

Land Use-Transport Interactions (LUTI) of High-Speed Rail development

Francesca Pagliara

Dep. of Civil Architectural and Environmental Engineering

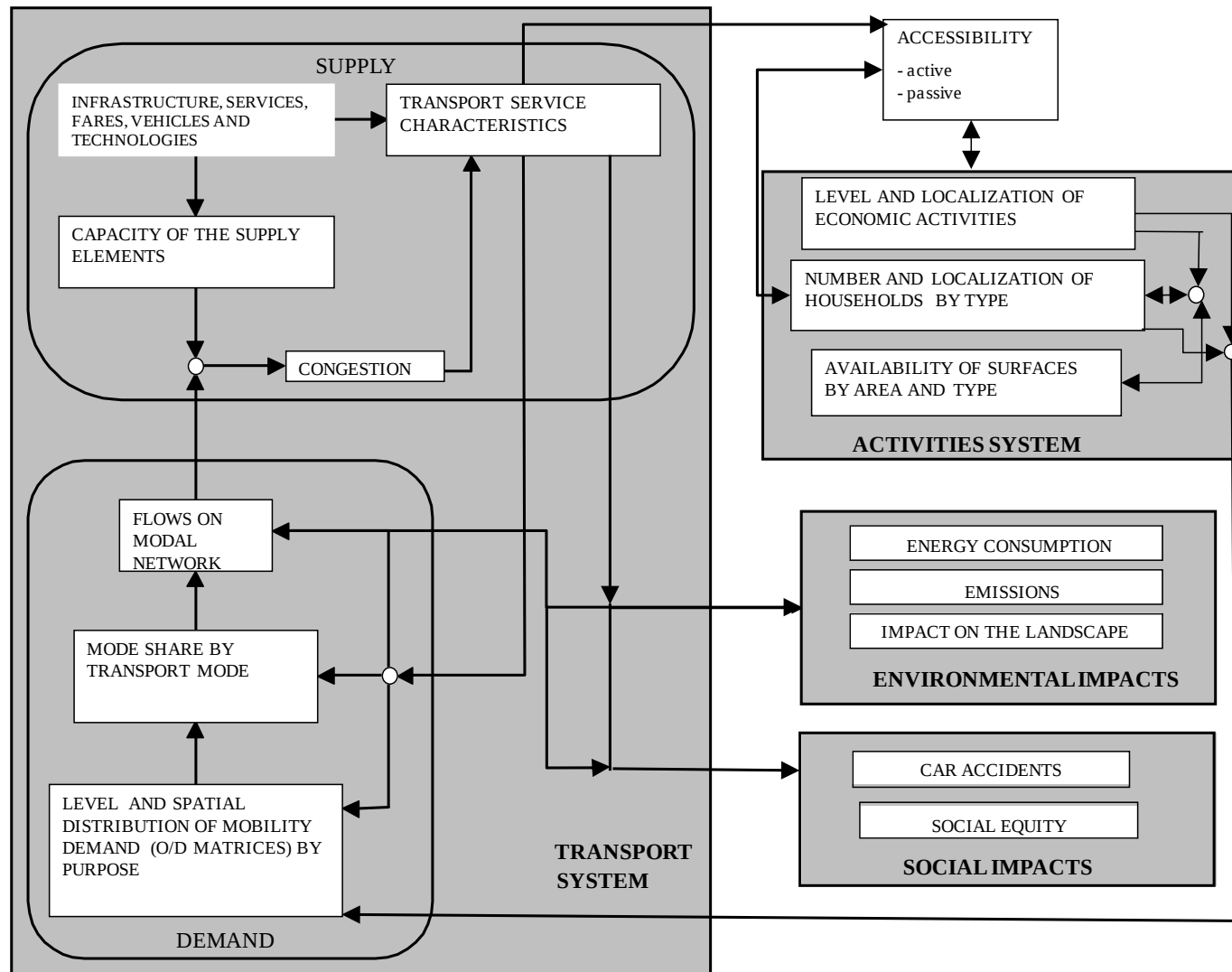
University of Naples Federico II

email: fpagliar@unina.it

This is not an ADB material. The views expressed in this document are the views of the author and/or their organizations and do not necessarily reflect the views or policies of the Asian Development Bank, or its Board of Governors, or the govts. they represent. ADB does not guarantee the accuracy and/or completeness of the material's contents, and accepts no responsibility for any direct or indirect consequence of their use or reliance, whether wholly or partially. Please feel free to contact the authors directly should you have queries.

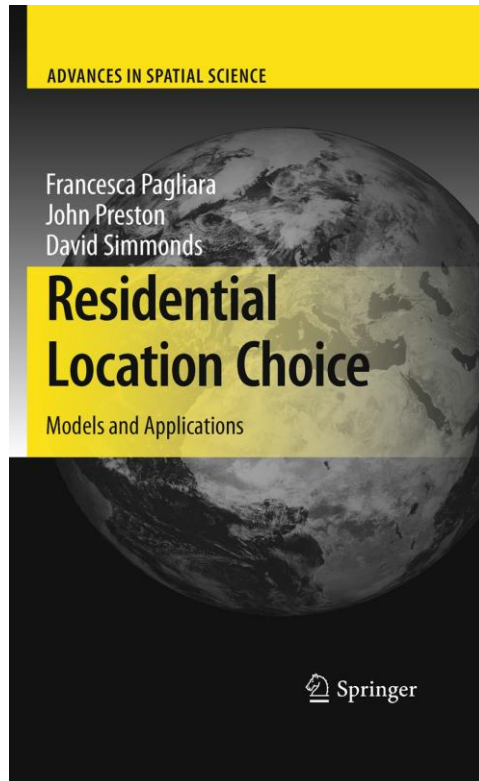


The Land Use-Transport Interactions (LUTI)

