Introduction: the Italian High Speed project

History of projects

The Italian High Speed Railway (in Italian “Alta Velocità”) was conceived in 1990 as a new system, substantially independent from the rest of the network, to provide fast links among the cities of Turin, Milan, Bologna, Florence, Rome and Naples (RFI 2007), along the “backbone” line of the country. Soon, the former model inspired to the well known French system, turned into something different, namely a new high performance doubling of the existing network, but completely integrated with it through numerous interconnections and despite the different voltage. In 1996, according to this new vision, the name of the planned system was changed into AV/AC (acronym of High Speed/High Capacity, in Italian “Alta Velocità/Alta Capacità”). It conceived the new lines as high capacity fast doublings, capable to host heavy freight trains thanks to low slopes, together with high speed passengers trains. This radical change was officially inspired by environmentalist stakeholders, aiming at making the rail mode attractive also to freight, thanks to higher speed and performance, and thus helping modal shift.

Works of the first phase lasted more than a decade and were recently completed in the main parts. To date, the Italian high speed network is made of the sections listed in Table 1 and represented in Figure 1. The full Turin – Salerno axis, excluding only Florence and Bologna urban sections, has been completed on December 2009. Table 1 clearly points out one of the main differences in the current network, homogeneous only in appearance. The Florence – Rome line is much older and was essentially a fast doubling of a conventional line, still using the normal Italian voltage of 3kV DC. The rest of the line Turin – Naples is the core of the project conceived in the Nineties and is the core of the project conceived in the Nineties and...
adopts the French standards of 25kV AC. It requires specific high speed rolling stock. The two end sections of the Milan – Venice line, not yet existing as a whole, adopt the same 3 kV DC standard and must be seen again as a fast doubling due to capacity reasons, not used by high speed trains only. Finally, the Verona – Bologna line must be mentioned. It was doubled and upgraded in the same period and opened in 2009 as an high performance traditional line and is currently used by the High Speed services to Rome by multi-power fast trains.

Currently, high speed programmes count numerous new lines to be built (see Figure 1). The main one will connect Milan to Venice, linking numerous mid-sized cities at short distance. Other lines will connect Milan to Genoa, Naples to Bari and Naples to southern regions. However, the largest and most expensive projects underway aim at connecting Italy to neighbour countries through the Alps: the Frejus line (Turin – Lyon), the Brenner line (Verona – Munich), the Trieste – Divaca line. Not all the mentioned projects are already fully defined and financed.

In the period between the first projects and now, the functional model changed again. While all new lines, except the Brenner, were originally presented as High Speed lines, the lack of significant passenger traffic turned them to high capacity lines, supposed to host both heavy freight trains and fast passengers trains. This is particularly true for the expensive Alpine crossings. Finally, during 2011, the
The governance and the regulatory context of Italian railways

Italian railways apply the European directives concerning unbundling of network and services. Both the service branch Trenitalia and the infrastructure branch RFI are owned by the same public holding, Ferrovie dello Stato. Looking at the network, it remains an unregulated legal monopoly, as the whole national network, including the new High Speed lines, has been directly franchised (that is, without competitive tendering) as a legal monopoly to RFI – Rete Ferroviaria Italiana, the network manager of the State-owned holding FS, for 60 years since 2001. Such natural monopoly is not subject to any regulatory mechanism concerning efficiency: the subsidies and the investments are ruled by a Programme Contract; tolls are decided by the Ministry of Transport, but using only the relevant information and the costs of RFI itself.

Looking at passengers services, Trenitalia remains by far the dominant operator. In 2003 Italy implemented the European Directives on rail competition (2001/12/CE, 2001/13/CE and 2001/14/CE) into the Decreto Legislativo n. 188.
of 8 July 2003. It states that long distance passenger services ought to be opened to competition in the market. As a result, two newcomers (Arenaways and NTV) rose to compete with Trenitalia. The first started operating on the Milan Turin, but already closed due to normative barriers imposed. The latter is expected to start on high speed services. A regulatory body for services only has been created recently (2009) inside the Ministry of Transport, with the name of Ufficio per la regolazione dei servizi ferroviari (URSF).

The relative openness of the 2003 decree (in particular, the easiness to obtain the licence and the slots. Beria et al. (2010) is perceived as a threat by the incumbent that actually succeeded in partially blocking the competition by means of rising more restrictive entrance barriers or by the increase in the costs of the network. In particular, the 2012 Financial Law requires high speed users, including the newcomers, to pay an extra train access charge to cross finance social services.

