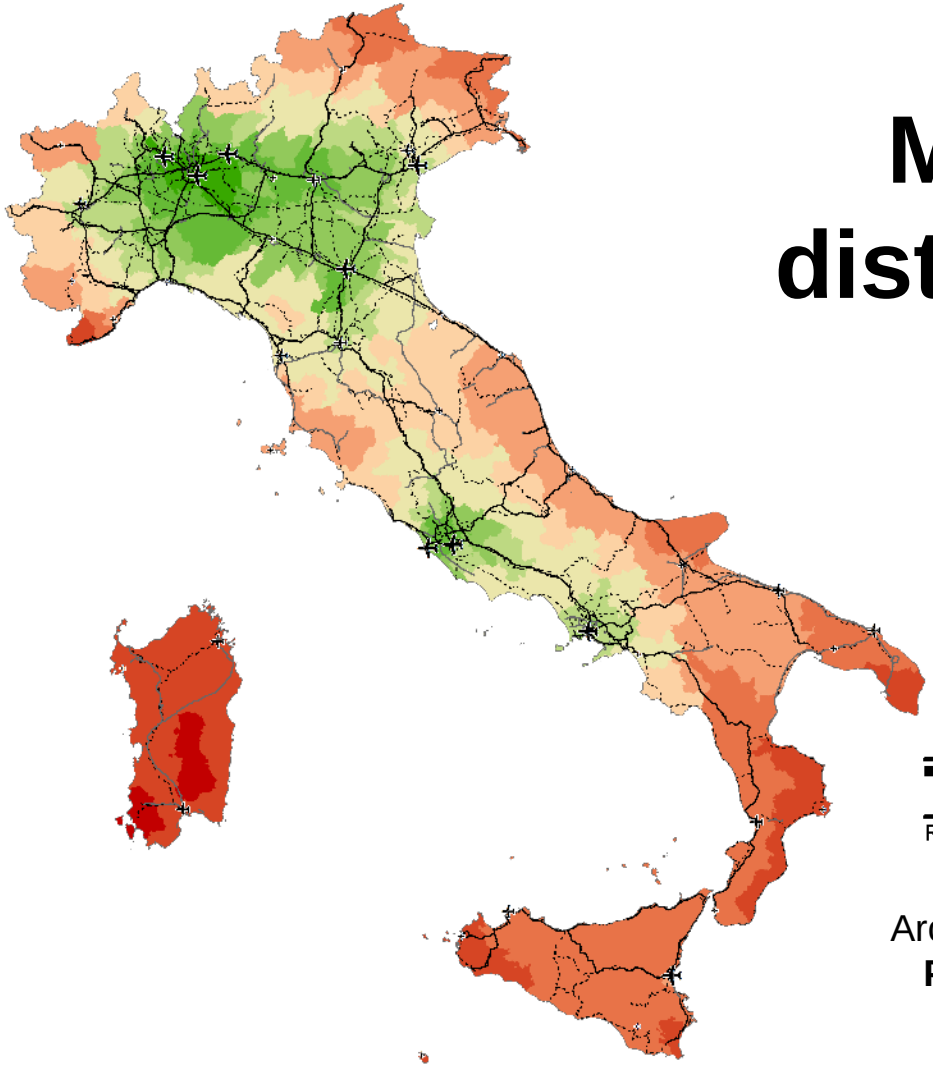

Measuring the long distance accessibility of Italian cities

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Introduction

Paper aims

The paper aims at answering at the question **whether and where there is a problem of long distance accessibility to Italian regions**, measured in a consistent way, and **overcoming a debate based on the sole networks extension**.

Multimodal transport model + Potential accessibility definition
→ Accessibility analysis

The analysis show interesting results, partially counterintuitive, because revealing **the complexity of the geography of a transport system** at national scale, not necessarily matching with common sense expectations.

CONTENTS

- Accessibility measures
- Methodology
- Results
- Policy conclusions

Accessibility measures

Approaches to accessibility

Accessibility is an intuitive concept, related with the easiness, or not, to reach a destination or access to a service.

However → **many definitions of accessibility exist**!

→ studies are apparently similar, but **not fully comparable**.
→ some of the most complex accessibility indicators **lack of physical meaning**,
  → accessibility should always be a **relative measure** and not as an absolute propriety of a place.

Accessibility measures

Approaches to accessibility

Three “approaches” in the national debate (but not in literature…)

1. **Stock-based measures**
   e.g. How many km of networks are available in a given area, possibly normalized

2. **Supply-based measures**
   e.g. Level of service or quantity of services available per capita or per area

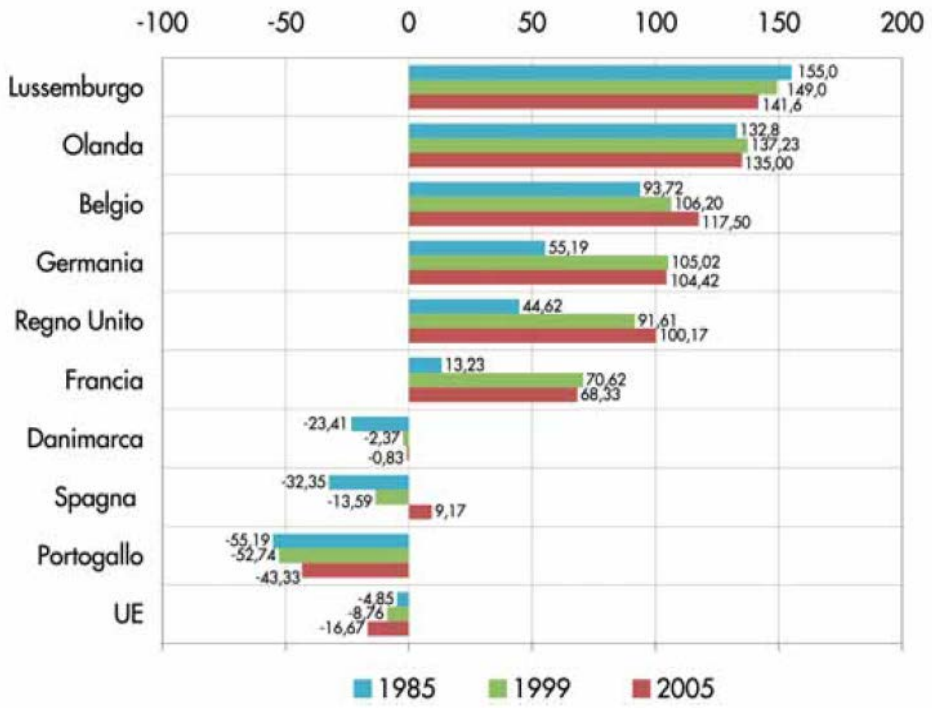
3. **Potential Accessibility**
   More articulated definitions, taking into account all components of accessibility, which are **not limited to transport stock**!
   → see after

Accessibility measures

The fallacy of stock-based measures

Numerous studies, **mainly in Italian**, use the **network extensions** to evaluate the level of infrastructure supply in Italy.
Usually, they evidence a lack of infrastructure with respect to the rest of Europe and differences within the country between North and South. Usually this problem is referred as "**infrastructural gap**".

The concept of "infrastructural gap", is scientifically nonsensical and also misleading for the public opinion.



Comparison of Italian infrastructure stock (Italy = 0) vs. other European countries (Source: ACI, 2009).

