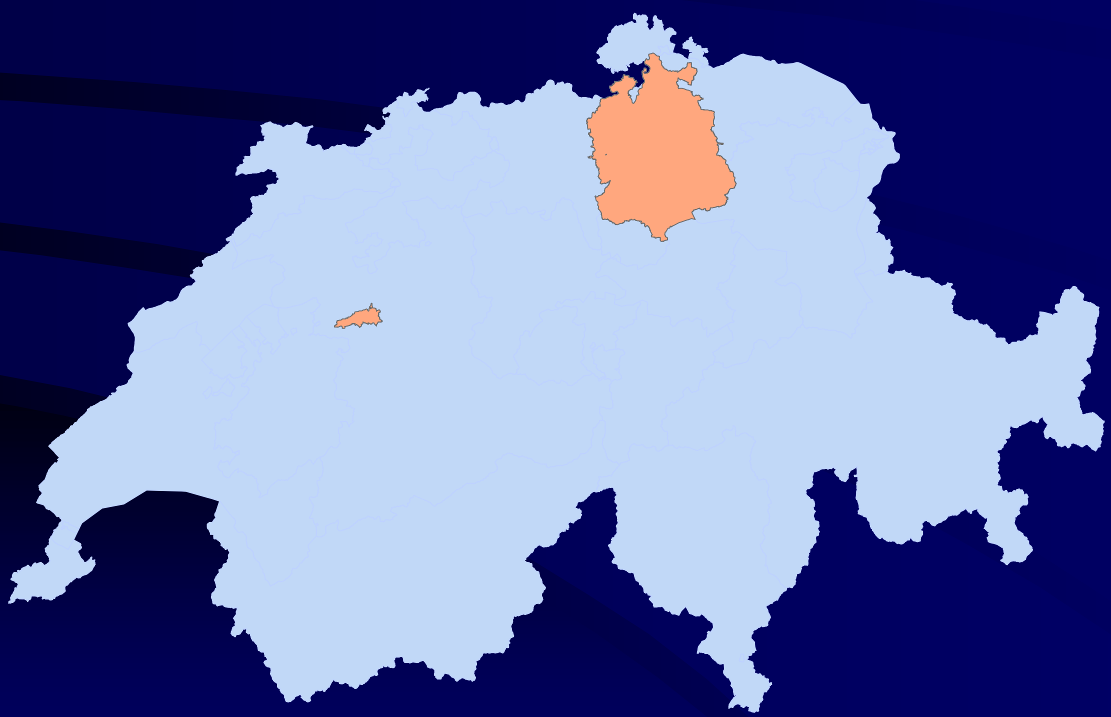
• Alternatively, dominance attributes can be generated for each alternative (e.g. the dominance degree itself – the position in the list) and used as perception attributes ***Y***.

CHOICE SET GENERATION (6)

•THE CASE STUDY: CANTON OF ZURICH (182 ZONES)

RP SURVEY (1166 observations)

547 COMMUTERS



CHOICE SET GENERATION (7)

- As "utility" attributes $\boldsymbol{X}_j$ of the generic residential zone *j:*

LAND PRICE, STOCK, LOGSUM_mode choice model (work), LDIST_LAKE

- As "availability/perception" attributes $\boldsymbol{Y}_{\mathrm{j}}$, TWO dominance attributes were generated.

DOMINANCE VARIABLES:

- A simple dominance degree of each alternative *j*, i.e. the number of zones *i* that are closer, with respect to *j,* to the commuter's workplace.

- A stronger dominance degree of each alternative *j,* i. e the number of zones *i* containing LOWER LAND PRICES, GREATER STOCK than that in *j* and, at the same time, closer, with respect to *j*, to the commuter's workplace.

CHOICE SET GENERATION (8)

PRELIMINARY RESULTS (BIOGEME 1.4)

MNL specifications	(1)	(2)	(3)	(4)
β_{LPRICE}	-0.0016	-0.0043	-0.00178	-0.0015
(*t*-statistic)	(-10.12)	(-8.8392)	(-10.84)	(-9.08)
β_{STOCK}	0.8260	0.7736	0.7957	0.6976
(*t*-statistic)	(15.94)	(14.86)	(14.10)	(11.28)
β_{logsum}	2.5402	2.4299	1.6450	1.6333
(*t*-statistic)	(16.64)	(15.80)	(9.54)	(9.50)
$\beta_{LDISTLAKE}$		-1.5875	-1.5750	-1.4844
(*t*-statistic)		(-5.61)	(-5.56)	(-5.22)
β_{DOM1}			-0.017	-0.0160
(*t*-statistic)			(-11.36)	(-9.85)
β_{DOM2}				-0.0569
(*t*-statistic)				(-3.18)
$ln\ (\mathbf{0})$	-2846.59	-2846.59	-2846.59	-2846.59
$ln\ (\beta)$	-2301.43	-2274.70	-2202.23	-2195.96
ρ^2	0.1915	0.2009	0.2263	0.2285

CHOICE SET GENERATION (9)

FURTHER RESEARCH:

- NEW VARIABLES WILL BE INTRODUCED
- AD HOC SURVEY ON THE CANTON OF ZURICH (for integration)
- APPLY THE METHODOLOGY AT THE URBAN-LOCAL LEVEL (CITY OF ZURICH)
- APPLY THE METHODOLOGY TO OTHER ACTIVITY LOCATION CHOICES (e.g. workplace location)