The regulation of investments

In the initial intentions of the Nineties, the new HS line should have been built through Project Financing by a new mixed society, called TAV SpA, with a 60% of private capital to be completely repaid. However in 1998 the State had already to buy back the whole shares of TAV, due to the unavailability of private shareholders to provide entitled capitals (RFI 2007). The process of re-nationalisation of TAV SpA lasted from 2000 to 2007 and ended with the coverage of 13 billion Euros of debt by the State balance (Beria and Ponti 2009). Today TAV SpA is no more operative as a project financing subject.

In the meantime, the costs of the Turin – Salerno axis rose from expected 10.7 billion € in 1992 to actual 32.0 billion € in 2006, meaning a doubling of costs in real terms (RFI 2007). Moreover the lines cost reached, on average, 32 M€/km, compared to 10 M€/km in France and 9 M€/km in Spain. This extraordinarily high costs have been analysed in the costs of the network. In particular, the 2012 Financial Law requires high speed users, including the newcomers, to pay an extra train access charge to cross finance social services.

Ex-post analysis of the existing Turin – Salerno line

In this section we carry out an early ex-post evaluation of the existing high speed network in Italy, one year and a half after the full start of the new services on December 2009, progressively activated since 2006. We evaluate the sections of the line through a standard and simplified cost-benefit benchmark, as suggested by de Rus and Nombela (2007) and de Rus and Nash (2007), presented in the following.

As studies on traffic elasticity suggest (for example, Litman 2010), demand usually needs at least five years in order to fully respond to reductions in travel time. So, a comprehensive and robust enough ex-post evaluation should be done only after such a time. However, the number of frequencies supplied on the lines looks now quite stable after the first years of operations and we think that it is already possible to draw some early considerations and to learn some lessons, in order to improve the planning of new lines.

A review of the (few) data available

Only a few data are nowadays available on High Speed demand in Italy. This fact is understandable from the viewpoint of the railway undertaking Trenitalia, this being a commercially sensitive information and considering that new operators are willing to enter the market in the near future. However, it seems that more transparency from the public side on the basic data and outcomes of one of the largest public works undertaken in the last decade, would benefit the public debate especially about planning new lines. To make a comparison, full data on air routes
Passengers and frequencies are publicly available (in ENAC 2010), despite the higher level of competition present in air sector. The data available specifically on HS lines is of two types: the timetable and some press releases with extremely aggregate data on ridership and average load factors. Ferrovie dello Stato declared that about 20 million tickets were sold in 2010 for high speed services (FS 2010), that is all Frecciarossa and Frecciargento trains (those in Figure 2). No information about average travel distance is available. In addition, some national newspapers reported that about 3 million passengers travelled6 the direct Milan – Rome relation in 2010 (ItaliaOggi 2010), that is not counting passengers starting or ending trips in the intermediate stops of Bologna and Florence. A recent paper (Cascetta et al. 2011) gives very disaggregated data about the Rome – Naples link, reporting 1.4 million passengers. Such data refers however to 2007: high speed services started on line in 2006, but the new infrastructure was not completed with final urban penetrations up to 2009, so time savings were still limited (1h27 vs. 1h10 today) and present ridership should be increased. Finally, other non official estimates report a traffic of 1.5 million passengers travelling on the Turin – Milan link, out of which 1.0 million travelling to Milan and 0.5 million continuing to other destinations southward. Further data on traffic is available on Trenitalia balance sheets, but they never refer to HS lines/services only and include the whole long distance branch.

On the basis of this very limited information we try to distribute total declared demand on the network, using a very simple gravitational model, with the typical form in Equation (1). It must be noticed that the model has no statistical significance, but more consistent simulations are impossible due to the lack of sufficient observations to calibrate the model. For this reason, the model will not be used for predictions, but only to distribute the declared total 2010 passengers. To cope with such limitedness, we will accompany the following CBA results with sensitivity analysis.