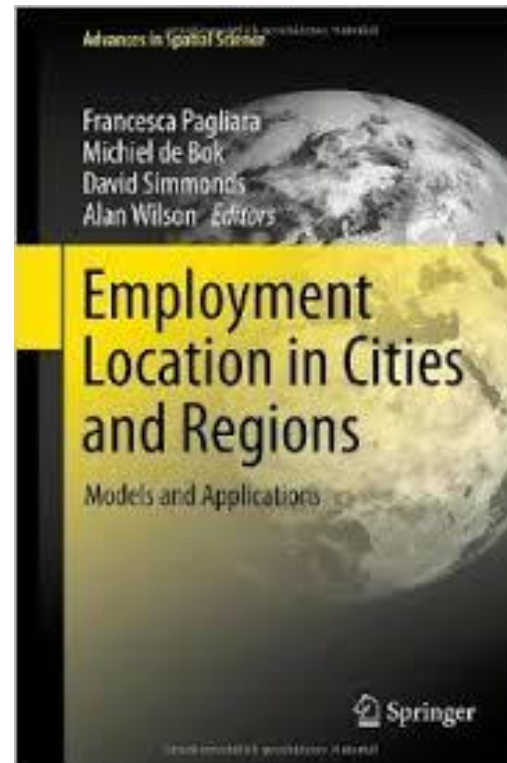


Main contribution to the literature on LUTI

2010



2013



If the infrastructure is HIGH SPEED RAIL (HSR)?

✓ Three different functional approaches:

❑ **high-speed**: passenger-oriented, set on new 300km/h speed lines and non-stop connections between large metropolitan areas (e.g. France).

❑ **high-capacity**: both for passengers and freight, serving also intermediate cities with up to 250 km/h train services, developed partly on renewed existing lines (e.g. Germany).

❑ **enhanced intercity network**: speeding up the Intercity service till 225 km/h, combined with frequent coincidences in all the stations to other destination on the network (e.g. Switzerland and England).

If the infrastructure is HIGH SPEED RAIL (HSR)?

- ❑ **HSR** implementation plays an important **role in reshaping travel patterns and activities of people**, consequently **changing the ways cities develop**.
- ❑ Motivations to develop HSR systems for many countries are (Sussman, 2011):
 - ... **not only**:
 - ❖ Increasing transport infrastructure capacity
 - ❖ Providing a “green” transport alternative
 - ... **but also**:
 - ❖ Promoting economic growth and regional development

ISSUES

- ☐ **HSR and megalopolis formation**
 - ☐ **HSR and tourists destination/location choice**
 - ☐ **HSR and temporary offices location choice**
 - ☐ **HSR and land market**
 - ☐ **HSR and equity issues**
-
- ☐ **Multi-disciplinary approach: Engineering, Economics, Geography, Political Science, Sociology, Psychology**

HSR and megalopolis formation

RESEARCH ON HSR SINCE 2008



Travel time between Napoli and Roma 1 hour now, 2 hours before HSR

HSR and and megalopolis formation

O-D matrix between Naples and Rome (trips %)

	ORIG \ DEST	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
CAR	NAPLES	0	0	86	10	3	Weekday
	ROME	53	33	0	0	14	
	NAPLES	0	0	91	8	1	Saturday
	ROME	55	38	0	0	7	
	NAPLES	0	0	81	10	9	Sunday
	ROME	61	26	0	0	13	
	NAPLES	0	0	85	10	5	Total
	ROME	57	32	0	0	11	

	DEST \ ORIG	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
IC	NAPLES	0	0	88	7	5	Weekday
	ROME	62	32	0	0	6	
	NAPLES	0	0	86	7	8	Saturday
	ROME	70	28	0	0	2	
	NAPLES	0	0	87	4	9	Sunday
	ROME	70	25	0	0	5	
	NAPLES	0	0	87	6	7	Total
	ROME	68	28	0	0	4	

	ORIG \ DEST	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
HS	NAPLES	0	0	96	2	2	Weekday
	ROME	68	24	0	0	8	
	NAPLES	0	0	91	1	8	Saturday
	ROME	62	29	0	0	9	
	NAPLES	0	0	82	6	12	Sunday
	ROME	66	27	0	0	6	
	NAPLES	0	0	92	2	5	Total
	ROME	66	26	0	0	8	

	DEST \ ORIG	NAPLES	PROV. OF NAPLES	ROME	PROV. OF ROME	OTHER	
ES	NAPLES	0	0	92	3	5	Weekday
	ROME	85	15	0	0	0	
	NAPLES	0	0	91	2	7	Saturday
	ROME	73	22	0	0	5	
	NAPLES	0	0	88	3	9	Sunday
	ROME	80	20	0	0	0	
	NAPLES	0	0	90	3	7	Total
	ROME	78	19	0	0	3	

COMMUTING FLOWS EVERY DAY

HSR and megalopolis formation

- ❑ **HSR** has the potential for **megalopolis** formation.
- ❑ **Defining megalopolis:** large agglomerations, megaregions, mega-cities, megaplexes, megapolitan regions, etc.
- ❑ Formation of ***Megalopolis - an integrated economic urban complex*** - created by fusion of multiple cities connected by high-speed transportation of 200-300 km/h (Sussman, 2011).
- ❑ *A geographical area that shares a common labor market and a common market for household and business services” (Blum et al., 2009).*

POSITIVE IMPACTS:

- Larger labor markets and commercial markets, thus greater productivity.
- *“Better and more effective than cities alone in meeting the economic and social challenges” (Ross, 2009).*