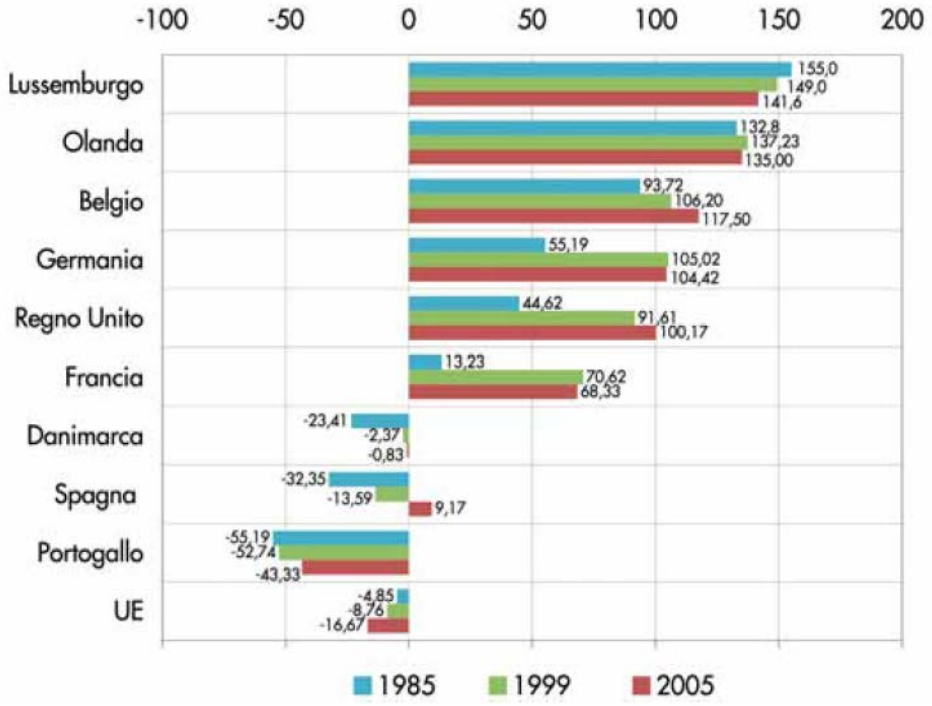
Accessibility measures

The fallacy of stock-based measures

Why **is nonsensical and misleading**?

1. **Depends on the definition** of what is included or not. Municipal roads are in? Lanes matter?
2. Ignores the **geography**: a country is not homogeneous!
3. **Ignores the needs**: is there anyone to be moved? Where are they going?
4. **Ignores congestion and LOS** in general
5. **Ignores trade-offs**: it is good to have a lot of infrastructure, but who pays? Is it efficient or not to double the stocks? (e.g. Messina, 2007)
6. **Very easy to manipulate!!!**

Comparison of Italian infrastructure stock (Italy = 0) vs. other European countries (Source: ACI, 2009).



Accessibility measures

Proper definitions of accessibility measures

Some reviews exist:
Handy and Niemeier (1997), Geurs and van Wee (2004), Martìn and Reggiani (2007) and Vandenbulcke et al. (2009)

Geurs and van Wee (2004) →

Table 1
Perspectives on accessibility and components

Measure	Component			
	Transport component	Land-use component	Temporal component	Individual component
Infrastructure-based measures	Travelling speed; vehicle-hours lost in congestion		Peak-hour period; 24-h period	Trip-based stratification, e.g. home-to-work, business
Location-based measures	Travel time and or costs between locations of activities	Amount and spatial distribution of the demand for and/or supply of opportunities	Travel time and costs may differ, e.g. between hours of the day, between days of the week, or seasons	Stratification of the population (e.g. by income, educational level)
Person-based measures	Travel time between locations of activities	Amount and spatial distribution of supplied opportunities	Temporal constraints for activities and time available for activities	Accessibility is analysed at individual level
Utility-based measures	Travel costs between locations of activities	Amount and spatial distribution of supplied opportunities	Travel time and costs may differ, e.g. between hours of the day, between days of the week, or seasons	Utility is derived at the individual or homogeneous population group level

Accessibility measures

Location based measures

One of the most common and intuitive measure is that of **location based accessibility**.

The commonest definition is **potential accessibility**

accessibility from the origin *i*,

$$A_i = \sum_{j=1}^{n} M_j \, f(\beta, x_{ij})$$

M_j "mass" of opportunities at destination *j*

β is the sensitivity parameter to x_{ij}, which is the impedance variable of the trip from *i* to *j*.

Accessibility measures

Location based measures

One of the most common and intuitive measure is that of **location based accessibility**.

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accessibility from the origin *i*,

$$A_i = \sum_{j=1}^{n} M_j \, f(\beta, x_{ij})$$

M_j "mass" of opportunities at destination *j*

Land-use component: why going there?

Transport component: effort to go there

β is the sensitivity parameter to x_{ij}, which is the impedance variable of the trip from *i* to *j*.

Accessibility measures

Location based measures

Still a very general definition:
1: what represents the opportunities at destination?
2: what represents the effort to reach destination?
3: which function rules the decay of attractiveness of a destination?

$$A_i = \sum_{j=1}^{n} M_j \, f(\beta, x_{ij})$$

1 2 3

Accessibility measures

A review of potential accessibility studies

National-scale accessibility studies are not frequent, basically because they **need many structured inputs to be consistent**.

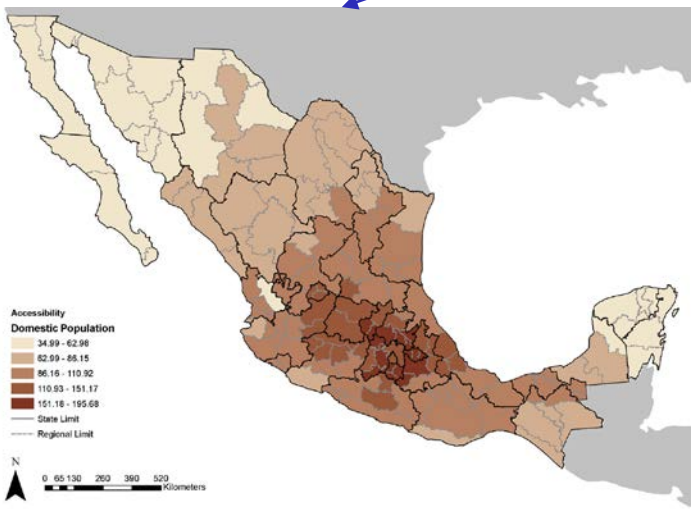


Table 1. National-scale accessibility studies, not using exponential decay functions.

	Geography	Detail	Modes	Accessibility definition	Opportunities indicator M
Condeço-Melhorado et al (2011)	Spain	NUTS4	Ro	$\Sigma_j(Mj / C^{\alpha}ij)$	GDP, POP, JOBS
Duran-Fernandez & Santos (2014)	Mexico	NUTS3		$\Sigma_j(Mj / T^{\alpha}ij)$	POP, JOBS (various), income (various)
Geurs & van Eck (2003)	The Netherlands	M	Ro, PT	Log-logistic(Tij)	JOBS
Gutiérrez & Urbano (1996)	EU	98 cities	Ro	$\Sigma_j(Tij * Mj) / \Sigma_i Mj$	GDP
Holl (2007)	Spain	M	Ro	$\Sigma_j(Mj / D^{\alpha}ij)$	POP
Jiao et al. (2014)	China	Prefecture (~330 zones)	Ra	$\Sigma_j(Mj / T^{\alpha}ij)$	√POP*GDP
Karampela et al. (2014)	Greece	Islands	A, F	Access time from Athens including frequency	n.a.
Keeble et al. (1982)	EU	NUTS2	n.a.	Σ_j (Mj / Dij)	GDP
Martin & Reggiani (2007)	EU	88 cities	Ra	$\Sigma_j(Tij * Mj) / \Sigma_i Mj$ $\Sigma_j(Mj / D^{\alpha}ij)$ $\Sigma_j(Mj * f(Tij))$	GDP, POP
Ortega et al. (2011)	Spain	M	Ro, Ra	Average effective speed	POP
Ortega et al. (2012)	Spain	M	Ra	$\Sigma_j(Mj / T^{\alpha}ij)$, α=1	POP
Östh et al. (2015)	Sweden	M	n.a.	$\Sigma_j(Mj / D^{\alpha}ij)$	JOBS
Vandenbulcke et al. (2009)	Belgium	M	Ro, Ra	Access time to towns and train stations	n.a.
Vickerman et al. (1999)	EU	70000 cells	Ra	$\Sigma_j(Mj / T^{\alpha}ij)$	POP

Detail: the level of geographical disaggregation. M: municipality; NUTS4: cluster of municipalities.
Accessibility definition: the formulation of accessibility used. α: friction parameter

Accessibility measures

A review of potential accessibility studies

National-scale accessibility studies are not frequent, basically because they **need many structured inputs to be consistent**.