The model considers an Origin-Destination matrix of $n \times n$ zone; $T_{ij}$ the number of expected trips from origin zone $i$ to destination zone $j$, $P_i$ and $P_j$ are the populations of $i$ and $j$; $C_{ij}$ is a travel cost friction factor, while $\alpha$ and $\beta$ are calibration parameters.

$$T_{ij} = \alpha \frac{P_i P_j}{C_{ij}^\beta}$$  \hspace{1cm} (1)

We adapt this standard definition for our purpose by:

- using total passenger traffic in stations’ Pax as a proxy of “rail” populations. The number of inhabitants would be too rough, also because needs to define the catchment area of each station. The total passenger traffic in stations might represent both the dimension of the urban area (i.e. the catchment area), the dimension of rail market and the “propensity” of inhabitants to use rail;

- developing a cost friction factor with a Cobb-Douglas function proportional to high speed service travel time (in minutes) and inversely proportional to service frequency (in HS connections/day, with $\gamma < 0$, excluding trains not using the lines and thus not included in the observation of total traffic).

As a consequence, the form used is the one in Equation (2).

$$T_{ij} = \frac{Pax_i Pax_j}{travel_{ij} \cdot time_{ij}^\gamma \cdot freq_{ij}^\beta}$$  \hspace{1cm} (2)

We build an 8x8 matrix made of the following zones: Turin, Milan, Bologna, Florence, Rome, Naples, Verona and Venice/Padua. Such matrix ignores trips using the services continuing northbound and southbound the main axes Turin – Naples and Venice – Naples. We estimate that ignoring those services should make us lose some 1.2 million passenger in 2010, that we initially remove from the total during the calibration phase. Data on frequencies and time is taken from Trenitalia 2010 timetable.

This distribution model estimates the values in Table 2 and gives the results of Figure 3. The map shows that the core of demand is between Bologna and Rome, where the large demand from Milan and the smaller from Verona and Venice sum up. Moreover, from

<table>
<thead>
<tr>
<th>Section</th>
<th>Demand relations</th>
<th>Reference value</th>
<th>Simulated value</th>
<th>Error</th>
<th>Source of reference value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milan – Rome</td>
<td>direct relation only</td>
<td>3.00</td>
<td>3.00</td>
<td>0.0%</td>
<td>FS (2009)</td>
</tr>
<tr>
<td>Milan – Turin</td>
<td>all ODs</td>
<td>1.00</td>
<td>1.01</td>
<td>-1.1%</td>
<td>unofficial</td>
</tr>
<tr>
<td>Rome – Naples</td>
<td>all ODs</td>
<td>1.50</td>
<td>1.34</td>
<td>10.7%</td>
<td>Est. from 1.4 in 2007, Cascetta et al. (2011)</td>
</tr>
<tr>
<td>Total passengers on HSR</td>
<td>sold tickets</td>
<td>2.00</td>
<td>2.18</td>
<td>-9.1%</td>
<td>FS (2010)</td>
</tr>
</tbody>
</table>

Comparison among simulated and reference values for demand on available Italian HSR sections (Table 2).
Bologna to Florence nearly all links are classified as HS and just a handful of regional connections still exist. To the contrary, Turin – Milan and Rome – Naples have a very limited demand because of competition from car, but also from regional trains. In conclusion, only the line Milan – Rome has a significant demand, while the rest is scarcely used, even when a new line exist (Turin and Naples).

A stylised Cost Benefit Analysis to assess the socio-economic effects

The demand itself is not a sufficient indicator of economic success/insuccess of an investment, being at least also the cost relevant. To assess such results also from an economic perspective we then move to a CBA perspective.

To do that, in a context of missing data, we refer to De Rus and Nombela (2007) and de Rus and Nash (2007), that proposed a simplified cost benefit methodology to make broad comparative evaluations of high speed railways. They develop a comprehensive formula to estimate first year passenger traffic to justify the investment on the basis of travel time savings and cost differences with respect to the former situation. This obviously ignores a lot of aspects related to HSR schemes, for example environmental and decongestion benefits due to mode shift. However most of the evaluations made on HSR made it clear that travel time savings are by far the most important benefit of such projects, and that it is not possible to justify HSR investments only on the basis of environmental reasons. We will comment and roughly quantify the dimension of such ignored effects later in the paper.

