4th INTERNATIONAL WORKSHOP ON HIGH-SPEED RAIL SOCIOECONOMIC IMPACTS

Can Megalopolis be shaped by HSR System?

Evidence of Italian case studies RONA and MITO

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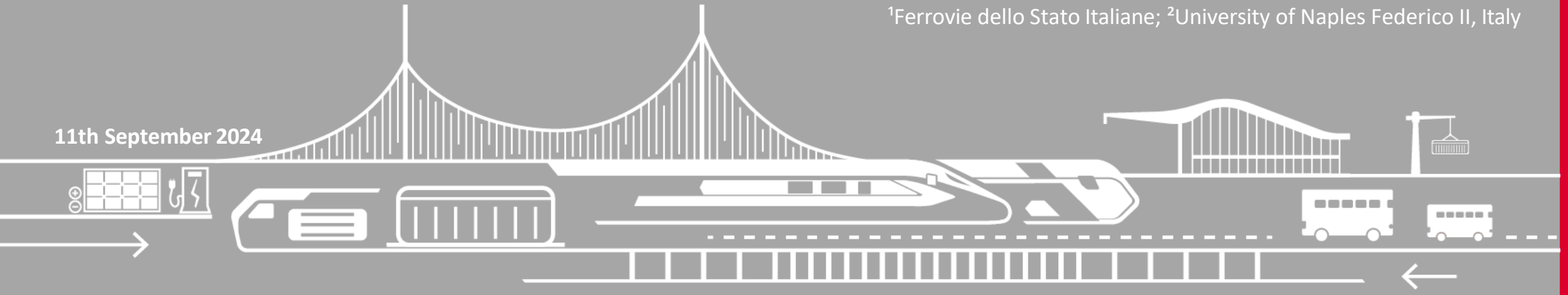

