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Empirical Applications and Scenarios

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Abstract

Environmental issues have received a prominent place in transport policies of most European countries. The coordination of such policies however, is fraught with many difficulties. The increasing freight flows after the European integration are a source of concern, but have not yet led to straightforward and effective environmental strategies.

The paper focuses on the Trans Alpine freight transport systems in the light of the future integration of single national transport systems into the European transport network. The environmental, social and institutional peculiarities of this ‘region’ have favoured - in the past - the development of strong nationally-oriented policies, partly in contrast with the goals promoted by the European Union. The present analysis aims to highlight opportunities and limits inherent in the implementation of various infrastructure projects oriented towards a drastic change of the Alpine transport systems structure.

The Alpine countries, viz. Austria and Switzerland, play a central role in the promotion of environmental benign modes of transport of goods, with a clear focus on rail. The route choice and modal split of freight flows in Europe are simultaneously taking place. In the paper the results of European freight flow models (based on logit analysis and neural networks) will be presented. An important exercise is then to assess the consequences of various types of eco-taxes on road transport in Europe. In this context, several policy scenarios will be dealt with.

1. INTRODUCTION

In the last few years several important economic and political events have contributed to the appearance and consolidation of new views on boundaries in international trade relations. The setting-up of the European Single Market, the development of trade relations with the members of the EFTA and the opening-up of the frontiers of the Eastern European countries have all favoured the concept of an integrated European market stimulating the growth of international trade between the European nations. Consequently, also the transport sector plays a more prominent role. For example, for a country like Italy, Europe accounted in 1993 for almost three-quarters of Italian international trade, the most favoured members of the European Community being Germany and France.

The changes which have taken place in the structure of economic and social relations have given rise to a considerable growth in distribution and mobility of goods (see Nijkamp 1993). Indeed, a flourishing European economy is also closely linked to the efficiency and viability of its transport sector. Such a system is fundamental in order to exploit to a full extent integration benefits over space and time in the European space-economy and is thus an essential part of European economic and social organization. It lasted however, until the nineties, that a greater awareness arose of the fact that competitiveness in the European system would be irreversibly compromised by a lack of integration of single national freight systems. The existence of missing networks would erode the integration benefits. Examples of missing networks are the Transalpine links and the Scandinavian links.

At the same time it is increasingly recognized that more trade and more transport have highly detrimental impacts on the environment in Europe. This has generated a wide diversity of fragmented environmental policy initiatives in Europe. Examples are the outcome of the Swiss referendum on banning through traffic by imposing a 28 ton truck size limit or the Austrian decisions on night and weekend freight transport. The European Commission has in the meantime published its green paper on European transport policy, but thus far there is only little coordination.

As an illustration of the intricate issues of European environmental policy vis-à-vis the transport sector we will focus here mainly on Transalpine transport. The key to understanding the problem of crossing the Alpine chain lies in the integration and maximum exploitation of the European free market. The Alps actually concern most EU countries, but as all of Italy's northern borders are facing this mountain chain, it is clear that any road or rail link between Italy and the rest of Europe is obliged to face this obstacle.

Historically speaking, the Alpine chain has always played the role not only of a crossing-place but also that of a meeting-place for many different cultures. To consider this chain nowadays as a mere obstacle to mobility between the European nations would be tantamount to ignoring its intrinsic potential. The Alps constitute both a natural and a socio-economic environment which has to be safeguarded from the viewpoint of the culture of its population groups and its high environmental quality. To promote the development of a transport network by keeping in mind the typical 'Alpine' culture and environment will undoubtedly lead to greater integration of single national systems and more generally to the integration of the European network.

Over the next few years the Alpine network is expected to witness a large rise in traffic. In various feasibility studies concerning new railway infrastructures, the annual growth rate of freight transport has been estimated to fall between approx. 2.5% and 3%, that is, twice the present volume over the medium to long terrn. As these figures do not take into consideration the potential of the Eastern European markets, it is reasonable to assume even a higher increase in traffic flows in the Eastern sector of the Alpine chain, an area which up to now has not played an important role as regards infrastructure projects.

Over the last few decades road transport has accounted for all additional domestic and international traffic. The development of the new European market together with emerging environmental, ecological and social problems require, however, that over the next decades a scientific assessment be carried out concerning modal split development, by focussing in particular on the potential of rail transport.

Several adjustments to the existing Alpine chain railway system are necessary in the short term in order to improve the performance and access to the network itself. Moreover, by the year 2010 four new high-speed rail routes for both goods and passenger traffic are foreseen to be completed. The potential increase in supply deriving from the new European network will enable the present transit rate to increase threefold.