The authors built the Formula (3) that estimates the first year diverted demand from conventional rail to high speed rail in order to have NPV=0. All the needed parameters are listed and briefly described in Table 3.

\[ Q_0 > \frac{1}{\nu s(1+\alpha)} \left( \frac{r-\delta}{1-e^{-(r-\delta)\theta}} \right) + C_1 - \frac{1-e^{-rT}}{r} - C_c(1+\alpha) \]  

(3)

In fact, as we are looking at current traffic on the network, we will estimate total traffic after the construction of the new rail link, that is high speed traffic on first year in Equation (4).

\[ Q_{HS} = Q_0(1+\alpha) \]  

(4)

We set the parameters described in Table 2 as: \( v = 20 \) €/hour-pax, \( \alpha = 50\% \), \( r = 3.5\% \), \( \theta = 3.00\% \) and \( T = 40 \) years. We set economic investment value to be 80% of its financial cost to consider transfers and macroeconomic effects, and we consider a residual value - in the last year of analysis - of 50% of the economic investment (as suggested by the same authors of the model).

Available data confirm the fixed maintenance and operating costs (\( C_c \)) suggested by Campos and de Rus (2009) to be of the order of 30,000 € per kilometre of single track of high speed rail in Europe. Finally, economic train operating costs of high speed trains are calculated by the Italian transport network manager (RFI 2005) to be 9 €/train-km for high speed trains and 10 €/train-km for conventional long distance trains. We thus estimate \( C_c \) and \( C_1 \) multiplying those value for the number of new high speed trains and the one of conventional trains removed.

On the basis of this model we then estimate the needed demand to justify the investment on the basis of benefits in terms of time reduction and operating costs, in Table 4. Comparing the needed demand with the simulated current traffic and with Trenitalia load factor targets (see Figure 4) we can have a first picture of the socio-economic results of the investment, considering that other than direct benefits (environmental, congestion and wider benefits) exist but are not changing the overall result (see afterwards).

The results of our simulation in Table 4 suggest that the achieved time and operating cost savings alone do not justify the investment in any of the considered sections, except the Milan-Bologna one in the most optimistic case. The section, together with the Bologna – Florence section, could achieve positive or marginal economic results considering the other than direct benefits, as we will discuss in a while. The balance seems instead negative for the Rome – Naples section and very negative for the Turin – Milan section. We will comment such results in the concluding section.

To complete the picture, as said, values in Table 4 have been estimated on the basis of time and operating costs savings only. It must be recognised that other significant benefits exist, even if usually minor (Nash 2009) and not capable of changing a result other than marginal:

- mode shift can provide a reduction in external costs, both in the shift from car and from airplane. Cascetta et al. (2011) evidenced that 7.8% of the HS users were diverted from car on the Rome-Naples section in 2007. To assess the value of those external costs saving it would be crucial to
understand which part of those diverted users used to travel during peak hours, when the non-internalised part of external costs is significant due to congestion (Nash 2009). Assuming the Rome - Naples as a benchmarking, the amount of demand shifted from car for all pairs (especially the longer) is however irrelevant compared to the overall highway traffic: no more than 2,000 cars/day on the most crowded section. Data on air traffic shows a decrease of 1.3 million passengers a year (i.e., 647 million passenger-km. Our elaborations on ENAC 2007 and 2010) on city pairs linked to HSR, with respect to the national trend (that showed a +5.31% increase 2007-2010). Considering 1.1 €/pax-km (Nash 2009) of non-internalised external cost by plane, it means a benefit of 7 M€ per year, i.e., 214 M€ of total actualised benefit. If we compare this indicative value with the total economic cost of the HSR of 17,700 M€, plus the external costs of high-speed train operations and of the construction of the new lines, we understand that the benefit due to air pollution reduction is not significant.

- the shift of high-speed trains to the new line releases new capacity for freight and regional trains on the existing lines. If those were close to saturation, this could be a benefit. According to the last Italian transport plan (MTN 2001), in the late
Nineties the Milan – Bologna line was close to saturation between Piacenza and Bologna; also the Florence – Bologna line and the western part of the Turin – Milan (between Turin and Santhià) experienced high traffic levels. Urban nodes represented the most acute capacity problems: however new HS lines did not solve those problems and even worsen them by generating new traffic.