HSR and megalopolis formation

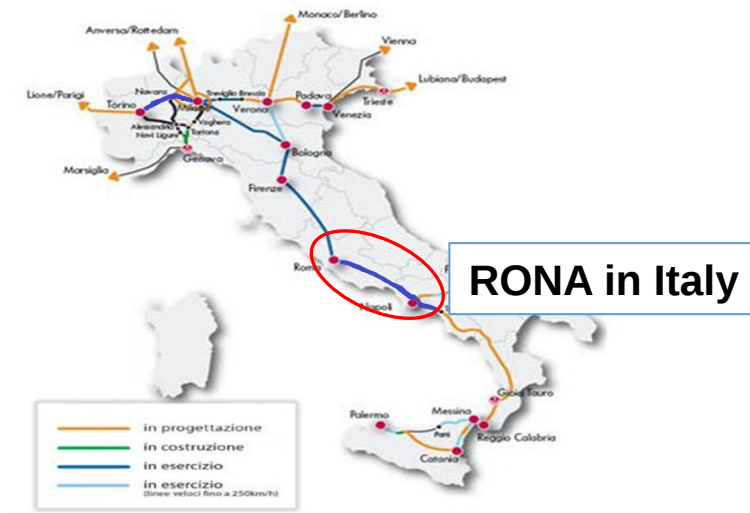
- ❑ How one would know that a megalopolis emerges as a result of HSR deployment?

- ❑ No precise parameters, but some considerations arise:
 - Significant increases in one-day round trips between a pair or group of cities.
 - Increase of generated induced demand.
 - Induced demand for business trips.
 - Increase in the number of daily commuters.
 - Decrease in overnight hotel stays.

However, these parameters may be affected by factors other than HSR infrastructure, making the causal relationship difficult to verify.

Potential corridors to analyse are:

- ❑ Frankfurt - Cologne in Germany
- ❑ Madrid – Ciudad Real in Spain
- ❑ Corridors in Japan, China



- ❖ **Megalopolises or megaregions** present the need for planning on a **new spatial scale**. This implies **institutional change**.

HSR and megalopolis formation

Regression models

ΔPOP_t	is the population change between the two cities under analysis for every year t.
$\Delta HousePrice_t$	is the house price change between the two cities under analysis for every year t
$Growth-Rate_t$	is the weighted average population growth rate change between the two cities under analysis (change measured for 1000 inhabitants) for every year t
$Res-Dens_t$	is the average residential density change between the two cities under analysis for every year t (no. of inhabitants/km ²).
$Migration-Rate_t$	is the difference between the number of immigrants and that of the emigrants between the two cities under analysis for every year t (change measured for 1000 inhabitants).
GDP_t	is the Gross Domestic Product change between the two cities for every year t;
$UNEMP-RATE_t$	is the unemployment rate change between the two cities for every year t;
$TIME-HSR$	is the HSR travel time expressed in minutes along a given corridor;
$COST-HSR$	is the HSR travel cost expressed in Euros along a given corridor
$FREQ-HSR$	is the HSR frequency expressed in number of runs along a given corridor
$COMF-HSR$	is the HSR comfort, which is a dummy variable equal to 0 before the inauguration of the HSR line between the two cities and 1 after the inauguration

COMMUTING FLOWS SHOULD BE CONSIDERED AS DEPENDENT VARIABLES. MOREOVER OTHER VARIABLES TO BE INTRODUCED SHOULD BE FOR EXAMPLE THE SALARIES CHANGES. THERE IS NOTHING IN THE CURRENT LITERATURE FROM A QUANTITATIVE PERSPECTIVE

HSR and megalopolis formation

Corridor RONA – analysis based on *POP*

Coefficient						
	$\beta_{\text{Growth-Rate}}$	$\beta_{\text{Res-Dens}}$	$\beta_{\text{Migration-Rate}}$	$\beta_{\text{FREQ-HSR}}$	$\beta_{\text{COST-HSR}}$	$\beta_{\text{TIME-HSR}}$
Value	0.2	0.45	-0.25	0.75	-1.25	-2.5
	(4.32)	(4.51)	(-4.38)	(7.74)	(-3.69)	(3.70)
ρ^2	0.58					
ρ_{adj}^2	0.57					

Corridor RONA – analysis based on *HousePrice*

Coefficient					
	$\beta_{\text{Res-Dens}}$	$\beta_{\text{UNEMP-RATE}}$	$\beta_{\text{FREQ-HSR}}$	$\beta_{\text{COST-HSR}}$	$\beta_{\text{TIME-HSR}}$
Value	0.09	-2.60	0.42	-0.58	-0.15
	(3.74)	(-4.06)	(3.61)	(-2.15)	(-2.10)
ρ^2	0.55				
ρ_{adj}^2	0.54				

HSR and tourists destination/location choice

High-speed rail stimulates tourism

2012-March-30 08:53 Shenzhen Daily

PASSENGERS with high-speed train tickets from Shenzhen or Guangzhou to Wuhan can enjoy discounts of 30-40 percent when visiting major tourism attractions in Central China's Hubei Province in April, a promotion of Hubei tourism authority said Wednesday.

Economy-class tickets for ~~high-speed trains from Shenzhen~~ to Changsha, capital of Hunan Province, and Wuhan, capital of Hubei Province, on April 1, the opening day of Shenzhen-Wuhan High-Speed Rail, have sold out.

The high-speed rail, which cuts the Shenzhen-Wuhan journey to four hours, is expected to greatly stimulate tourism along the line.