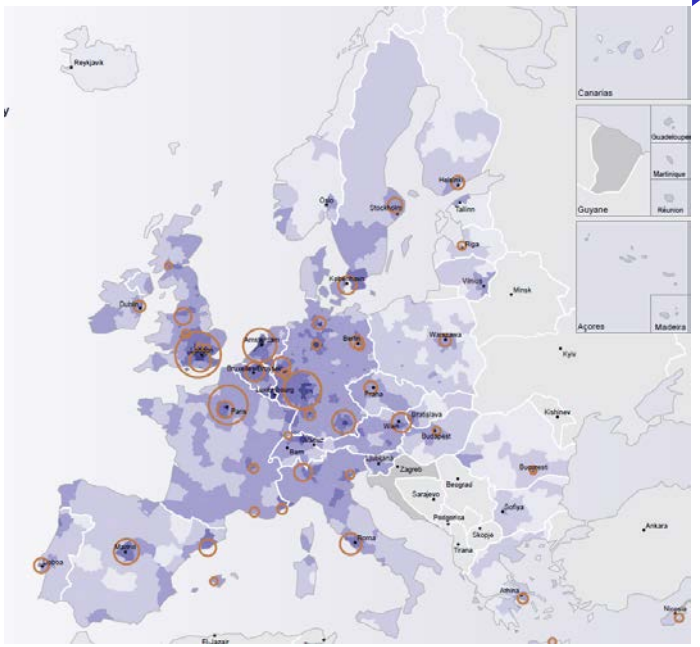
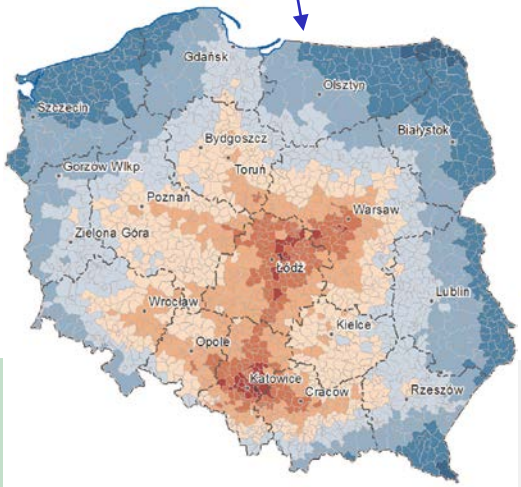
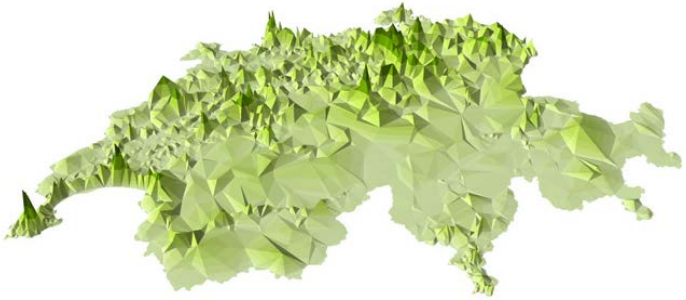


Table 1. Recent studies on accessibility at national or supranational scale, using an exponential decay impedance function $e^{-\beta X_{ij}}$

	Geography	Detail	Modes	Opportunities indicator	Impedance variable X	β value
Alampi and Messina (2011)	Italy, EU	NUTS3	Ro, Ra, A	Population	Dij, Tij	0.005
Axhausen et al. (2011)	Switzerland	M	Ro, PT	Population	Tij	0.2
Brödner et al. (2014)	EU	NUTS3	Ro, Ra, A	Population	Tij	n.a.
Reggiani et al. (2011)	Germany	M	Ro, Ra	Jobs	Tij	0.008**
Rosik et al. (2015)	Poland	M	Ro	Population	Tij	0.005775 (int), 0.013862 (nat), 0.034657 (reg)
Spiekermann & Schürmann (2007)	EU	NUTS3	Ro, Ra	Population	Tij	0.005
Stępniak & Rosik (2015)*	Poland (Mazovia)	M		Population	Tij	0.023105

Notes. *: the paper looks at Mazovia region accessibility, but uses a national scale model; **: the beta is calibrated using commuting trips only (i.e. without the other purposes, very relevant in the long-distance segment).
Detail: the level of geographical disaggregation. M: municipality; NUTS4: cluster of municipalities.
Modes: the mode considered. Ro: road. Ra: rail. A: air. F: ferry. PT: public transport.
Impedance variable adopted. Cij: generalised cost. Tij: travel time. Dij: distance.





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Methodology

Potential accessibility definition

3: We use one of the commonest definition of decay function, the **exponential decay**

1: We consider three indicators for opportunities at destination, because different are the travel purposes:

Population: personal purpose trips
Private sector employees: business trips
Public sector employees: visits to public offices, tribunals, hospitals and all trips typically attracted by administrative centers

2: Distance or travel time are too rough for long-distance accessibility, because loose the quality of connections, the timetables, the transport costs, the market structure. We instead prefer the **generalised cost**, much more comprehensive and calculated with a transport model.

$$A_i = \sum_{j=1}^{n} M_j \; f(\beta, x_{ij})$$

1

2

3

Methodology

Potential accessibility definition

The final functions used are the following ones, further specified for each mode:

$$Apop_i = \sum_{j=1}^{n} Population_j \cdot e^{-\beta c_{ij}}$$

$$Ajob_i = \sum_{j=1}^{n} Private\_sector\_jobs_j \cdot e^{-\beta c_{ij}}$$

$$Apub_i = \sum_{j=1}^{n} Public\_sector\_jobs_j \cdot e^{-\beta c_{ij}}$$

In addition, an indicator based on the sole distance, ignoring the transport dimension:

$$Adist_i = \sum_{j=1}^{n} Population_j \cdot e^{-\beta d_{ij}}$$

Methodology

Profiles and modes considered

Two travel purposes and 4 modes are considered:

	Business travellers	*Economy travellers*
Road	●	
Rail	●	●
Air	●	●
Coach		●
All modes	●	●

Single-mode accessibility is calculated directly with the formula.

The **multi-modal** one is calculated considering the best mode for each O-D pair.

Methodology

Generalised costs calculation

Generalised costs are calculated with a conventional 4-steps model, fed with a large supply database (Beria et al., 2015).

Zoning: **371 zones** → NUTS-4 level (subprovincial).

The **supply module** includes:

- **multimodal graph** (rail network, road network, ports and the main maritime navigation routes, airports and air navigation routes);
- a **timetable database**
- a **hypergraph** of public transport services, zonal and intermodal connectors
- **fares functions**, depending on mode, supplier, competition, etc.