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FS Research Centre
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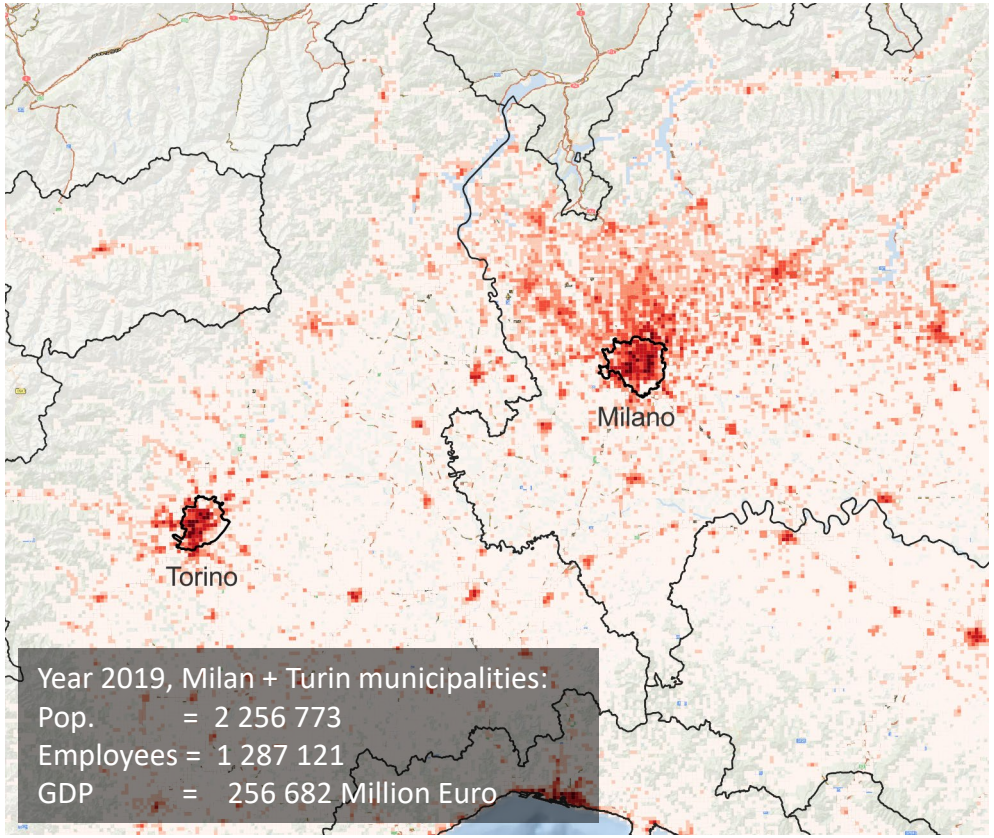
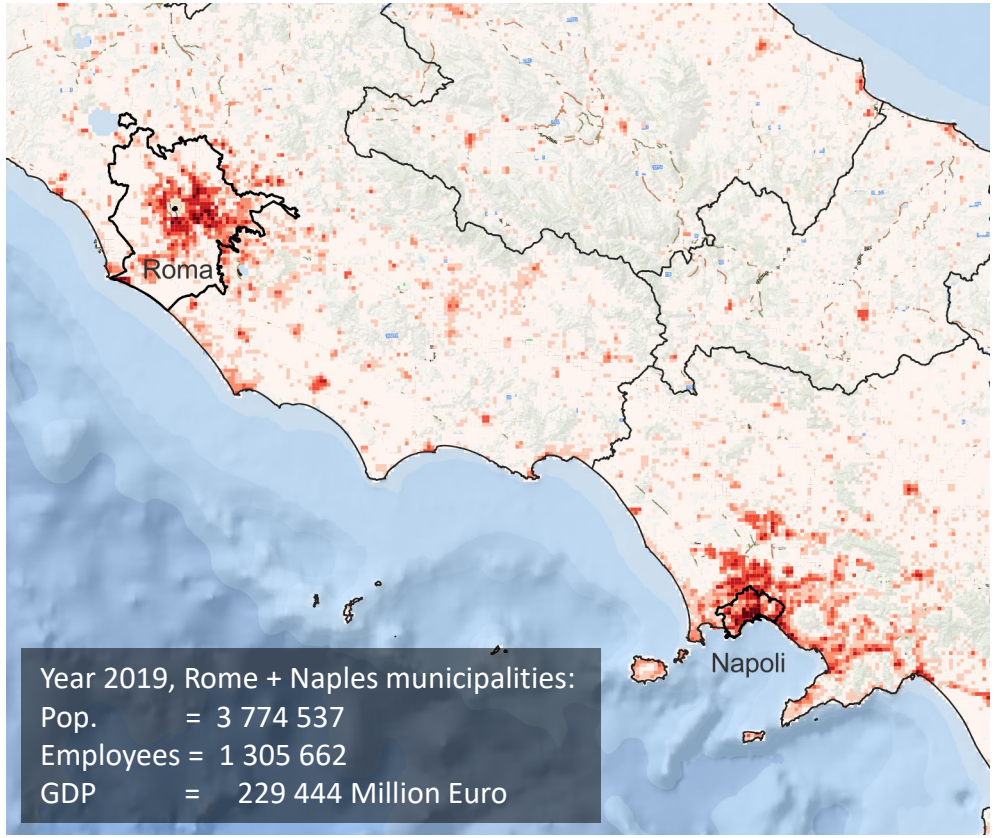
Study object

The study aim is to investigate the relation between **HSR** and a **selection of socio-economic variables** in the context of Italian **Megacity Regions**, **Rome-Naples (RoNa)** and **Milan-Turin (MiTo)**.





Municipality boundary
Regional boundaries
Pop. Eurostat grid - 1X1 km
1 - 412
412 - 1664
1664 - 3917
3917 - 7981
7981 - 16790
16790 - 37192

Megalopolis definitions

Literature review

In 1961 Jean Gottman used in a new way the term Megalopolis to "denote a large and highly connected" urbanized zone stretching along the Boston-Washington corridor in the Northeastern part of the United States.

J. Gottmann 1961

***"This particular type of region is new, but it is the result of age-old processes**, such as the growth of cities, the division of labor within a civilized society, the development of world resources. The name applied to it should, therefore, be new as a place name **but old as a symbol of the long tradition of human aspirations** and endeavor underlying the situations and problems now found here. Hence the choice of the term Megalopolis, used in this study."*

Pickard, 1962,clarified that is not a single city (the city 500 miles long) but «…a region of concentrated urbanism- a continuos zones of metropolises, cities, towns ana exurban settlement…»