- **wider economic benefits** due to generated demand are usually not considered in traditional cost benefit analyses. Nash (2009) outlines that “leisure trips may benefit the destination by bringing in tourist spending, commuter and business trips reflect expansion or relocation of jobs or homes or additional economic activity”. However there is still debate on whether these changes really are additional economic activity or whether it is simply relocated. Those benefits are usually significant for projects connecting depressed areas to economic centres and when the reduction in generalised travel costs is large. Typically, infrastructures generate significant wider economic effects in developing economies. European detailed calculations are rare. The estimated value of those benefits for the first section (London – West Midlands) of the planned British High Speed 2, a project costing 17,800 M€, is 4,000 M€\(^2\) (DfT 2011). Rules of thumb suggest values of 10 to 20% of direct benefits in the best cases (Nash 2009, but also the World Bank).

Finally, the used value of expected traffic growth $\theta$ of 3% per year may appear as rather optimistic. However, one must consider that in the first years of operation traffic is expected to grow at faster rates, as the comparison of the supply in 2010 and 2011 in Table 5 suggests. This may be due to some facts:

- people needs **time to change their behaviour** (Litman 2010) as a response to a reduction in travel times, in particular when it comes to change residence or workplace;
- a new open-access train operating company (NTV) is expected to enter the market in 2012, with a significant increasing in the supply of services. In particular it will be interesting to observe if competition with the public incumbent Trenitalia will generate a reduction in average fares and more complex yield management with more low price offers. The combination of new supply and reduced fares should anyway attract new demand to HS services.

**Comments on the ex-post analysis**

A first comment can be spent on the demand. The lines in operation, from Turin to Naples – Salerno, are the core of Italian long distance traffic, connecting the most important urban areas with the exception of West-East line from Turin to Venice. For this reason, one can expect that this line will be the most used even if the network will increase. Moreover, the distances involved are those suggested as the most suitable for HS trains. However, only the central section of the line, from Milan to Rome, has a significant amount of demand. The two marginal

<table>
<thead>
<tr>
<th>Section</th>
<th>2010 supply</th>
<th>2011 supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turin – Milan</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>Milan – Bologna</td>
<td>68</td>
<td>76</td>
</tr>
<tr>
<td>Bologna – Florence – Rome</td>
<td>100</td>
<td>118</td>
</tr>
<tr>
<td>Rome – Naples</td>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>Naples – Salerno</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Venezia – Bologna</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>Verona – Bologna</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>
sections, connecting the large cities of Turin and Naples with the mainline (but also Verona, even if not at 300 km/h) have much less travelers and trains far from the line capacity.

We try to suggest possible explanations for such disappointing outcomes: the Turin-Milan relation seems to be made of significant relations among intermediate origins and destinations (e.g. Vercelli-Milan, Novara-Turin, etc.), which cannot be served by high speed trains, but would have benefited from faster inter-city services.

Probably, if the line would have been designed and built with lower standards (similar to those of the Florence-Rome in Table 1) the balance would have been much better, with slightly lower benefits for the direct Milan-Turin relation, but significant benefits for other origins and destinations on the line.

The Rome-Naples relation probably suffers from the fact that the two big metropolitan areas experience very high travel times to the respective central stations, so that a fast connection between city centres marginally benefits the connections among the big peripheral areas.

Concerning the socio-economic assessment, even if demand results quite good (near to the major European HS lines) and benefits are high due to important time savings, the socio-economic result is not satisfying. In all the sections, except Milan - Bologna, the demand is no more than half of the needed one to justify the public cost. The main indication, especially for the central section, is then on the cost side: if the line would have had the expected cost and not the double or more, or if costs would have been in line with European average, the whole line from Milan to Rome would have been positive.

Comparison among current and expected passenger rail traffic (in trains/day) - as forecast by the official documents (our elaboration on sources). Forecasted values for the Brennero and Frejus base tunnels refer to the complete new line. For the Frejus, the secondary source elaborates the complex official estimations (Table 7).
Ex-ante considerations on planned extensions

A long list of projects related to the High Speed/High Capacity network expansion are at stake in Italy, already depicted in Figure 1. In the following we will refer to the major projects included in the last public document released by the Italian Ministry of Transport - the Strategic Infrastructure Program (MIT 2010) - which can be considered the most recent planning document, even if not giving any reference to actual and forecasted demand and lacks of cost-benefit considerations.

Expected demand, cost and performance

In absence of detailed data necessary to carry a full CBA, we will present in this section a first benchmark of the costs, of the present demand and of the official estimations on expected traffic for the main projects under consideration (Table 6). Among them, the Brennero base tunnel is part of the Verona - Munich high speed line, and the Frejus base tunnel is part of the Turin - Lyon high speed line. The Treviglio - Brescia - Verona - Padova is the central part of the Milan - Venice high speed line, whose extreme parts (Milan - Treviglio and Padua - Venice) have been already built with no high speed standard (see Table 1). Similarly to the existing lines, also the new links are supposed to be interested by both passenger and freight traffic. Three of them, the Brennero, the Frejus and the Third Giovi pass, are mainly freight lines.

In Table 7 and Table 8 we report traffic values - current and forecasted - for considered projects. The same values are comparatively commented in the next paragraph (Figure 5 and Figure 6).

A comparative assessment of planned extensions

Comparing official estimations with current demand (Figure 5 for passengers and Figure 6 for freight), we can derive the following indications:

- All lines are expected to heavily increasing the present demand: often doubling for passengers and two to five times increasing for freight. These trends, if looked together and not singularly, appear very optimistic and in contrast with pre-crisis steady trends (see Trenitalia balance sheets).

- The Naples – Bari line appears comparatively weak from any point of view: few passengers, few freight and moderate time savings\(^1\). Since the existing line is obsolete, this means that if an investment is needed, this must not be a huge and costly HS line, but a cheaper but effective doubling and modernisation. Otherwise, the line should be ranked low due to its large cost.

- The Frejus tunnel and line is the project whose freight demand is expected to increase more (nearly five times the 2007 pre-crisis values). In our opinion this is hardly unjustifiable since the relation has continously lost traffic in the last decade\(^2\). According to forecasts, it is instead expected to overcome the Brenner line, which today experiences two times more traffic.

**Comparison among current and expected freight rail traffic (in trains/Year) - as forecasted by the official documents (our elaboration on sources) (Table 8).**
Very high demand is expected on the Milan – Venice and this is realistic. However, the lessons learnt from the Milan – Turin line should not be forgotten: the presence of many medium sizes cities and Venice not being a big and dense metropolis suggest that average trip distances should be low (100-200 km) and demand should not be concentrated but spread among many OD couples. Thus, the pure speed is probably not needed like from Milan to Rome and the investment should focus on increasing capacity, reliability and frequency of intercity trains, following the German or Swiss examples.

The Brenner is the only project in which a saturation of the concurrent mode – the motorway – seems possible, while the others expect a future saturation of existing rail.

The Brenner and the Frejus lines have opposite capacity problems: the first one has a capacity problem on long distance freight trains and the latter on regional trains near Turin. The two projects should take into account this, preferring a doubling of the line around Turin before the doubling of the pass line; the opposite is true for the Brenner.

A huge freight traffic is expected on the Third Giovi pass, but one must take into consideration the capacity and the performances of the Genoa port. Moreover, the present line is actually a 5 tracks connection, characterised by strong slopes (up to 35%) but with a capacity of 450 trains/day and a potentiality of 700 (Gronda di Genova 2009), the double of existing demand.

Concluding remarks

Summary of results

In the paper we faced two issues: to evaluate ex-post the demand and the results of the new Italian HS lines between Turin – Milan – Rome – Naples and Verona – Bologna, and to provide a comparison of future extensions. For the first question, we built a simple distribution model to reconstruct the OD matrix starting from the very limited demand data available. We estimated the flows on the sections of the line and in general on the HS trains classified with the commercial name of “Frecciarossa” and “Frecciargento”. The most used sections are the central ones between Milan to Rome, with flows ranging from 6 to 12 Mpax/year in 2010. The other HS sections to Turin and Naples have much less demand, below any expectation and far below the capacity of the line, used exclusively for HS trains.

These results on demand, partially positive, partially negative, translate into a variable judgement from the socio-economic viewpoint: it is marginally positive for the Milan – Bologna line and potentially marginally positive for the expensive Bologna – Florence tunnel.

Instead, neither the environmental benefits of shift from air (approx 250M€ overall in 40 years), the possible wider economic benefits (no more than 10 to 20% more, in the most optimistic case), the reduction of congestions (very small and concentrated around urban areas only) and the expansion of capacity (that was already sufficient), can change the result of non-core sections, namely the Turin – Milan, the Rome – Naples. In all cases, the socio-economic benefits – although benefits are sometimes very high – have been dramatically reduced especially by the investment cost, that have been overwhelmingly high compared to similar European lines and substantially underestimated.