Methodology

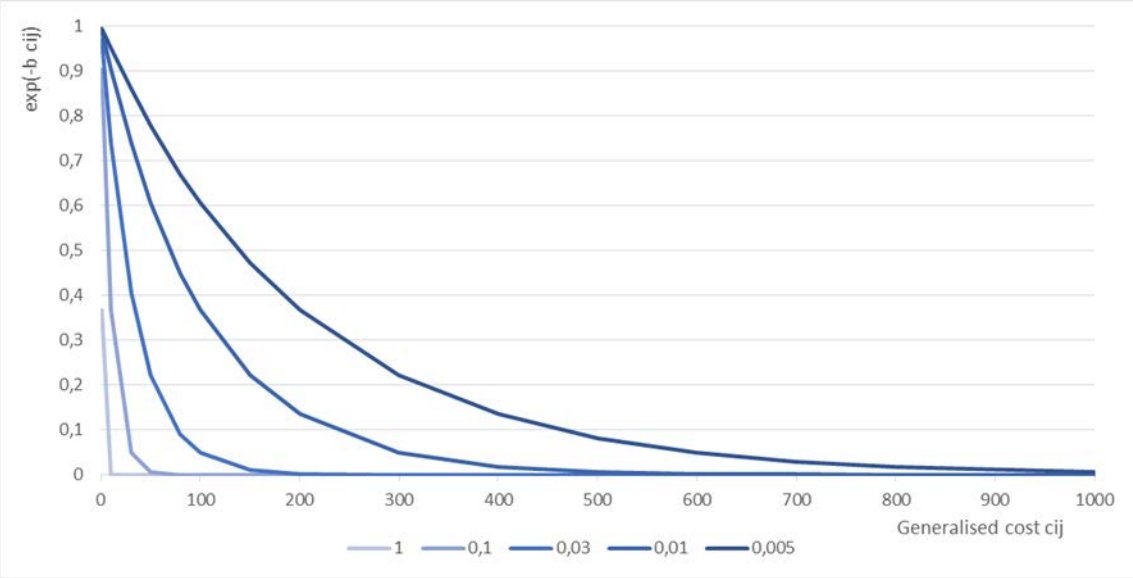
The beta parameter

Literature is not very helpful in suggesting a β, because cases are hardly comparable, functions different (generalized cost is never used before in literature!!!) and all betas are different across sources…

β describes the generalised cost sensitivity of the users and results are extremely sensitive to this parameter.

Large values rapidly reduce the influence of far destinations and are the typical values to be used for commuters' accessibility.
Small values, instead, better describe the generalised cost sensitivity of long distance travellers, for which "far" destinations are not irrelevant

We use **β = 0,01**



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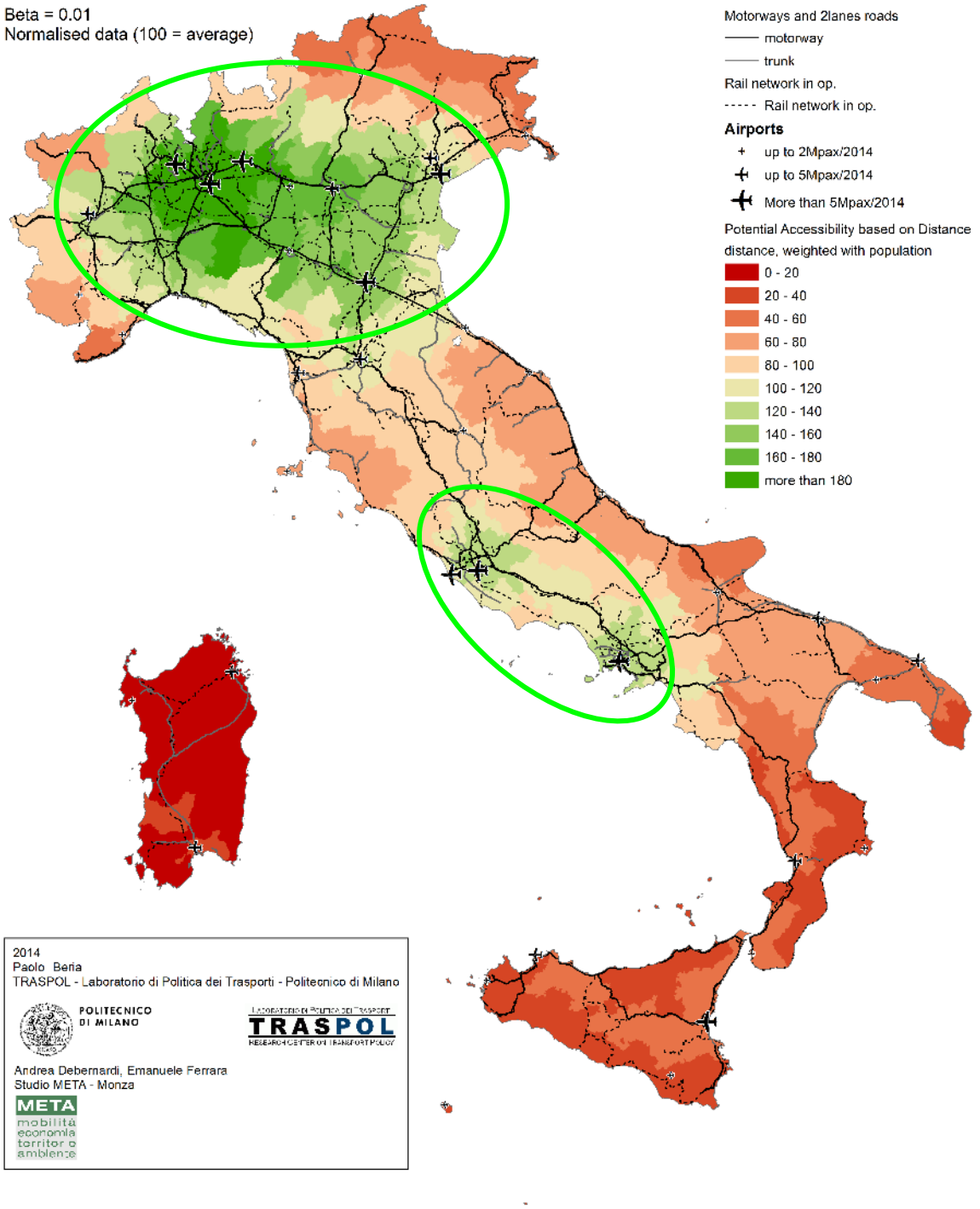
Results

1. Distance based: remoteness

$$Adist_i = \sum_{j=1}^{n} Population_j \cdot e^{-\beta d_{ij}}$$

- 10 M inhab. relatively near to the others → accessibility far above the national average.
- In the South, only Rome and Naples show have the indicator above the average, thanks to their dimension and vicinity.
- **Three areas: Po Valley, Rome-Naples, rest of Italy.**