Megalopolis definitions

Literature review

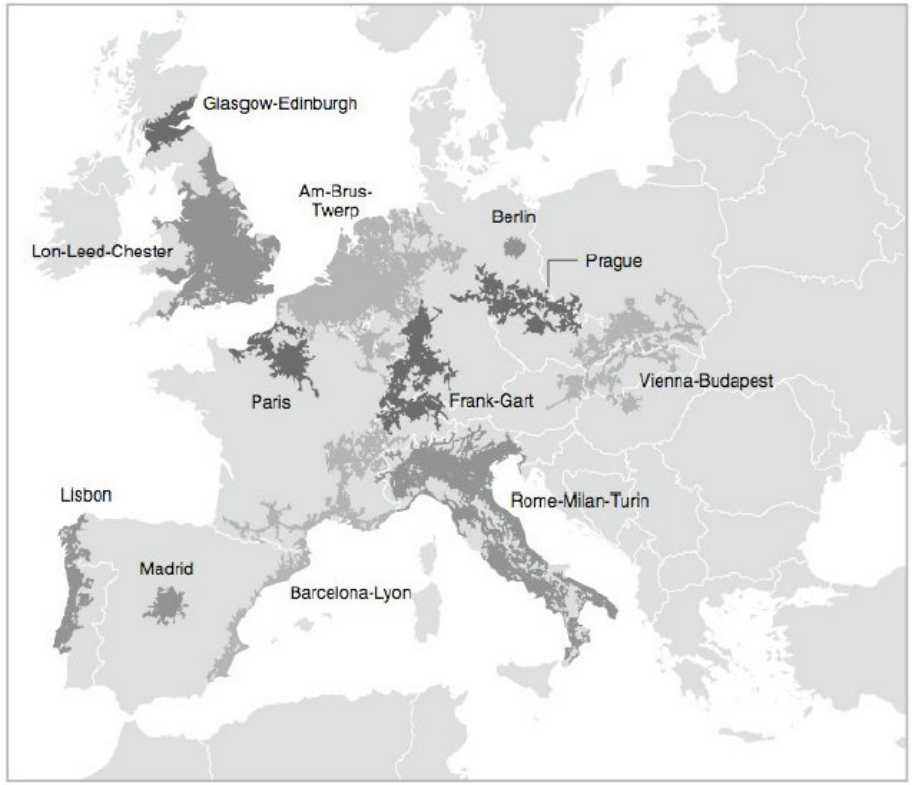
Other terms, used in literature to refer to similar concept of “megalopolis”, include:

- **Urban region:** *“...a region of high concentrations of urban activities and urbanized population.” [Pickard,1970]*
- **Extended functional region:** **«***cities that are linked together into a band of cities by means of a high-speed train connection are transformed to an extended functional region or in other words an* ***integrated corridor economy****. »* [Blum et al, 1997]
- **Mega-city region: «***polycentric networks of up 50 cities and towns, physically separate but functionally networked, clustered around one or more larger central cities, and drawing enormous economic strenght from a* ***new functional division of labour****.» [Lang and Knox 2009]*
- **Megapolitan region:** integrated networks of metropolitan areas, principal cities, and micropolitan areas. *[Lang and Knox 2009]*
- **Megaregion:** linked network for metropolitan areas that serve as a **functional unit for economic activity** [Contant and Nie, 2009]
- **Megalopolis or urban agglomeration**: *“is a spatial aggregation of cities that occurs when the relationship among them switches* ***from competition to joint development and mutual competition****.” [Yang et al., 2020]*

Megalopolis definitions

Literature review

Other authors combined Nighttime light contours with socio-economic data to identify megaregions around the world.