"Hubei is now better connected with Pearl River Delta cities and we are inviting Guangdong travelers to enjoy sakura flowers in Wuhan University and visit our tourism attractions, such as Yellow Crane Tower, Three Gorges Dam and Donghu Lake," Zhang Dahua, Hubei tourism chief, said at a promotion Wednesday.

Shenzhen travel agencies are also mulling package tours to Wuhan and Changsha.

According to Liu Ke, marketing manager of China Travel Service Shenzhen Co., the three-day trip to Wuhan costs 2,000 yuan (US\$317.25).

It costs 540 yuan for an economy seat to Wuhan and 390 yuan to Changsha.

According to line operator Guangzhou Railway Group, there will be 20 pairs of trains a day between Shenzhen, Changsha and Wuhan and the intervals for departures at Shenzhen North Railway Station are between 30 minutes and 90 minutes.(Han Ximin)

HSR and tourists destination/location choice

- ❑ **Three tourist destinations: Madrid, Rome and Naples.**
- ❑ Investigating the **impact of HSR** on the choice of a tourist destination.
- ❑ **HSR** has an **impact** in the case of **Naples**.
- ❑ For **Madrid and Rome** an impact exists since **HSR** is chosen for visiting cities close to them. **HSR** is not a key determinant of tourists' choice of destination since the majority are international tourists arriving by air.



- ❑ An **empirical analysis** has been carried out: **dataset** containing information both **on tourism** and **transport for 99 Italian provinces**, during the **2006-2016 period**.
- ❑ The dataset is composed of **1089 observations** (99 provinces x 11 years).
- ❑ The methodology adopted: Panel data regression models since data are of panel type.

HSR and tourists destination/location choice

VARIABLES DESCRIPTION

Variable	
DEPENDENT	
IT_Tourists	number of Italian Tourists
FOREIGN_Tourists	number of Foreign Tourists
INDEPENDENT	
HSR	binary variable taking value 1 if HSR is available, 0 otherwise
HUB2	binary variable taking value 1 if the airport is a second level hub of a network carrier; 0 otherwise
Low-Cost	number of operating bases of low-cost airlines
GDP	is the Gross Domestic Product
SEA	dummy variable equal to 1 if the destination is on the sea; 0 otherwise
Attraction	number of activities attracting tourists in a given destination (e.g. sum of museums, historical sites, etc.)
Robbery	number of robberies registered in a given destination
Crime	number of crimes reported in a given destination

HSR and tourists destination/location choice

FACTORS INFLUENCING TOURISTS 'CHOICES

Variable	Italian Tourists (t-student)	Foreign tourists (t-student)
HSR	0.0281 (2.98)	-
HUB2	0.8558 (17.09)	1.4209 (22.63)
LOW-COST	-	0.0024 (2.59)
GDP	0.0031 (4.56)	0.0050 (7.74)
ATTRACTION	0.0006 (10.07)	0.0013 (22.22)
SEA	0.2277 (4.88)	0.3389 (7.05)
CRIME	-1.5760 (-3.74)	-2.1553 (-4.28)
ROBBERY	-	-0.0041 (-6.03)
Const	1.9994 (38.26)	1.3122 (20.92)
R ²	0.32	0.48

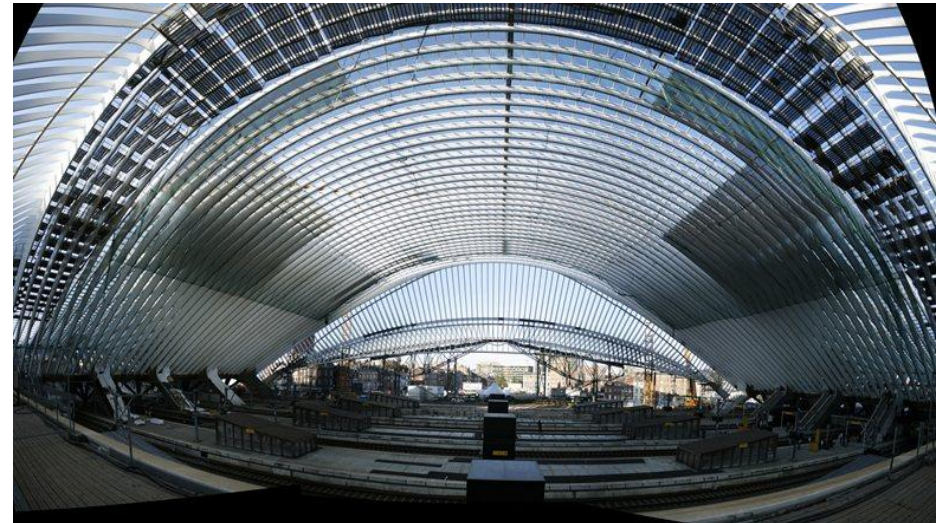
**OTHER MODELS SPECIFICATIONS AND OTHER VARIABLES SHOULD BE TESTED.
WHAT WILL BE THE IMPACT OF COVID-19 ON TOUSISTS' TRAVEL CHOICES?**

HSR STATIONS: PIECES OF ARTWORK



HSR station at Reggio Emilia (Italy) by S. Calatrava

HSR station at Liège-Guillemin (Belgium) by S. Calatrava



HSR and temporary offices location choice

HSR STATIONS: PIECES OF ARTWORK



**HSR station at Haramain
(Saudi Arabia) by N.
Foster**

**HSR station at Naples-
Afragola (Italy) by Z.
Hadid**



BUT THEY ARE ALSO WORKPLACES...

.....Investments in HSR systems can:

- ✓ increase the number of business travellers
- ✓ Encourage the development of offices inside and around stations

What are temporary offices?

Fully-equipped offices to be rented by mobile workers for a given time-period.

“Mobile workers” are all the professionals who spend part of their time working in different places. They usually do not own head-offices.