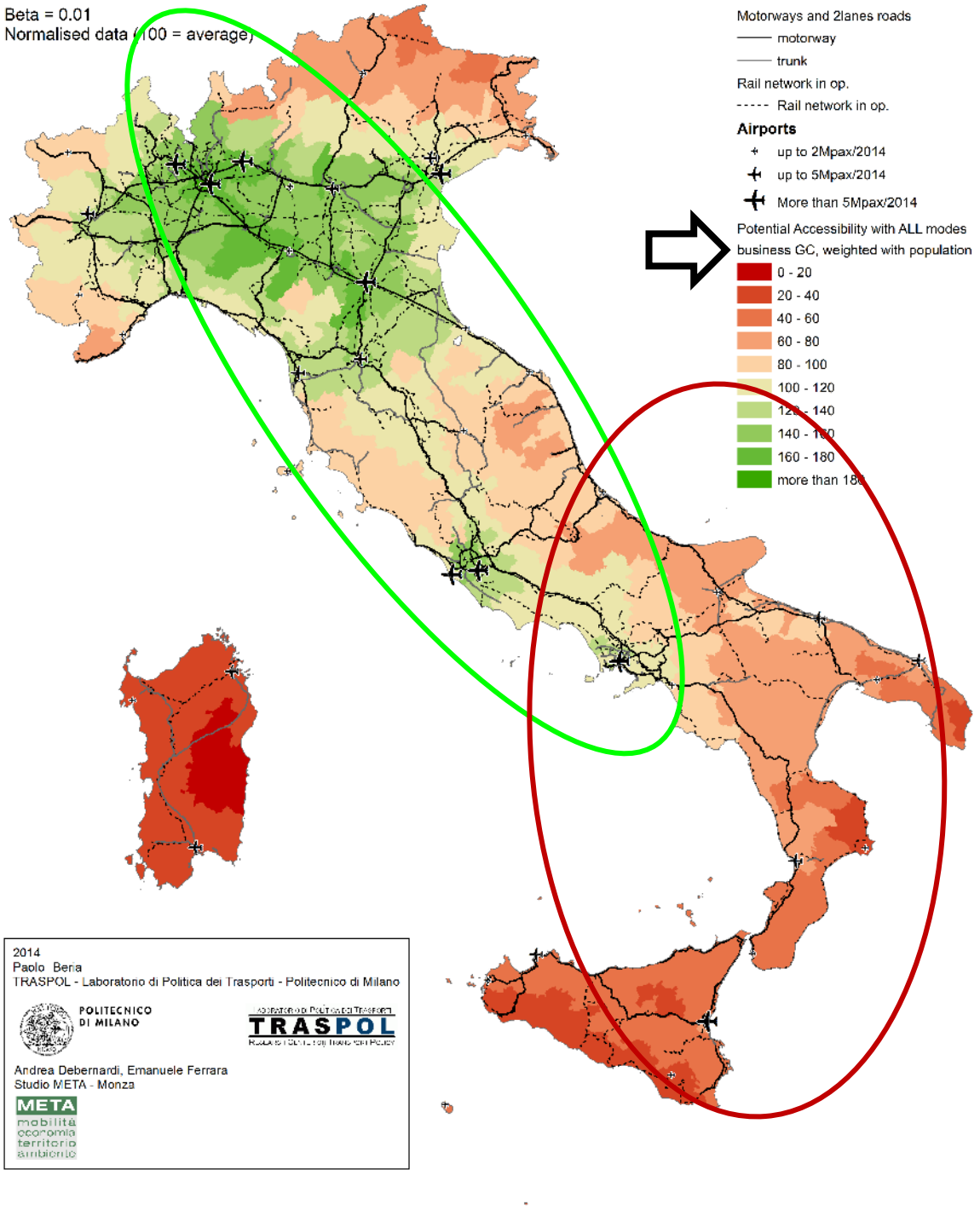
Results

2. Generalised cost accessibility

$$Apop_i = \sum_{j=1}^{n} Population_j \cdot e^{-\beta c_{ij}}$$

When considering transport (=GC), some things change:

- South slightly less «far», thanks to long distance services, including air transport
- Adriatic coast problematic
- **Well visible the effect of A1+AV corridor!**
- Rome, Naples, Rimini, Florence are nearly as accessible as northern areas
- <u>Economy more homogeneous</u>



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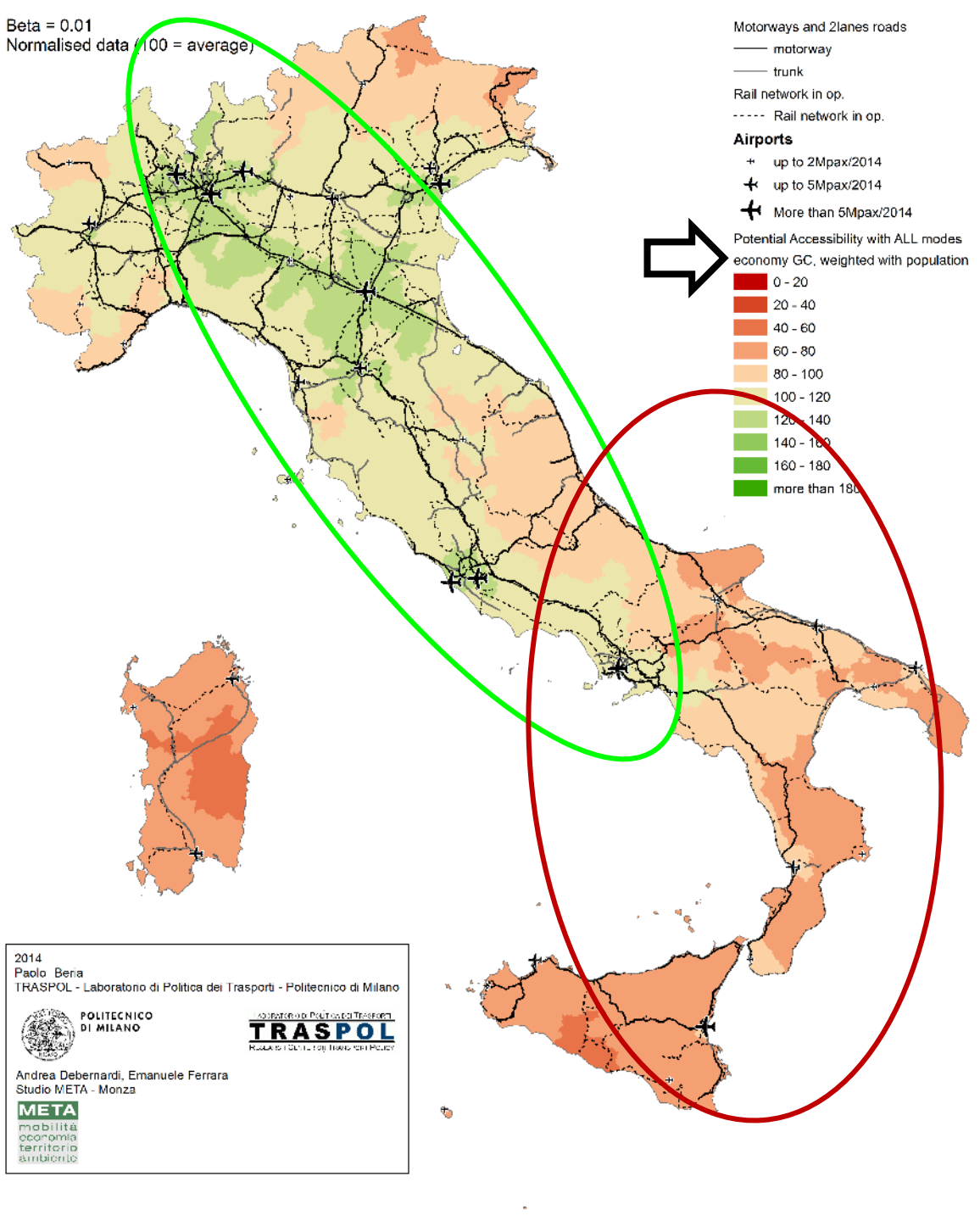
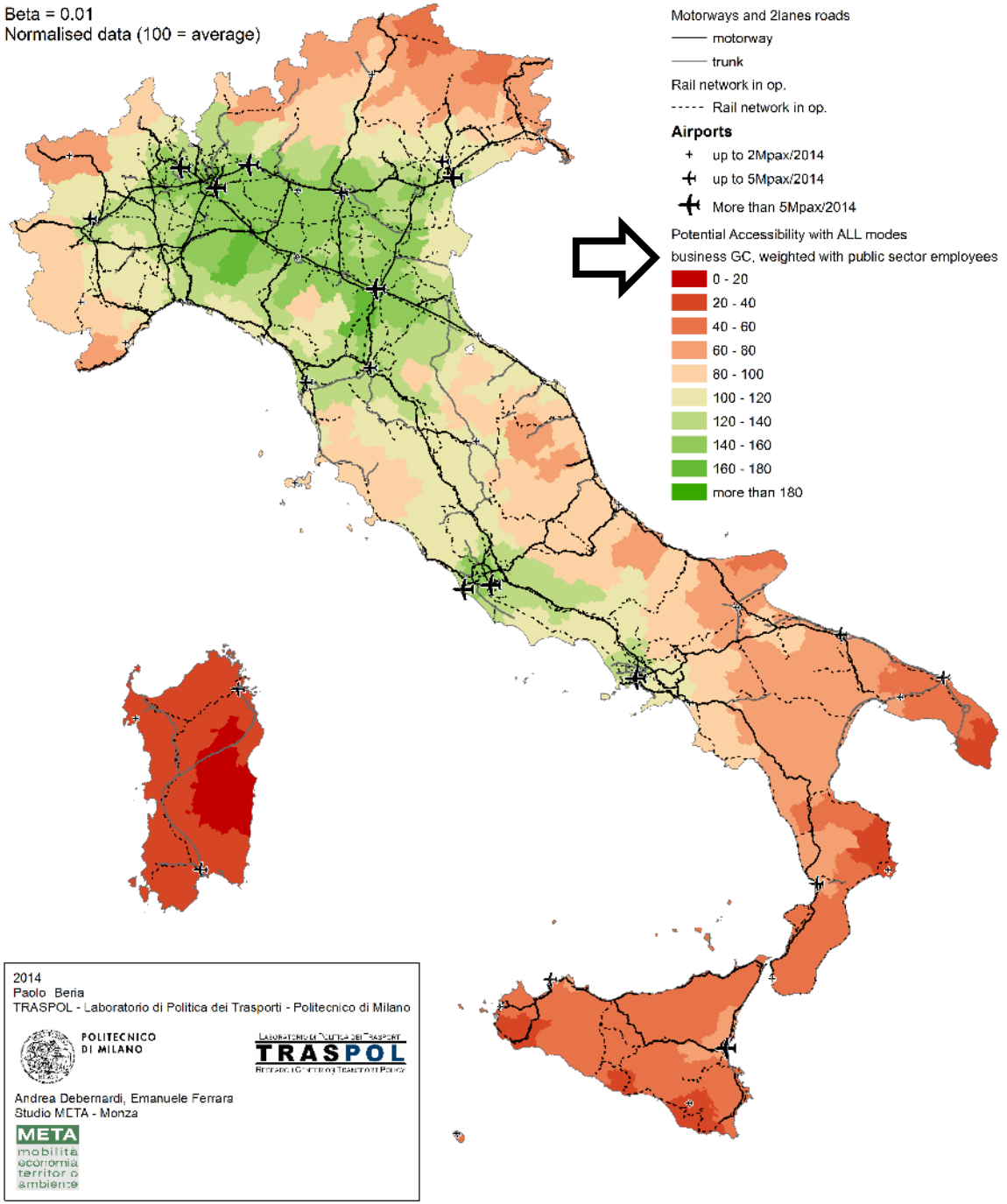