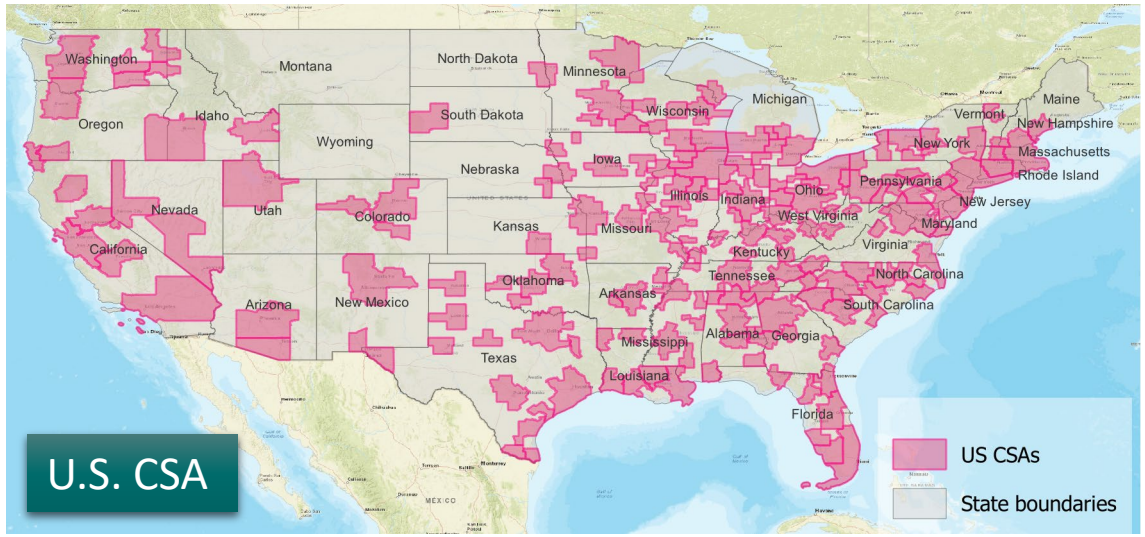


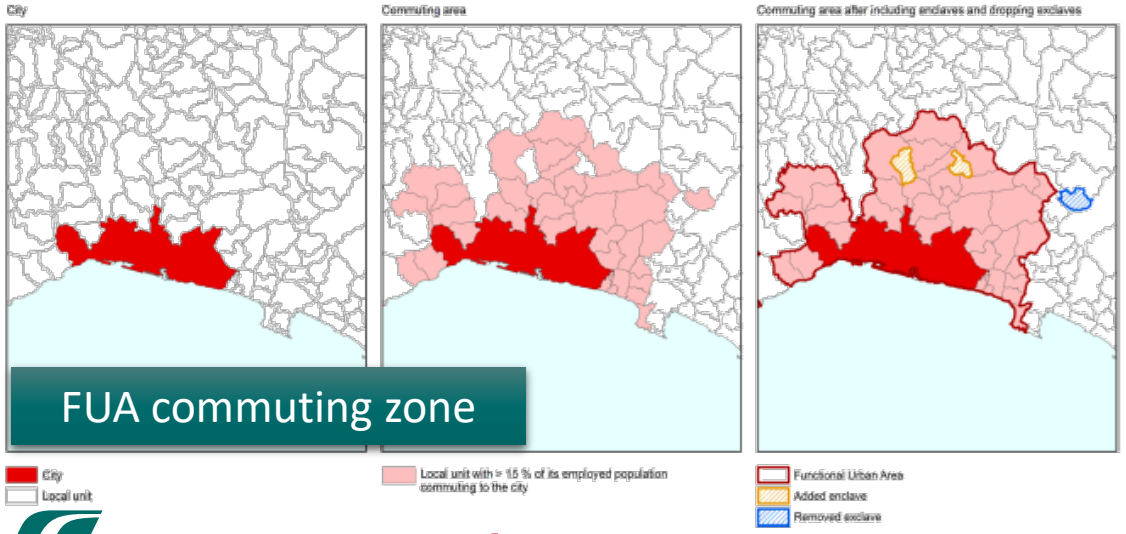
The Rise of the Mega Region
(Florida et al.,2007)

Megalopolis: An Assay for the Identification of the World Urban Mega-structures
(ARELLANO & ROCA, 2015)

Megalopolis definitions

Literature review





Lang and Knox, 2009, also link the concept of megalopolis to the definition of the **Combined Statistical Areas** (CSA) of the US Bureau of the Census. The Census considers **commuting patterns** as the key **to identifying economically integrated territories** and uses commuting flows as a proxy for other quantities such as retail and the housing market. To be defined as a CSA, metropolitan areas must share 15% of commuters.

The same threshold is used by the OECD and Eurostat methodology to identify commuting zones related to **FUA**s (Functional Urban Areas) that represent the evolution of LUZ (Large Urban Zone).