Regus is the world’s leading provider of flexible workspaces with 1500 locations globally.

HSR and temporary offices location choice

**Regus in Italy
since 1996**



Turin
City Centre



Milan
Duomo



Milan
Carrobbio



Rome
EUR



Naples
Garibaldi

Offices



City

City centres
Signature buildings
Business parks
Key office centres



Community

Small town
Local
Community integrated

Third places



Airports



Rail station



Service Station



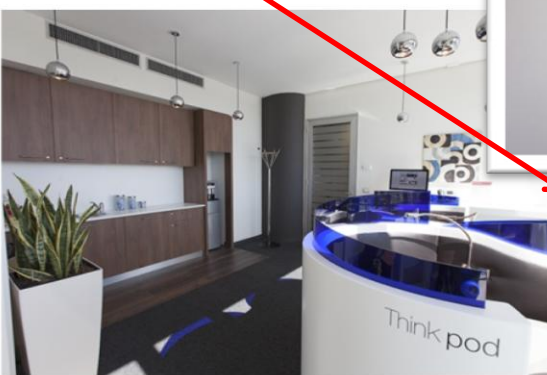
Retail centres



HSR and temporary offices location choice

Regus offices inside the
HSR station of Naples
since Sep 2013

6th FLOOR



HSR and temporary offices location choice

	%
Regus offices were chosen in Naples because they were inside the HSR station	37
HSR was chosen because the Regus services were cheaper	3
HSR was chosen because of the provided services	12
Regus offices were chosen because of the provided services	49

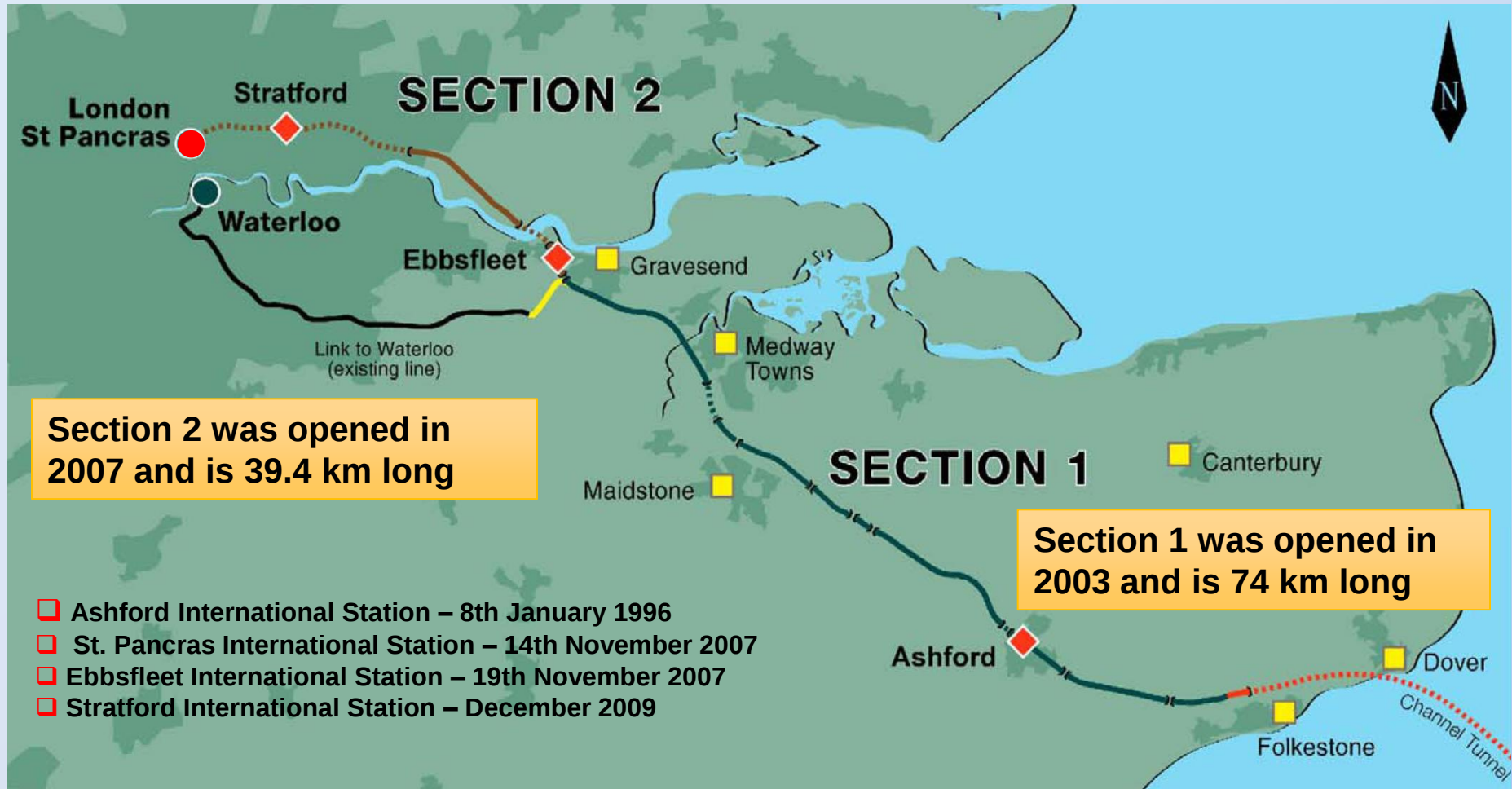
❑ **37% of the clients** have chosen **temporary offices** because of their location **being inside the HSR station**, being also served by metro lines.

❑ **Surprisingly**: these services have been also used by **workers with low monthly income**.