Results

2. Generalised cost accessibility

$$Apub_i = \sum_{j=1}^{n} Public\_sector\_jobs_j \cdot e^{-\beta c_{ij}}$$

The **accessibility to administrative centres is more effective** and the disadvantage of the South and Adriatic coast slightly decrease.



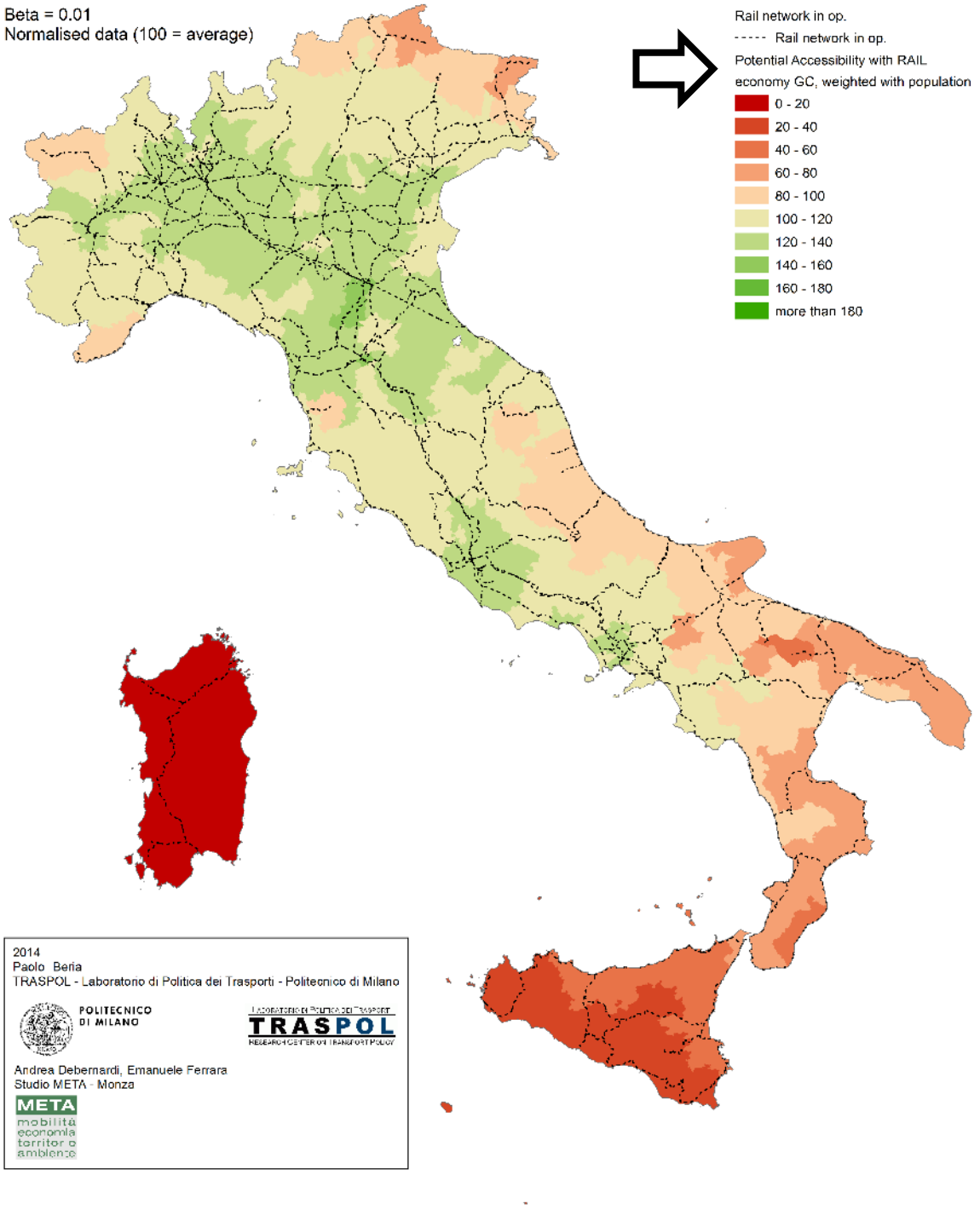
Results

3. Single-mode accessibility

$$Apop_i = \sum_{j=1}^{n} Population_j \cdot e^{-\beta c_{ij}}$$

Long-distance **rail** services accessibility for Economy users is **homogeneously above the average on most of the territory**. The recent investments has been **effective** in connecting North and South.