The two authors argue, however, that commuting patterns cannot be the only parameter to evaluate the existence or otherwise of Megalopolis, also due to the transformation taking place in labour market linked to the possibility of smart working,

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Relation between Megalopolis development and HSR

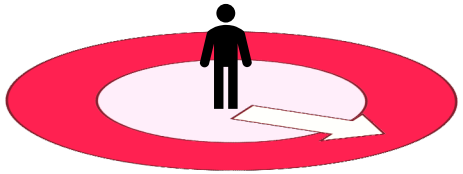
Literature review

HSR ? Megalopolis

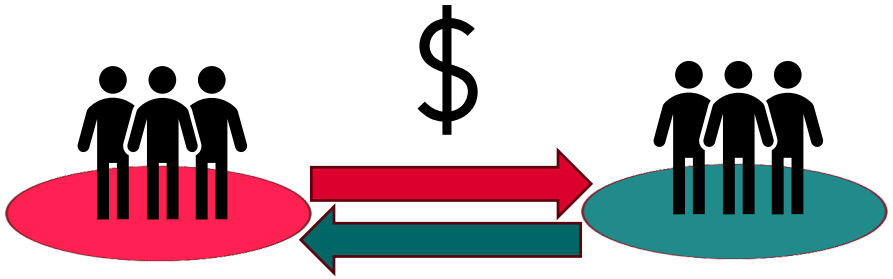
"(…)it is, however, impossible - ex-ante as well as ex-post - to determine the exact relationship between the advent of the HST and regional-economic changes." *(POL ,2002)*

HSR:

Makes cities closer



Expands individual daily activity zones



- Labour market expansion and improvement: more demand and supply and better matching resource allocation.
- Information and Knowledge transfer

Socio - Economic integration and growth

It's also true that HSR investments are directed towards the realities on which there is a high potential for demand.

Relation between Megalopolis development and HSR

Literature review

Many authors looked for a relation between HSR and Megalopolis. In this slide and in the next one you'll see a selection of studies on this subject.

Title	Variables
Labour mobility between cities and metropolitan integration: The role of high speed rail commuting in Spain **Guirao et al (2018),**	**number of contracts in province B related to individuals who reside in province A (ContractsAB)** Distance between provincial capitals A HSR dummy variable (HSR). Location of the HSR station Population size (Pop) Provincial unemployment rate (Unemp). Provincial Gross Domestic Product per capita (GDP) Housing price per square metre (Hprice). Capital of region (Cap B) Time variable (Year)
High-Speed Railway Facilities, Intercity Accessibility and Urban Innovation Level—Evidence from Cities in Three Chinese Megacity Regions **Li et al. (2022)**	**Invention patents granted per 10,000 people** Utility models granted per 10,000 people Cities connected within 2 h (by HSR) Cities connected within 4 h (by HSR) Cities connected within 6 h (by HSR) Ratio of higher education students connected within 2 h (by HSR) Ratio of higher education students connected within 4 h (by HSR) Ratio of higher education students connected within 6 h (by HSR) Ratio of technological funds connected within 2 h (by HSR) Ratio of technological funds connected within 4 h (by HSR) Ratio of technological funds connected within 6 h (by HSR)

Dependent variable

Indicators and variables in Megalopolis studies

Literature review

Many authors looked for a relation between HSR and Megalopolis. In this slide and in the previous one you'll see a selection of studies on this subject.

Title	Variables
On the joint impact of high speed rail and megalopolies policy on regional economic growth in China **Yang et al. (2020)**	**Gross Regional Product per Capita** Gross Regional Product Household Registered Population at Year-end Proportion of Secondary Industry in GRP Proportion of Tertiary Industry in GRP Number of Projects for Contracted Foreign Direct Investment Amount of Foreign Capital Actually Utilized Investment in Fixed Assets (Excluding Rural Households) Investment in Real Estate Development Policy interventions, Mp, HSR and MPxHSR defined as dummy variables, which take the value of one if the prefecture was intervened by the policy in a particular year, and zero otherwise
The impact of intercity economic complementarity on HSR volume in the context of megalopolization **Hu et al. (2021).**	**Annual average daily HSR passenger flow (thousand people)** Logarithm GDP per capita of origin city (Yuan) Logarithm permanent resident population of origin city (ten thousand people) Logarithm GDP per capita of destination city (Yuan) Logarithm permanent resident population of destination city (ten thousand people) Flow-weighted average travel time from origin city to destination city via HSR network (one hundred minutes) Krugman specialization index