Feasibility studies for such infrastructure projects need operational network models of long term changes for the modes of transport adopted, including especially rail transport. Indeed, it is expected that there will be a considerable increase in competitiveness as far as the new routes being planned are concerned. On the other hand, the real possibility that the rail network will manage to secure a large part of the existing road transport share for itself is likely to depend on a number of other factors. In order to induce a complete reversal of present trends, a global policy - which includes the entire transport network - is necessary, since the development of a multi-modal system depends particularly on its competitiveness (over road transport) regarding delivery times, safety, reliability and flexibility. The validity of the various scenarios and the exploitation of new Alpine chain capacities will therefore depend on the policies actually implemented in transport planning. In other words, the achievement of higher levels of efficiency cannot be limited to rail routes, but should also include the whole transport network in Europe.

A critical point for the future of integrated/combined transport in the Alpine chain regions concerns the limitations inherent to the development of supply. Limiting factors are found both in the capacity of the present infrastructural network and as regards the integration and organization of actors or operators involved.

Combined transport can create a large-scale improvement in the rationalization of the use of available resources, improving both infrastructures and productivity. This is even more true as regards Transalpine traffic, where the cultural impact of the environmental policies of Switzerland and Austria has caused a rapid orientation towards the concepts of intermodality and integration between networks. However, integrated and co-ordinated management of the network itself is indispensable for a coherent development of all regions involved.

For the economic future of the Italian production system, there is an evident need for the country to become integrated into the process backed by the EU, by accepting rapid, efficacious and flexible multimodal integration. Nevertheless, many problems still have to be solved. Integration in the transport sector requires a profound cultural rethinking, as it means improvement of quality, efficiency and performance in a market-oriented system.

A global solution of the Alpine problem, particularly with reference to the economic significance that the Alpine chain has taken on for the consolidation of the Italian economy in Europe, appears now to be essential for the reorganization of the transport sector according to the new European perspective. In order to offer some background information for our subsequent analysis, we will first present some numerical data on the Transalpine transport system.

2. THE TRANSALPINE TRANSPORT SYSTEM: EXISTING FORECASTS

The undeniable need for the railway network to regain a market share has determined the simultaneous development of four important infrastructure operations centred around the four central passes linking Italy to France and Austria. Data supplied by the Italian State Railways (FS) in 1992 show that these passes account for 73% of all railway import traffic, (that is, 22.5 Mt of the 30.8 Mt entering Italy) and 83% of all export traffic (that is 11 Mt. of the 13.1 Mt leaving the country). Switzerland saw a transit of 40.5% of import flows and 45.3% of export flows.

Recent empirical analyses have confirmed that following the 28 ton ban introduced by the Swiss Government to limit freight transit by road through Swiss territory, the Confederation has not managed to attract a flow of traffic which, in order to proceed by the shortest route to its destination, would normally have crossed Switzerland. Instead, this ‘market share’ has remained loyal to road haulage but has chosen alternative routes, routes which are longer (via France and Austria) but which evidently are more competitive (see Beuthe and Jourquin, 1995, and Maggi and Muller, 1996).

It is undoubtly true that the problem of crossing the Alpine chain depends totally on the use of these four passes (Fréjus, Simplon, St Gottard and Brenner). A more balanced ratio between demand and supply in both the Western section of the Alps (Ventimiglia) and the

Eastern sector (Tarvisio and Villa Opicina) is predicted for the year 2000 and the year 2010[1]. On the other hand, three quarters of all demand and supply is concentrated around the Fréjus, the Simplon, the St Gottard and the Brenner passes (see also Table 1). The various infrastructural interventions which took place in the late eighties and early nineties were a response to the need to (re)create a certain sense of competitiveness for rail traffic. Data show that by the year 2000 the projected technical improvements will have created a freight capacity which is more than adequate to satisfy demand for the transport of goods by rail. Estimates forecast 85/90 Mt. of total supply against 53.6 of forecasted demand.

Table 1 about here

In the short term, however, it is not realistic to consider a drastic change in the division or the market share for transport among the various means of transport, a change which is, instead, the basis of several long-term predictions. An overview of various estimates for the freight transport demand on the Alpine crossings is given in Table 2.

Table 2 about here

A study commissioned by the Italian State Railways forecasts a flow equal to 63.3 mt. of which 45 may be attributed to the 'key' passes. