

THE NEW HIGH SPEED SERVICES IN ITALY: EXPECTED DEMAND EFFECTS

Ennio Cascetta

Department of Transportation Engineering
University of Naples Federico II
enniocascetta@gmail.com

Andrea Papola

Department of Transportation Engineering
University of Naples Federico II
papola@unina.it



Nuova stazione AV Napoli Afragola
Vista ingresso stazione lato Nord Est Rendering
Progetto ZAHA HAD D ARCHITECT

1. High Speed Railways in Italy

High Speed Railways in Italy

- *Operating and work-in-progress HSR lines:*
 - *lengths and travel times*

High Speed Railways

1.355 km

Total National Railways Network

24.179 km



High Speed Railways in Italy

Current Scenario

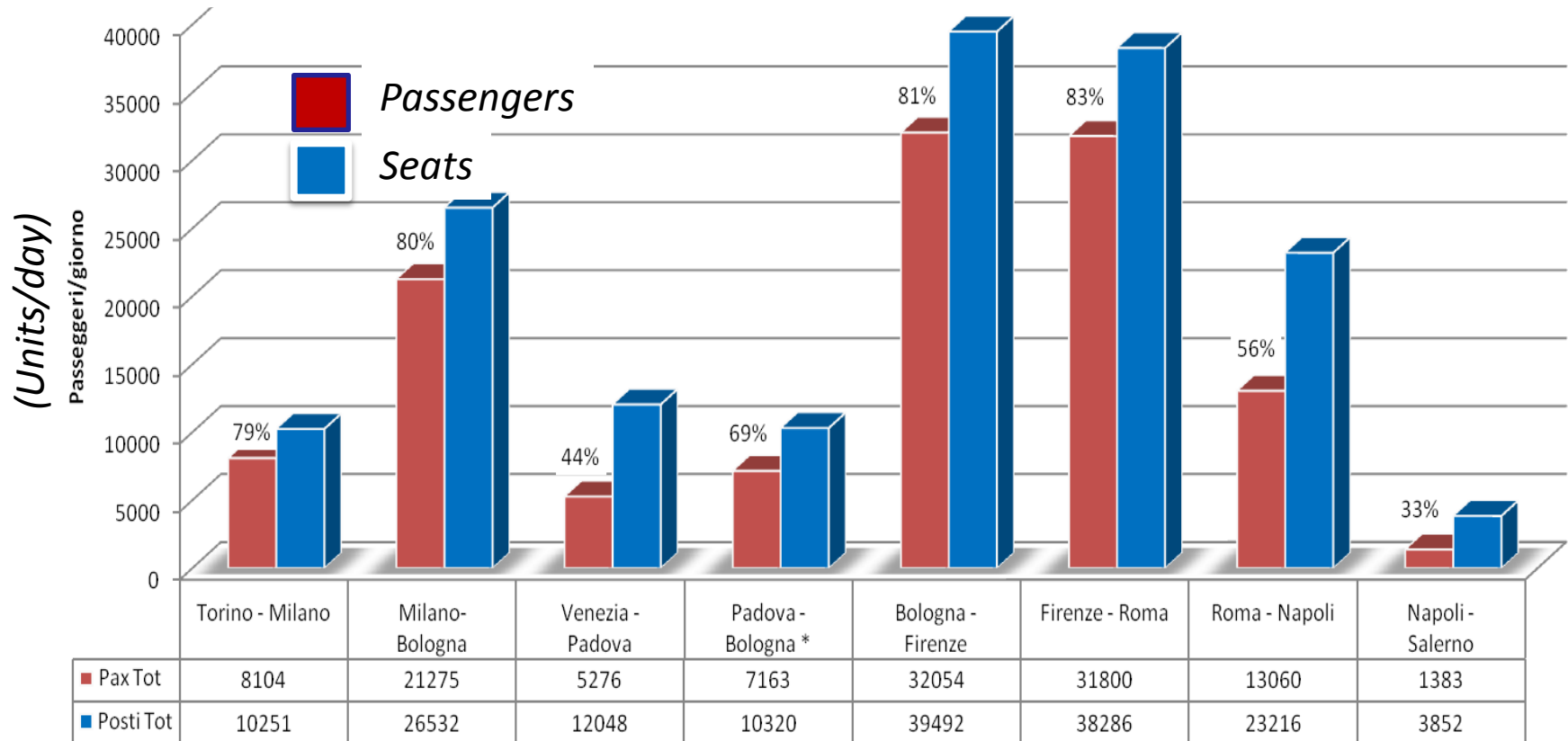
The study area : the catchment area of the stations of the Italian High Speed network

Modal shares in the study area

	Inter-province trips (%)
Auto	66.5
Air	4.3
Intercity Railways	9.2
High Speed Railways	20.0
	100,0%



HSR demand vs. supply by OD pair (avg. working day)



Data not including Roma-Milano direct service (Fast)

A growing market...

completion of the HSR link Bologna-Firenze and Torino-Milano, and completion of the HSR urban penetration in Naples (Dec, 2009)

	train-km/year	seats-km/year	Pax Km/year*
2009	$19\,624 \times 10^3$	$12\,750 \times 10^6$	
2010	$27\,327 \times 10^3$	$15\,029 \times 10^6$	
$\Delta\%$	39.25%	17.87%	45.3 %



**estimates from two surveys carried on in May 2009 and May 2010*

HSR operators

TRENITALIA

Italian National Operator (incumbent)

NTV

expected entry time 2011

	#runs	TrainKm	SeatKm (mil.)	Avg. Distance per train	Avg. TrainCapacity
Trenitalia	111	64.953	40	585	620
NTV	54	36.597	18	678	500

NTV partner	Holdings	Shareholders of NTV partner
Totale MDP Holding	33,5%	Della Valle - Montezemolo - Punzo (equal holding)
IMI Investimenti	20,0%	Intesa SanPaolo
VFE-P SA	20,0%	SNCF
Generali Financial Holdings FCP-FIS	15,0%	Generali
Nuova Fourb	5,0%	Bombassei
MaIS Spa	5,0%	Seragnoli
Reset 2000	1,5%	Sciarrone
Total	100,00%	

2. The HS/HC rail link Roma-Napoli: empirical evidences

The HS/HC rail system in Italy: the link Roma-Napoli



- HS line completed in 2006
- HS line completed in 2009
- RFI network

Metropolitan area of Roma: n. inh.: 4,145,822
Res. Dens.: 473,19 inh./km²

Metropolitan area of Napoli: n. inh.: 3,582,900
Res. Dens.: 1900,27 inh./km²

In March 2008 an RP survey was employed on the link Roma-Napoli and vice versa.

The reference universe is made up of all the users who travel on the link under study with HS trains, but also with alternative modes/services which have been identified in:

- ☐ Highspeed trains (HS)
- ☐ Eurostar trains (ES)
- ☐ Intercity trains (IC) and
- ☐ Car on the highway

The universe is assumed to be diverse for the weekday and for the Saturday and Sunday, therefore three different demand scenarios have been considered.

The sample is made up:

For the weekday:

1200 users on HS/ES trains (Universe: 5626 users)

700 users on IC trains (Universe: 2384 users)

700 users close to the service stations on the highway (Universe: 7882 users)

For the Saturday:

500 users on HS/ES trains (Universe: 2994 users)

350 users on IC trains (Universe: 2695 users)

350 users close to the service stations on the highway (Universe: 7813 users)

For the Sunday:

500 users on HS/ES trains (Universe: 2668 users)

350 users on IC trains (Universe: 3227 users)

350 users close to the service stations on the highway (Universe: 10433 users)

Demand on HS trains

Demand on HS trains	HS					
	Weekday		Saturday		Sunday	
	N. Users	%	N. Users	%	N. Users	%
Demand generated by new trips	568	12,5	274	13,6	164	8,8
Demand generated by an increase of trip frequency	44	9,8	165	8,2	180	9,6
Demand taken away from car	355	7,8	250	12,4	269	14,4
Demand taken away from plane+bus	28	0,6	27	1,3	25	1,3
Demand taken away from IC+ES	3144	69,2	1300	64,5	1233	65,9
TOTAL	4539	100	2016	100	1871	100

Reason for choosing HS

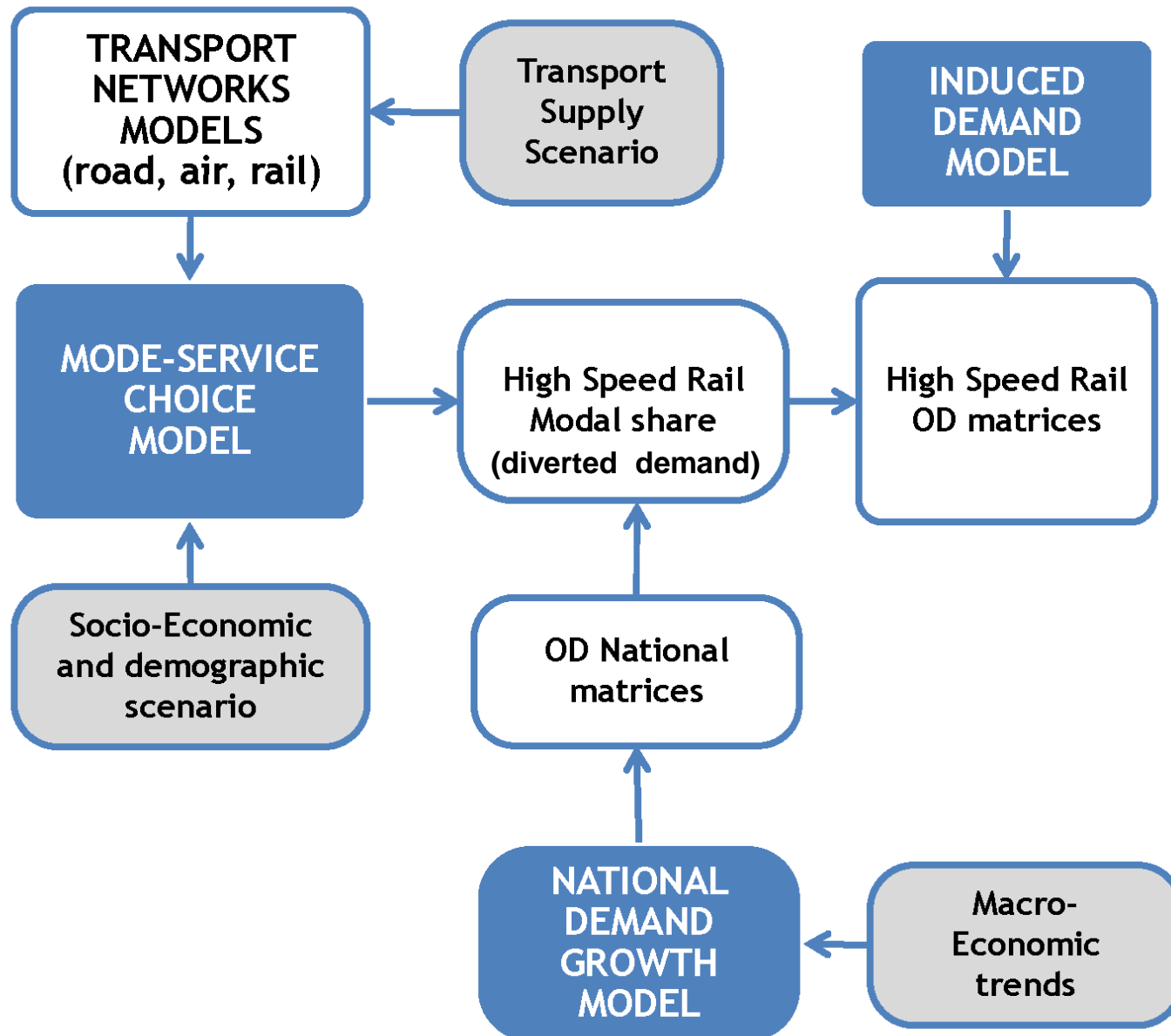
Main reason for choosing HS	WEEKDAY		SATURDAY		SUNDAY		AVERAGE
	N. USERS	%	N. USERS	%	N. USERS	%	%
Less travel time	3302,794	72,8	1222,956	60,7	1143,232	61,1	71,163
Respect of departure and arrival times	307,399	6,8	233,258	11,6	112,813	6,0	7,059
More on board services	8,805	0,2	26,964	1,3	13,293	0,7	0,307
More comfort	213,004	4,7	125,311	6,2	208,056	11,1	5,216
Agreement with the users' travel times	696,275	15,3	396,190	19,7	385,521	20,6	15,983
Get off/get on at Mergellina/Campi Flegrei stations (users ES)	10,722	0,2	7,547	0,4	0,000	-	0,231
Less risky, safer than car	-	-	3,773	0,2	8,085	0,4	-
To try	-	-	-	-	-	-	-
TOTAL	4539	100	2016	100	1871	100	100

Trip purpose before and after HS

Trip purpose	BEFORE HS		AFTER HS		
	IC	ES	IC	ES	HS
Work	67,0	51,4	39,8	56,2	71,8
Study	6,6	4,9	10,2	7,2	4,8
Shopping	-	7,8	5,1	4,8	2,7
Visiting parents/friends	18,8	16,1	26,0	21,1	11,6
Tourism	-	16,8	10,2	5,9	4,8
Other	7,6	3	8,7	4,9	4,2
TOTAL	100	100	100	100	100

3. HSR traffic forecasting models system

HSR traffic forecasting models system



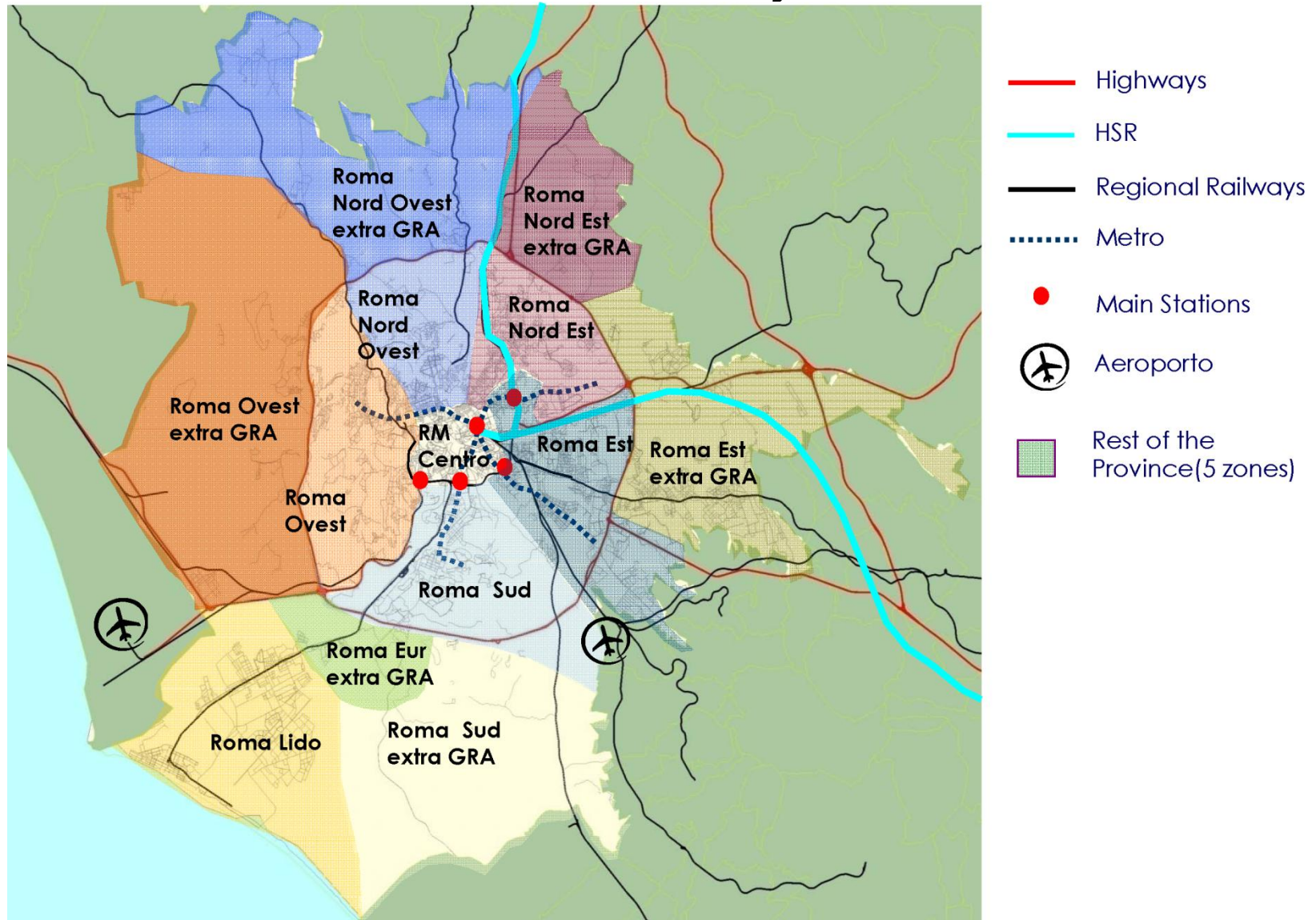
Supply models

220 zones:

- each Province in the catchment area split into two zones (i.e. the main city and the rest of the province)
- the regions Abruzzo, Molise, Trentino-Alto Adige and Valle d'Aosta → one zone
- the main Italian cities (Rome, Milan, Naples, Turin, Florence, Bologna) cities split into multiple zones



Supply models *the 13 zones of the city of Rome*



Supply models

the road graph



the railways graph



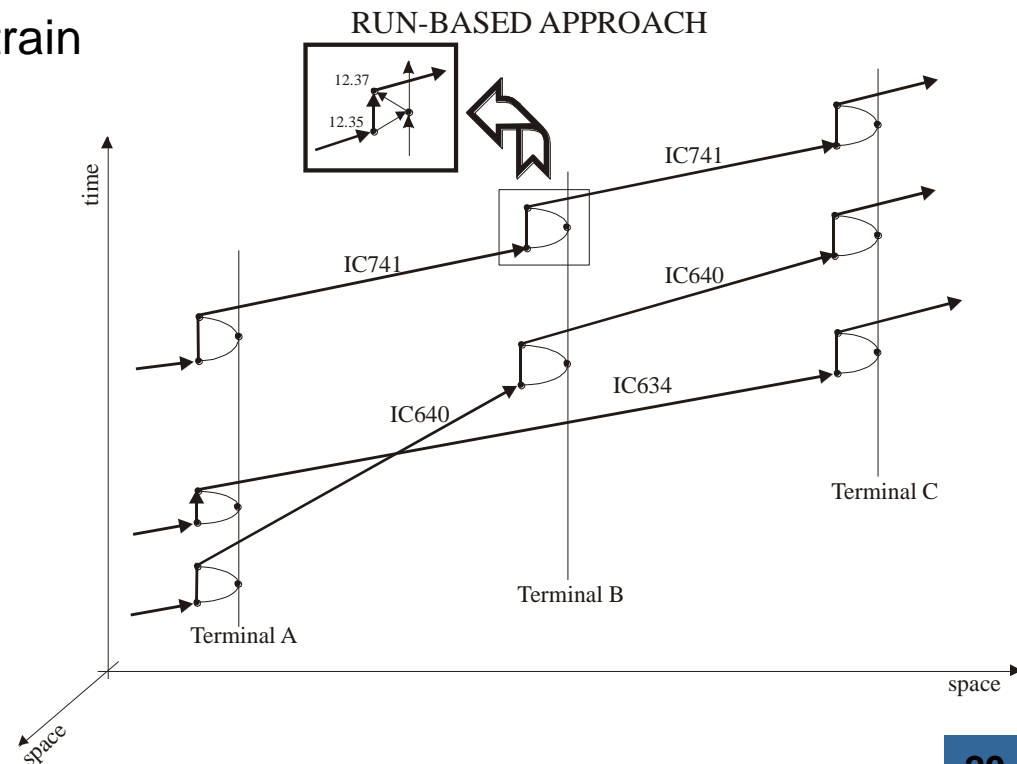
Supply models

The services simulated using a diachronic network includes:

- 500 **daily domestic flights** between major Italian airports
- the following **railway services**:
 - 111 High-Speed and Eurostar trains;
 - 232 intercity trains;
 - 4.466 interregional and regional train

The **diachronic network** consists of:

- 126.526 nodes
- 329.657 links



The demand growth model

- The model estimates the evolution of traffic volume based on the Gross Domestic Product (GDP) and the oil price evolution between two successive years
- The model has been estimated using 1980-2007 series pax-Km's
28 observations in total ;
8 observations with GDP yearly-variation less than 1%
- The model derives elasticity's of demand with respect to GDP growth for periods of increasing economy and for periods of recession

The demand growth model

$$\frac{\Delta[HwT_t]}{HwT_{t-1}} = \alpha + \beta^+ \cdot (1 - \delta_t) \cdot \frac{\Delta[GDP_t]}{GDP_{t-1}} + \beta^- \cdot \delta_t \cdot \frac{\Delta[GDP_t]}{GDP_{t-1}} + \gamma \cdot \frac{\Delta[Fuel_price_t]}{Fuel_price_{t-1}}$$

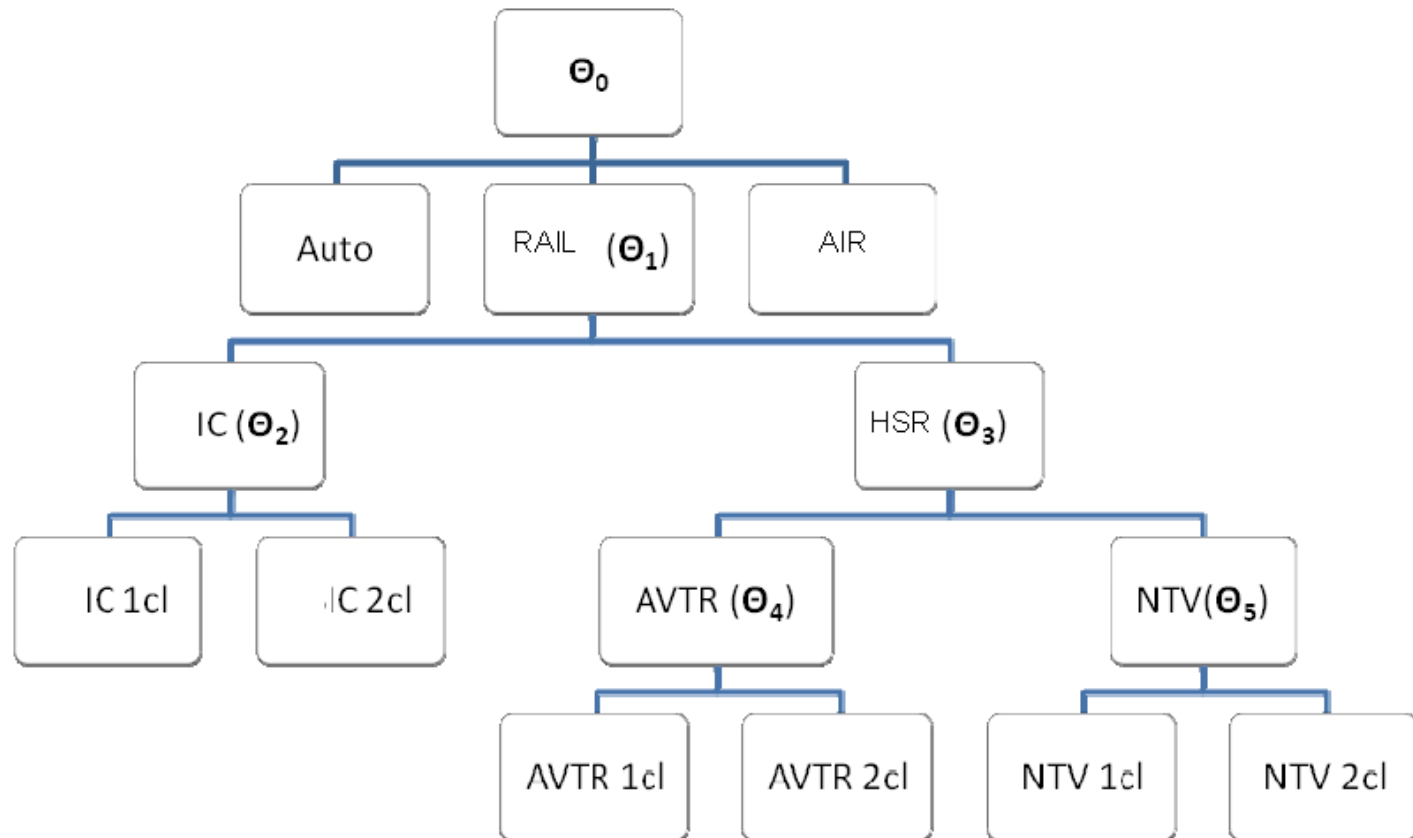
$$\delta_t = \begin{cases} 1 & \text{if } \frac{\Delta[GDP_t]}{GDP_{t-1}} < 0,01 \\ 0 & \text{otherwise} \end{cases}$$

	alpha	beta +	beta -	gamma
<i>estimates</i>	0,001	1,186	0,602	-0,157
<i>T_ratio's</i>	0,085	4,568	1,554	-2,517

- the multiplier of the GDP evolution has two values: a low value if the growth is below 1% and a high value if GDP growth is greater than 1%
- demand volume resulted to be less sensitive to GDP in period of recession than in period of growth

The mode-service choice model

Nested logit models with a nesting structure to capture higher degrees of substitutions among specific subsets of modal alternatives, particularly the HSR alternatives provided on the same route by different operators, NTV vs. HighSpeed Trenitalia (AVTR).



The mode-service choice model

The mode-service choice model has been estimated, through max-Likelihood methods, using mixed RP-SP data:

- RP survey → 3500 interviews gathered from a national panel
- SP survey → 600 interviews with 8 games per respondent to test:
 - “Brand” effect
 - introduction of additional services
 - *on board* (e.g. internet connection)
 - *at the station* (e.g. dedicated waiting hall)
 - L.o.S. attributes

*Focus on LOS
attributes parameter
estimates*

(“Business” purpose)

Coefficients	RP	SP	RP/SP
acc/egr time (min)	-0,00433	-0,0114	-0,0109
	(-1)	(-8,99)	(-9,19)
Travel time (min)	-0,0107	-0,0109	-0,00906
	(-5,16)	(-10,7)	(-10,84)
Air /train Cost (€)	-0,0115	-0,0113	-0,011
	(-3,52)	(-8,71)	(-9,26)
Auto cost (travelling alone) (€)	-0,00777	-0,0206	-0,0191
	(-1,49)	(-7,5)	(-8,22)
auto cost (travelling in gorup) (€)	-0,00693	-0,00965	-0,0103
	(-1,14)	(-3,74)	(-4,52)
Headway (min)	-0,000626	-0,00135	-0,00153
	(-1,23)	(-3)	(-4,81)
...	...		
β_{tv} / β_{cv} (€/h)	55,83	57,88	49,42
$\beta_{tv} / \beta_{cv_auto}$ (€/h)	82,63	67,77	52,78

Model elasticity's

- *Direct (arc) elasticity w.r.t HSR cost*

	HSR cost -10%	HSR cost +10%
HSR demand 1 st class	-0.49	-0.41
HSR demand 2 nd class	-0.34	-0.38

- *Cross (arc) elasticity w.r.t travel time by car*

	CAR TRAVEL TIME -5%	CAR TRAVEL TIME +5%
HSR demand 1 st class	-0.55	-0.51
HSR demand 2 nd class	-0.48	-0.45

The induced demand model

- The induced demand model is based on a relationship between existing HSR demand (dependent variable) to existing HSR travel times and costs.
- The attributes include socioeconomic variables related to population and employment in the zones connected by the HSR services.
- This model was calibrated by mean of a before and after study carried on travel in the Naples-Rome corridor, when the new HSR services was introduced (2005)

The induced demand model

$$d_{OD}^{HSR} = Population_o^{\beta_1} \cdot Workers_d^{\beta_2} \cdot \exp \left[\alpha + \beta_3 \cdot timeHSR_{od} + \beta_3 \cdot costHSR_{od} + \beta_9 \cdot Direct_HSR_service_{od} + \beta_{11} \cdot OandD_capProv_{od} \right]$$

	Parametri	t_student
Population	0,342	3,58
Workers	0,341	2,89
Constant	-4,554	-2,7
time HSR (h)	-0,228	-1,86
Cost HSR (€)	-0,020	-3,00
Direct HSR service	2.644	7,69
O and D_Cap prov	0,424	1,78

Some application and validation results: models estimates vs. traffic counts

- Roma-Napoli HSR link**
- Italian HSR network**

The scenario

- completion of the HSR link Bologna-Firenze
- completion of the HSR link Torino-Milano,
- completion of the HSR urban penetration in Naples (Dec, 2009)



- **Travel time before HSR / after HSR (few examples):**

Napoli – Roma : 1 h 27 min → 1 h 10 min

Bologna – Firenze: 1 hour 10 min → 37 min

Roma – Milano: 4,5 hours → 3,5 hours (3 hours with the direct service)

Napoli – Milano: 6 hours → 5 hours (4,5 hours with the direct service)

- **HSR ticket prices before HSR / after HSR (few examples):**

Napoli – Roma :

40 euro → 44 euro 2nd class

52 euro → 57 euro 1st class

Roma-Napoli HSR link

	observed data
oct-2009 (base year)	372
oct-2010	642
Passenger*km*10 ⁶	

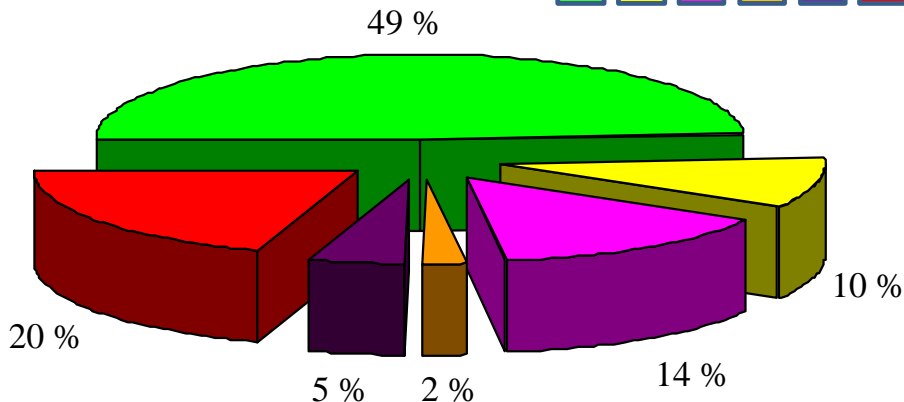
Application: modal shares forecasting between two cities at about 600 Km distance (*city center to city center* OD trips)

Base scenario

Existing modal alternatives

- Air
- HSR 1st and 2nd class (existing frequency 2 trains/hour)
- Intercity 1st and 2nd class
- Auto

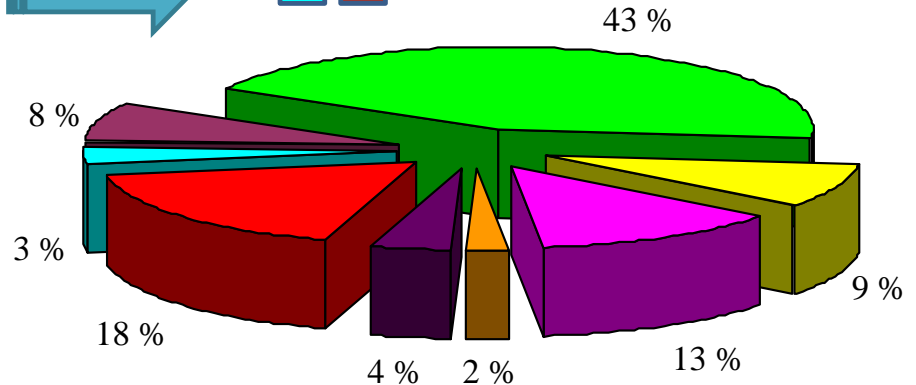
Air
HSR 1st
HSR 2nd
IC 1st
IC 2nd
Auto



Simulated scenario

➔ Entry of a new operator with a *Frequency increases 1 train/h*

New HSR 1st
New HSR 2nd



Italian HSR network

	observed data	model estimates
oct-2009 (base year)	6.700	6.700
	<i>induced demand</i> *	600
	<i>diverted from other modes</i>	900
oct-2010	9.700	total demand 8.200
		Trenitalia 7.200
		NTV 3.500
gen-13		10.700

* *only OD pairs < 250 Km*

CONCLUSIONS

Preliminary application has shown that :

- HSR market is increasing much more than prevision
- High V.T.T.S. time in spite of crisis
- The induced demand is probably the key point for understanding HSR market evolution rather than diverted demand and...
- it seems highly non linear w.r.t. reduction in travel time especially for close OD pairs
- is very difficult to be estimated and often underestimated
- and impacts on relocation of residence and worker activities is probably just begun