Dependent variable

Study data description and sources

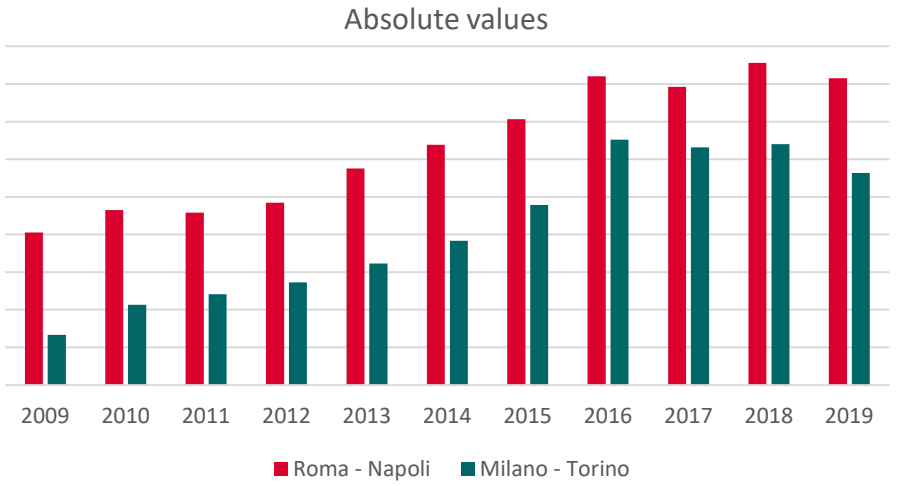
Dependent Variable - Journeys

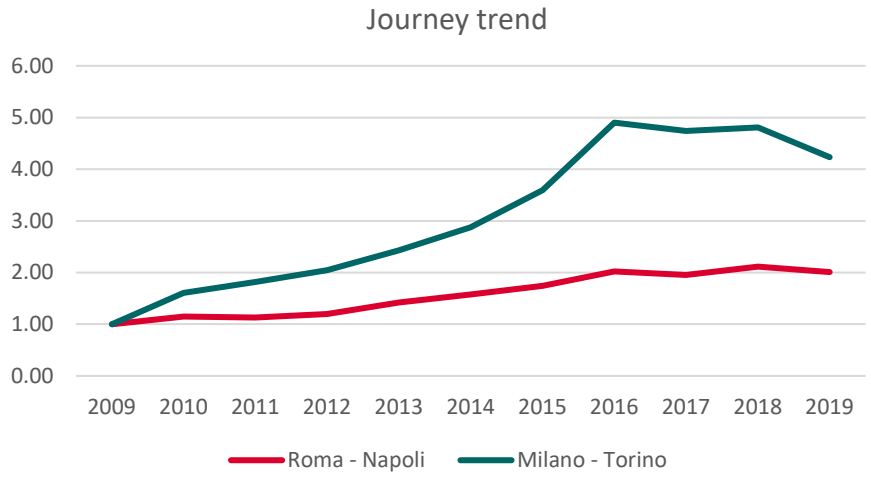
The journeys are derived from **ticketing data**, are distinguished by ticket type and class and **come from a dataset of long-distance journeys**.
Journeys do not coincide with passengers, because they could also include those who make a journey with a transfer at one or both of the reference stations of the OD pairs.

The types of tickets considered for the draw of journeys are as follows:

- Eurostar.
- Frecciarossa;
- Frecciargento;
- AV in the years in which the above types are not present.