Future extensions, with the relevant exception of Milan–Venice doubling, appears to be more and more marginal.
compared to the Milan – Rome line. All forecasts appear to be extremely optimistic, foreseeing doublings of demand on all lines. Being their expected costs similar or higher than existing lines, the socio-economic result cannot be better.

**Policy indications**

The analysis allows us to suggest some policy indications:

- Some priorities between new lines are needed: the whole cost cannot be paid at once and the best projects must be chosen, being their forecasts already very different. The demand already gives an indication on which lines must be preferred, but an extensive and comparative CBA is needed.

- Radical cost reduction strategies must be applied. Costs are too high compared to European standards. A relevant part of such extra-cost is due to non-competitive awarding for construction. A problem of overdesign seems also to exist.

- In particular, the model of High Speed lines must be overcome, since passenger demand on those lines is less and less and potential time savings are not changing behaviours substantially. Similarly, also the mixed-model expenditure.

- An interesting strategy is that of dividing the project into functional sections and analysing them with a phasing approach: a line can be built progressively, and the characteristics of extensions can be changed according to how demand responded. In this way one can obtain the same benefits at lower and diluted cost and, more important, reducing the risk of overinvestment (see Debernardi et al. 2011).

- Much attention must be spent on nodes, i.e. the place of the network where true capacity problems exist and where capacity and speed improvements give the better payoff.
Notes

1 Sole 24 Ore, “Opere più frugali per coinvolgere i privati”.
2 Ferrovie dello Stato turned his name to Ferrovie dello Stato Italiane in mid 2011.
3 Concession Act: Decreto Ministeriale n. 138T del 31 ottobre 2000, Ministero dei Trasporti e della Navigazione.
5 10.7 billion Euro$_{1994}$ is equal to 15.5 billion Euro$_{2006}$ (RFI 2007).
6 Actually the number refers to total year projections made on the basis of tickets sold up to October 2010.
7 Data are taken from station managers websites, www.grandistazioni.it and www.centostazioni.it. We sum all passengers using stations where high speed services start in each city. Turin Porta Susa station is managed directly by RFI and no data is available: we hypothesize a value of 15 million passengers.
8 Some trains continue northbound of Verona (1 train couple to Brescia, and 2 couples up to Bolzano), northbound of Venice (1 train couple up to Udine) and southbound of Naples (1 train couple to Reggio Calabria and 4 couples to Bari/Lecce).
9 With the hypothesis that average load factor on those peripheral sections is 200 passengers/train for trains to Reggio Calabria and Bari, and 150 passengers/train for trains to Brescia, Bolzano and Udine. Average High Speed load factor in 2007 was 215 (FS, 2007), but in this case the trains always continue to Rome serving also some intermediate cities.
10 See Table 5 for part of the used values.
11 This average value is confirmed by FS (2009) for the Milan - Rome relation, where a +50-60% of new demand is reported, and by Cascetta et al. (2011), where 30.8% of the 2007 high speed traffic between Rome and Naples is generated or diverted from other non rail modes (i.e. +44.5% of existing demand).
12 RFI estimates for the planned Naples – Bari line unit costs of 56,000 M€ per kilometer of double track line.
13 Reduction in greenhouse gases due to HSR introduction is quite controversial in general, even more in countries with high oil dependence for electric energy production like Italy or Britain (Nash, 2009).
14 Hypothesizing a traffic growth of 2%, a social discount rate of 3.5% and an horizon of 40 years.
15 However in Britain projects have to pass the cost-benefit test without considering wider benefits.
16 This is reflected also in the current supply on the relation, that is still made of 38 regional, 20 conventional long distance and only 20 high speed services (Source: Trenitalia website www.trenitalia.com, visited on September 2011. Simulated day: 12/10/2011).
17 Despite initial declarations, no freight traffic is using the existing high speed network.
18 Comparing current timetables with forecasts (RFI 2009) time savings are less than 1h in total.
19 Overall freight traffic (both on the road and on the rail) among France and Italy decreased from 51 Mtons in 2000 to 48.1 Mtons in 2007, before dropping to 38.2 Mtons in 2009. Considering only relations more strictly related to the project (namely Frejus/Moncenisio, Monte Bianco and Monginevro), values are 36.6 in 2000, 28.1 in 2007 and 20.7 in 2009 (BAV 2009).
20 Venice has 271k inhabitants and Padua 214k inhabitants.

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