❑ **Temporary offices** inside the HSR station are rented also by **local workers** and not only by mobile workers choosing HSR.

PROPOSE MODELS TESTING THE IMPACT OF HSR ON TEMPORARY OFFICES LOCATION CHOICE – NO CONTRIBUTION IN THE CURRENT LITERATURE

HIGH SPEED ONE IN UK



**St Pancras International
HSR Station in Camdem
Inaugurated in 2007**

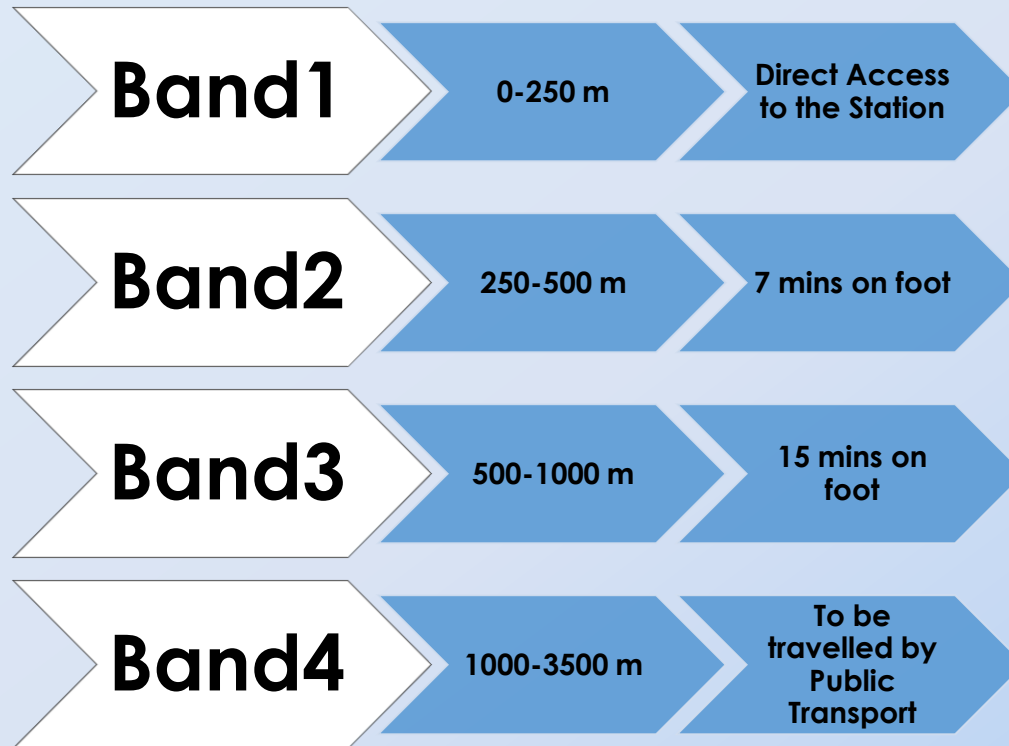


HSR and land market

**Stratford International
HSR Station in Newham
Inaugurated in 2009**



HSR and land market



Within Band1 and Band2 (**catchment area**), properties located within walking distance from the station **benefited from the improved accessibility** w.r.t. properties located 1000 m far from the station.

HSR and land market

Hedonic pricing method (Rosen, 1974): $P = \beta X + \varepsilon$

Dependent Variable	Property price	Hundreds of thousands £
Independet Variables		
Temporal	Sold year	Twelve dummy variables
Structural	Detached SemiDetached Terraced Flat NewHouse	Dummy variables
Zone	CarPark <i>Car Park presence</i> ResidentialRoad <i>House placed in a residential road</i>	Dummy variables
Accessibility	DistTube <i>Distance from nearest Tube Station [km]</i> DistMotWay <i>Distance from Motorway access [km]</i> TrainFreq <i>Train frequency in the nearest Tube Station [tr/hr]</i>	Space variables
Image	Band1YesHs Band2NoHs Band3NoHs DisturbArea <i>Image gain or loss of a property</i>	Dummy variables

HSR and land market

Stratford International	SemiLog Model		SemiLog Model		Log Model		Box-Cox LHS Model		Box-Cox BHS Model	
	β	t-student	β	t-student	β	t-student	β	t-student	β	t-student
Costante	.293	4.991	1.680	14.036	.182	5.635	.272	6.365	.288	5.426
Year2	.266	13.117	.337	8.142	.266	13.077	.290	10.773	.282	11.487
Year3	.509	24.751	.668	15.930	.508	24.680	.566	20.712	.547	21.967
Year4	.669	31.453	.947	21.843	.668	31.404	.769	27.250	.736	28.587
Year5	.657	29.796	.921	20.499	.656	29.764	.753	25.732	.721	27.015
Year6	.760	34.108	1.102	24.284	.759	34.064	.884	29.903	.843	31.261
Year7	.825	39.101	1.248	29.042	.824	39.035	.976	34.888	.926	36.271
Year8	.922	45.417	1.492	36.078	.920	45.324	1.122	41.675	1.055	42.951
Year9	.717	29.818	1.093	22.299	.717	29.800	.850	26.621	.805	27.646
Year10	.781	32.914	1.220	25.223	.782	32.926	.936	29.740	.883	30.762
Year11	.770	40.182	1.179	30.183	.773	40.237	.920	36.111	.868	37.411
Year12	.803	32.285	1.249	24.639	.807	32.344	.966	29.206	.909	30.179
Flat	-.287	-29.713	-.502	-25.532	-.285	-29.596	-.361	-28.252	-.337	-28.852
CarPark	.030	2.399	.087	3.365	.028	2.228	.047	2.792	.042	2.750
ResidentialRoad	.030	2.743	.039	1.750	.027	2.484	.030	2.080	.032	2.384
DistTube	-.035	-3.189	-.056	-2.546	-.047	-3.153	-.054	-2.756	-.091	-5.139
DistMotWay	-.143	-5.030	-.293	-5.061	-.017	-4.886	-.023	-5.059	-.044	-2.942
DisturbArea	-.032	-2.549	-.072	-2.816	-.029	-2.330	-.040	-2.417	-.039	-2.554
Band1YesHs	.232	6.973	.419	6.189	.249	8.028	.321	7.797	.287	7.418
Band2NoHs	.234	13.736	.430	12.415	.232	13.756	.304	13.578	.281	13.633
Band3NoHs	.193	12.617	.313	10.062	.189	12.403	.233	11.550	.222	12.006
λ							0.451		0.316	
R ² Adj.	.581		.478		.581		.545		.558	