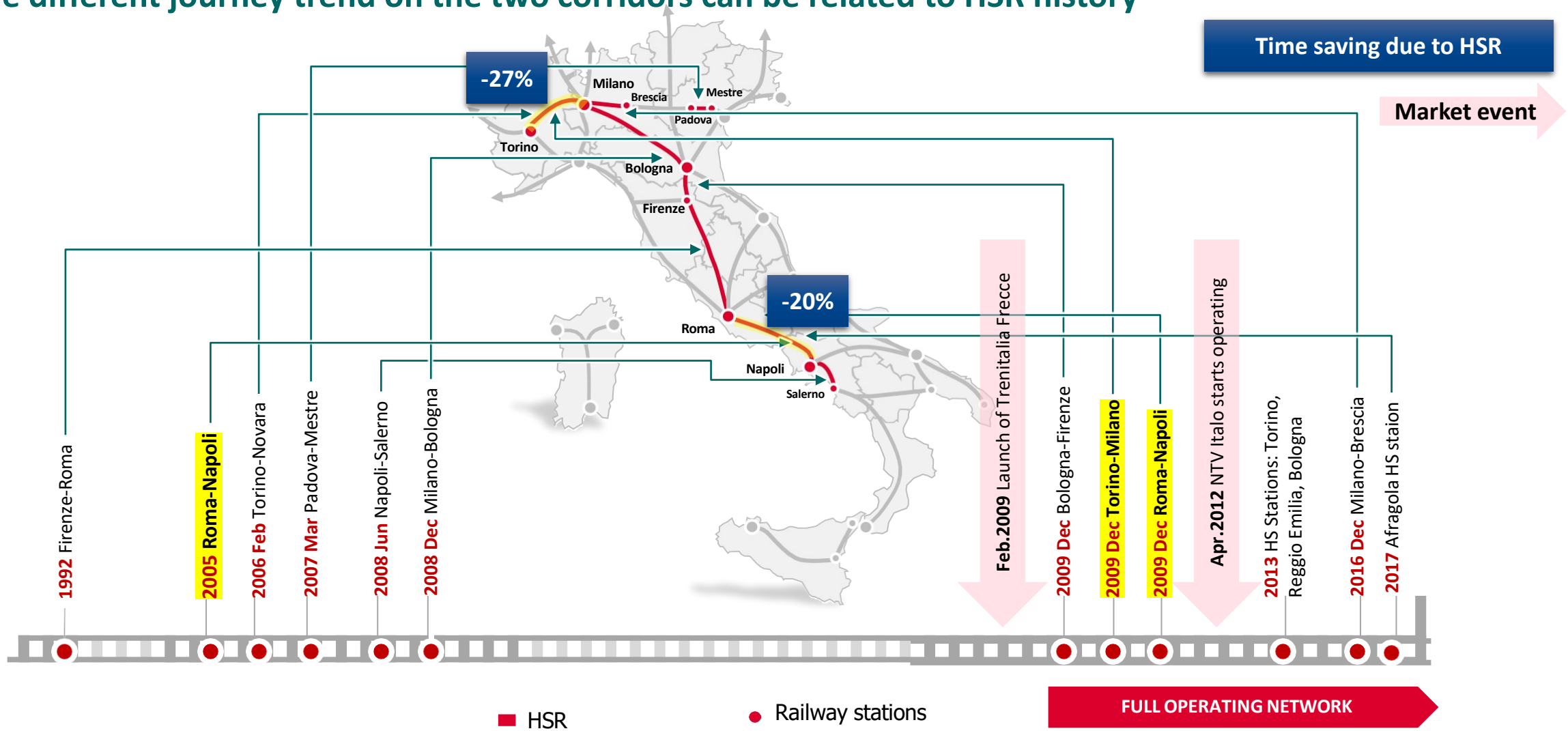
The types of trips that are not included in the evaluation are those made with intercity trains. There is no data from regional services in the dataset.
Through distribution data between Italo and Trenitalia deriving **from a sample survey about modal share, it was possible to estimate journeys also for the competing operator Italo.**





The chosen corridors

The different journey trend on the two corridors can be related to HSR history



Study data description and sources

Geo-socio-economic factors | Service related factors

Independent Variables

Data	Variable type	Territory	Operation	Time series	Sources
Population (pop)	All age population	Municipality	Σ	2009-2019	

Employees (emp)	• Total Employees
	• Employees of sector
	  • M (professional, scientific and technical activities) +
	  • N (rental, travel agencies, business support services)
		Municipality	Σ	• 2009-2010
				• 2011
				• 2012-2019	

Local production units (LU)	• Total Local production units
	• Employees of sector
	  • M (professional, scientific and technical activities) +
	  • N (rental, travel agencies, business support services)
		Municipality	Σ	• 2009-2010
				• 2011
				• 2012-2019
					Istat Istituto Nazionale di Statistica

Value added (VA)	Value of production minus the value of intermediate costs.	NUTS3	Σ	2009-2019	
Employment rate (e_r)	Employment rate evaluated for the megalopolis as a whole using the method provided in the ISTAT documentation	NUTS3	See descript.	2009-2019	
Unemployment rate (u_r)	Uneployment rate evaluated for the megalopolis as a whole using the method provided in the ISTAT documentation	NUTS3	See descript.	2009-2019	
GDP	Gross domestic product, current value	NUTS3	Σ		eurostat
Number of daily services	Number of total daily services OD+DO	O/D RELATION	OD+DO	2009-2019	**PUBLIC TIME TABLES**

Model results: RoNa

Starting from the whole data set of the previous slide, tables in this slide and in the next one show only variables that have the expected sign respect to HS journeys.