Only south of Ancona, Puglia, Calabria and Sicilia are below the average, but here the **geographic remoteness** really matters…



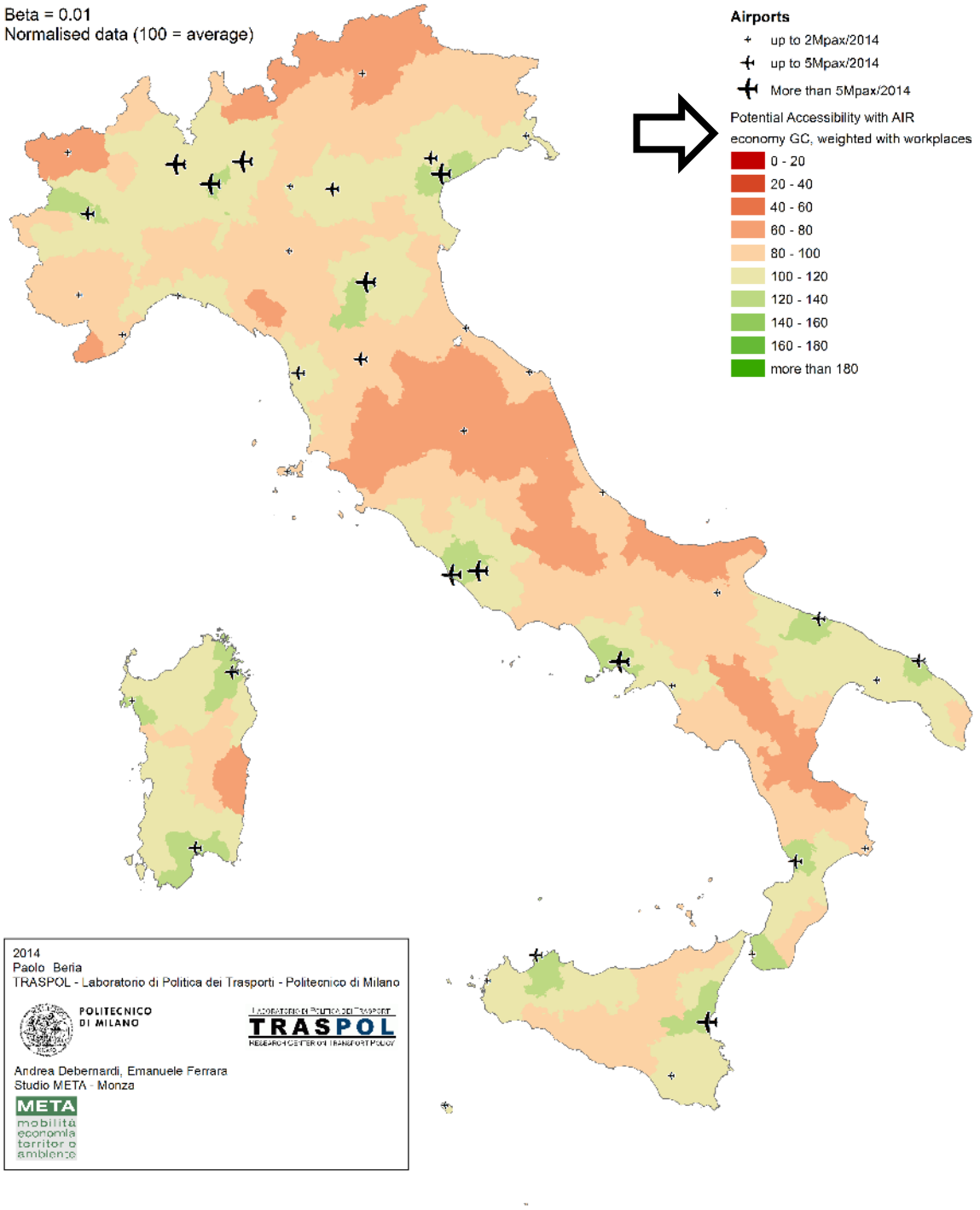
Results

3. Single-mode accessibility

$$Ajob_i = \sum_{j=1}^{n} Private\_sector\_jobs_j \cdot e^{-\beta c_{ij}}$$

Air services accessibility is obviously higher around the airports.

Milan looks less accessible than Sicily because **domestic flights** are less here (have been cut in the recent past) thanks to the AV to Naples, and because most of Italian population is not reachable by plane.



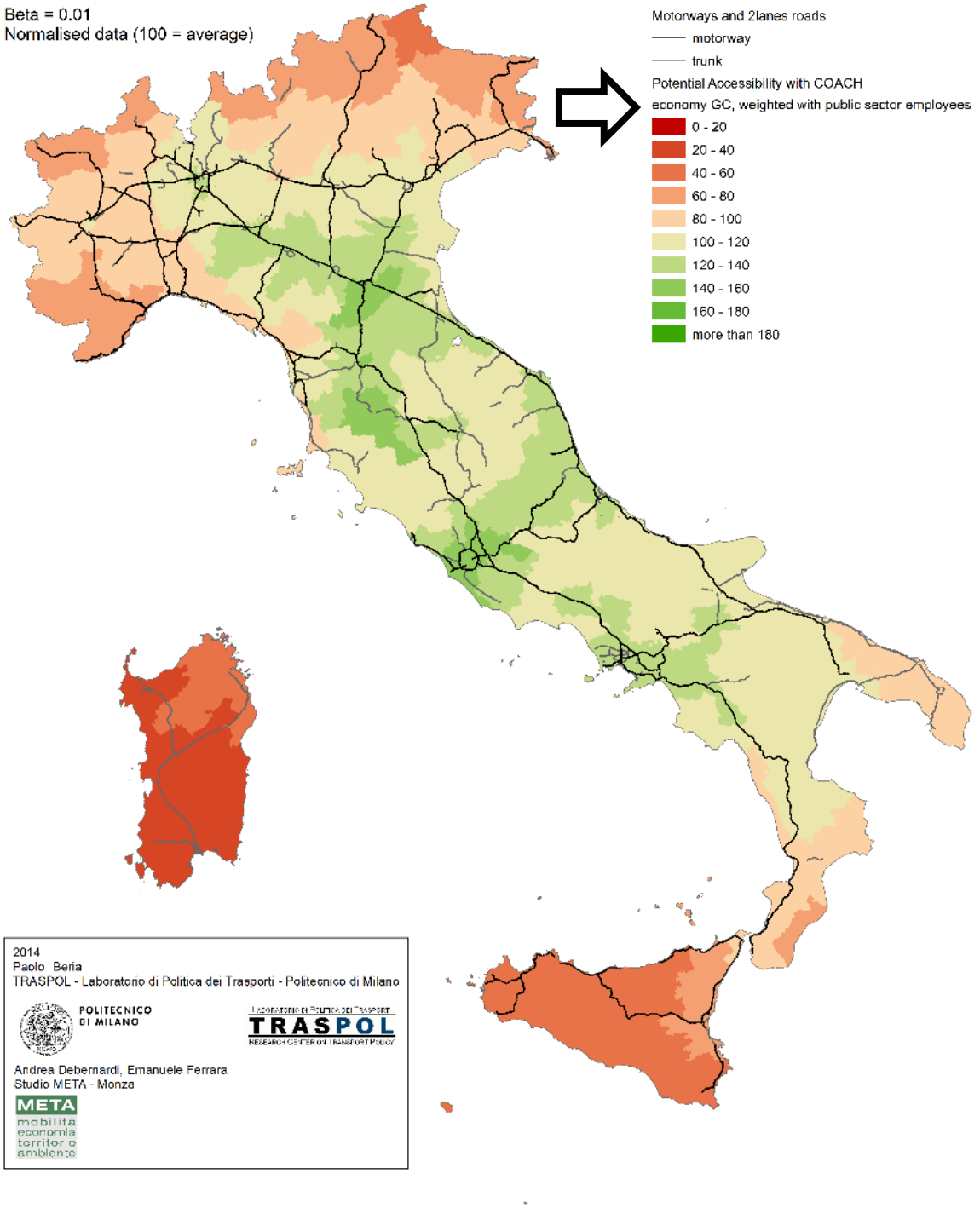
Results

3. Single-mode accessibility

$$Ajob_i = \sum_{j=1}^{n} Private\_sector\_jobs_j \cdot e^{-\beta c_{ij}}$$

Coach services are (until now) concentrated in South-North or South-Rome routes → the **role of coach in guaranteeing accessibility for the South** is important!