HSR and land market

St Pancras International	SemiLog Model		SemiLog Model		Log Model		Box-Cox LHS Model		Box-Cox BHS Model	
	β	t-student	β	t-student	β	t-student	β	t-student	β	t-student
Costante	0.725	8.847	1.705	5.009	0.623	7.624	0.562	9.34	0.652	5.337
Year2	0.127	3.93	0.283	2.092	0.127	3.898	0.105	4.387	0.16	3.307
Year3	0.171	5.22	0.404	2.942	0.168	5.095	0.136	5.589	0.221	4.5
Year4	0.247	7.673	0.667	4.97	0.24	7.441	0.187	7.884	0.33	6.876
Year5	0.3	9.473	0.751	5.688	0.291	9.187	0.229	9.821	0.394	8.34
Year6	0.396	12.586	0.991	7.55	0.389	12.344	0.305	13.158	0.524	11.165
Year7	0.59	18.14	1.626	12.038	0.573	17.681	0.438	18.34	0.802	16.57
Year8	0.573	15.885	1.604	10.674	0.56	15.515	0.428	16.106	0.782	14.536
Year9	0.542	13.888	1.674	10.289	0.531	13.589	0.396	13.77	0.761	13.082
Year10	0.658	21.076	2.042	15.672	0.652	20.832	0.486	21.089	0.93	19.967
Year11	0.677	21.491	2.109	16.044	0.671	21.256	0.5	21.539	0.956	20.353
Year12	0.773	13.442	2.879	11.993	0.766	13.286	0.556	13.118	1.137	13.254
Flat	-0.185	-2.464	-0.32	-1.021	-0.186	-2.476	-0.146	-2.643	-0.238	-2.127
CarPark	0.121	4.801	0.393	3.725	0.122	4.811	0.092	4.915	0.172	4.562
ResidentialRoad	0.104	6.437	0.264	3.901	0.106	6.5	0.08	6.72	0.143	5.909
DistTube	-0.164	-4.621	-0.073	-1.171	-0.033	-2.18	-0.026	-2.345	-0.099	-3.166
Band1YesHs	0.498	7.112	2.807	9.321	0.521	7.211	0.323	6.061	0.87	8.198
Band2NoHs	-0.167	-5.111	-0.524	-3.85	-0.153	-4.684	-0.107	-4.461	-0.238	-4.885
Band3NoHs	-0.229	-8.516	-0.686	-6.092	-0.217	-8.024	-0.158	-7.924	-0.322	-8.025
λ							-0.302		0.334	
R ² Adj.	0.51		0.501		0.507		0.477		0.527	

FEW CONTRIBUTIONS ON HSR IMPACTS ON THE LAND MARKET

DISTINCTION BETWEEN SOCIAL EXCLUSION AND POVERTY

□ According to **Silver (1994)** **social exclusion** is “A multidimensional process of progressive social rupture, detaching groups and individuals from social relations and institutions and preventing them from full participation in the normal, normatively prescribed activities of the society in which they live.”

□ **According to the UN (1996) poverty is** “A condition characterised by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information”.

Low income categories are not necessarily experiencing social exclusion.

SOCIAL EXCLUSION AND TRANSPORT: WHAT IS THE RELATIONSHIP?

“The process by which people are prevented from participating in the economic, political and social life of the community because of **reduced accessibility to opportunities**, services and social networks, due in whole or part to insufficient mobility in a society and environment built around the assumption of high mobility”.

(Kenyon et al., 2003)

HSR and equity issues

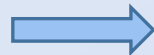
The seven social exclusion factors related to transport (Church *et al.*, 2000)

Physical



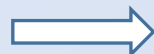
Physical nature of the transport system can create physical and psychological obstructions for people with restricted mobility.

Geographical



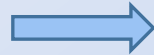
Places geographically far from the transport infrastructures may limit people in doing activities in the immediate proximities.

From services



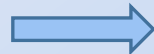
The increasing diffusion of shops and centralised services may result inaccessible if not served by infrastructures and services of public transport.

Economic



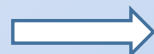
Costs of travelling can limit chances in making a transport mode choice than who has better economic possibilities to travel.

Time-based



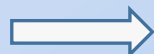
The departure/arrival times do not match those desired by the users.

Based on fear



Some people may be worried and feel in danger travelling in public spaces.

Based on Space Management



Some strategies for security and management of spaces in stations dissuade social-excluded people in using public transport.

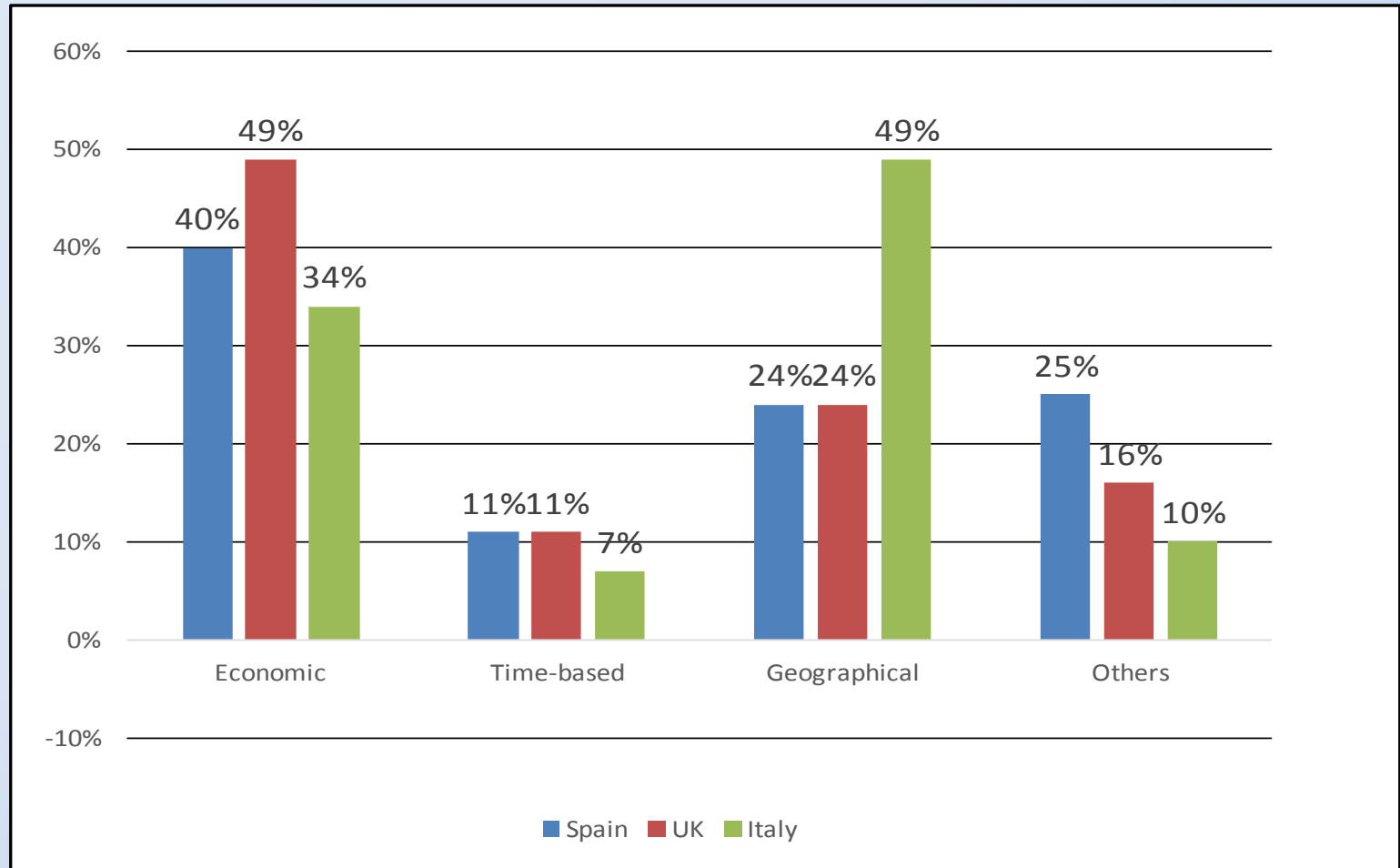
HSR and equity issues

Spain – UK – Italy: Economic, Time-based and Geographical exclusion



HSR and equity issues

Spain – UK – Italy: Economic, Time-based and Geographical exclusion



There is still a lot to do

HSR and equity issues



The image shows a screenshot of the Elsevier website. At the top, there is a search bar and a menu icon. Below the navigation bar, the breadcrumb trail reads: HOME > JOURNALS > TRANSPORTATION RESEARCH PART A: POLICY AND PRACTICE > CALL FOR PAPERS. The main heading for the special issue is "CALL FOR PAPER FOR THE SPECIAL ISSUE: HIGH SPEED RAIL INVESTMENTS AND EQUITY ISSUES". On the left side, there is a vertical menu with blue buttons: "SUBMIT YOUR PAPER", "SUPPORTS OPEN ACCESS", "VIEW ARTICLES", "GUIDE FOR AUTHORS" (with a dropdown arrow), and "ABSTRACTING/ INDEXING". The main content area features the title "Call for paper for the special issue: HIGH SPEED RAIL INVESTMENTS AND EQUITY ISSUES" in large, bold, black letters. Below the title, a paragraph of text begins: "Social equity is a concept that has become relevant in transport policy in recent years. In countries, such as UK, significant contributions have been made recognizing the important role of transport and social equity." On the right side of the banner, there is a vertical orange button labeled "Feedback".

- ☐ Before investing large amounts of money in a new HSR infrastructure, decision-makers should wonder: who will be the users of this new service?
- ☐ Is HSR a priori excluding some socioeconomic categories (such as low-income people, immigrants, women, etc.)?
- ☐ Analysis of the socioeconomic profile of HSR users.
- ☐ Factors excluding non-HSR users from choosing HSR as an alternative transport mode.
- ☐ Are destinations not served by HSR excluded from a possible development of tourism and other growth factors?
- ☐ Can the introduction of more than one railway company competing on the same HSR network (such as Trenitalia and NTV in Italy) solve the question of social equity?
- ☐ Policies to make HSR available to all socioeconomic users (e.g. new investments in low-cost HSR systems, such as Ouigo).