	Dependent variable: log(HS journeys)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(pop)	13.405*** (0.759)						
log(GDP_pc)		1.345 (2.783)					
log(emp)			3.276** (1.306)				
log(LU)				8.681*** (1.738)			
log(emp_MN)					2.865*** (0.577)		
log(LU_MN)						5.238*** (1.017)	
log(n_daily_services)							0.562*** (0.070)
Costant	-187.782*** (11.490)	0.211 (30.419)	-30.975 (18.306)	-95.610*** (22.141)	-21.106** (7.291)	-44.744*** (11.606)	12.485*** (0.322)
Observations	11	11	11	11	11	11	11
R^2	0.974	0.020	0.285	0.738	0.677	0.729	0.913
Adjusted R^2	0.971	-0.089	0.205	0.709	0.641	0.699	0.904
Residual Std. Error (df=9)	0.047	0.287	0.245	0.148	0.165	0.151	0.085
F Statistic (df=1;9)	330.831***	0.186	3.585*	25.406***	18.844***	24.168***	94.702***

Analysis main characteristics:

- linear regression;
- Distinct evaluation of two realities in order to understand if they have the same behaviour respect to the indipendent variables.

Note:
* p<0.1;
** p<0.05 ;
*** p<0.01

HAC Standard Errors in parenthesis

Model results: MiTo

Starting from the whole data set of the previous slide, tables in this slide and in the previous slide show only variables that have the expected sign respect to HS journeys.

	Dependent variable: log(HS journeys)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(pop)	23.538*** (3.102)						
log(GDP_pc)		8.622*** (2.437)					
log(emp)			5.918*** (1.487)				
log(LU)				18.419** (6.988)			
log(emp_MN)					5.086*** (1.383)		
log(LU_MN)						8.412** (2.443)	
log(n_daily_services)							0.640*** (0.071)
Costant	-329.311*** (245.311)	-83.251** (27.658)	-68.212*** (20.80)	-216.621** (87.638)	-49.868** (17.481)	-80.760** (27.671)	12.158*** (0.269)
Observations	11	11	11	11	11	11	11
R^2	0.937	0.589	0.439	0.632	0.750	0.526	0.931
Adjusted R^2	0.930	0.544	0.377	0.591	0.722	0.473	0.923
Residual Std. Error (df=9)	0.140	0.357	0.417	0.338	0.278	0.384	0.146
F Statistic (df=1;9)	133.471***	12.924***	7.046**	15.439***	27.019***	9.982**	121.455***

Analysis main characteristics:

- linear regression;
- Distinct evaluation of two realities in order to understand if they have the same behaviour respect to the indipendent variables.

Note:
* p<0.1;
** p<0.05 ;
*** p<0.01

HAC Standard Errors in parenthesis

Conclusion and further development

- Population, employees and local units have a positive and significant impact on HSR passenger flow.
- GDP pro-capita has a positive impact on HSR passenger flow, but it isn't significant for RoNa.
- Number of daily HS services positively and significantly affects HS journeys.
- Results confirm the interdependence between HSR and Megalopolis; the presence of HSR brings economic growth but its use is determined by socio-economic factors of the connected cities too. High speed alone is not enough to determine the development of a Megalopolis but it can enhance its beneficial socio-economic effects.
- **The study is preliminary, further developments** of the study will be possible when a greater number of data will be collected both in time series and at the territorial level:
  - The selected time series, in addition to the initial constraint coinciding with the activation of the actual HS service, is limited by the presence of the pandemic event that led to the exclusion of 2020, 2021, 2022. It may be possible to extend the time series starting from 2023.
  - On a spatial level, one could think of adding other similar realities, for example Bologna – Florence, and applying another methodology like a data panel analysis.
  - We could consider other more complex economic variables like Krugman specialization index.

Thanks

Do you have any questions?

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