In the North, only BO, SI and few other destinations are well accessible because **services are not diffused in the territory**.



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Policy conclusions

Methodological results

We built a consistent measure of accessibility according to a **consolidated literature.**

We used data **much more detailed than what found in literature** (**generalized costs instead of travel time, all modes, two travel purposes**).

The picture drawn is much more meaningful than what can be done with simple stock-based accessibility indicators, biased and misleading.

This kind of analysis can be used to **“visualize” the territorial differences** in accessibility, bot **not for the assessment** of policies and investments, because ignore the economic dimension.

Policy conclusions

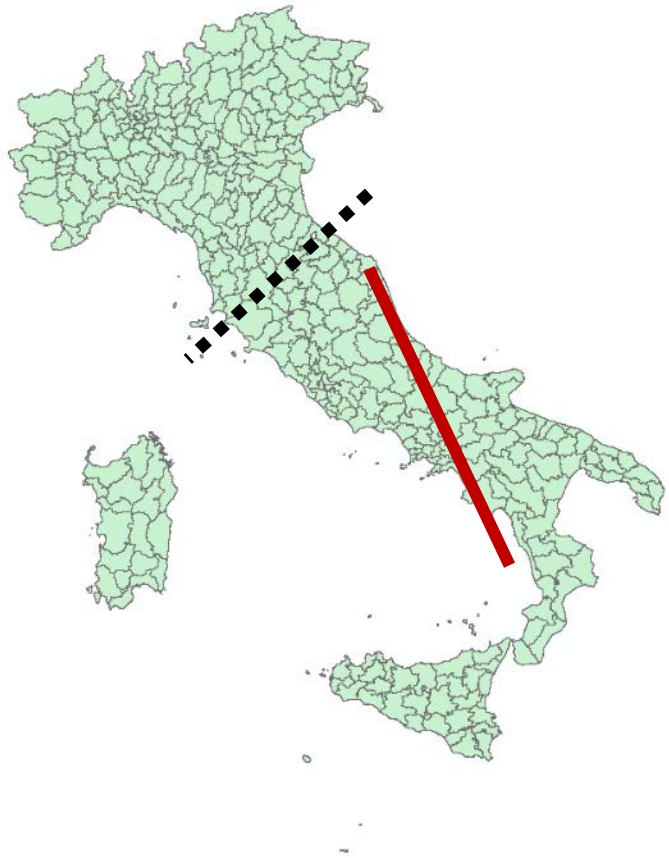
Policy results

The main corridors, especially the Milan – Naples one, have been effective in making part of the South “nearer” and effectively accessible.

There is no more difference between North and South, but between **North and West** vs. **South and East**!

Eastern coast is the area where we have found more unexpected results: despite the vicinity to Rome and Naples, the connections with the North are still below the average of the other coast.

However, **transport is not the only solution**!!!
Density of destinations will always matter!



Policy conclusions

Policy results

Inappropriate to plan new infrastructure ignoring the services using it, the land-use and the socio-economic efficiency of the available solutions

~~**Infrastructure**~~

Misleading and biased to plan infr. only

Infrastructure + services

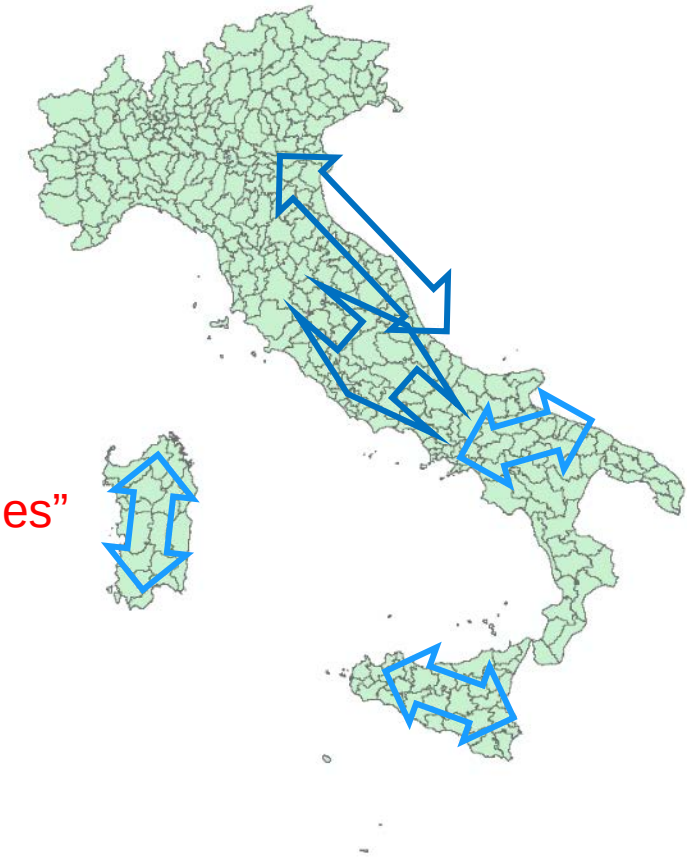
Ignores the geographical dimension

Infrastructure + services + land-use

This paper: considers also the "mass of opportunities"
→ why going there? How many people served?

Infrastructure + services + land-use + economic efficiency

Includes also the efficiency of the expenditure



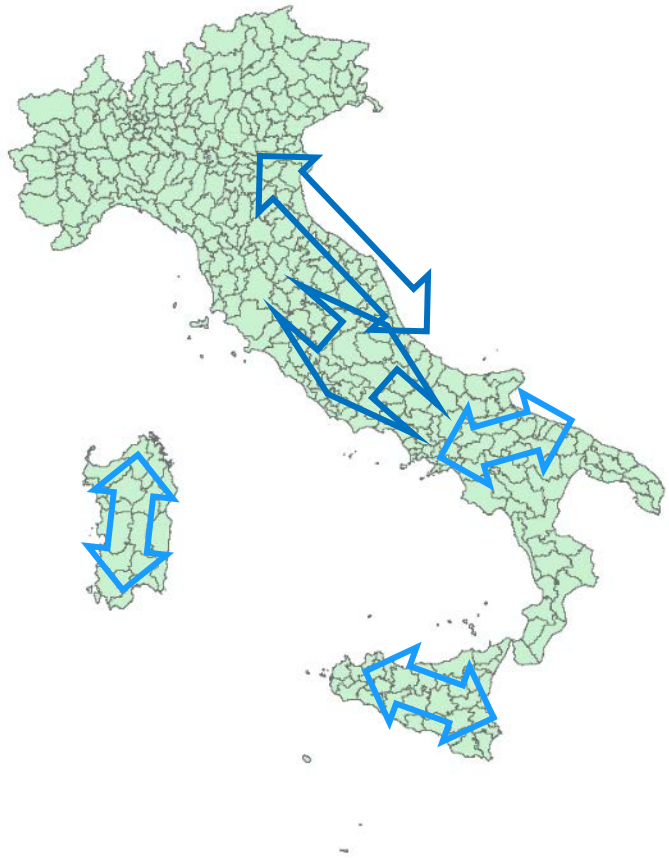
Policy conclusions

Policy results

The first efforts should be on the Adriatic coast, not only to connect it faster to the North, but also to Rome.

Bari – Naples is an interesting direction for investments, but as usual, scarce flows should suggest lighter investments than what have been done between Milan and Naples.

The recent experience of Sicily (Catania – Palermo trains) and the future ones in Sardinia (Pendolino train) show that **much must be done firstly on the services side**, before spending huge amounts of money in new and possibly redundant infrastructure!



Grazie per l'attenzione!!!

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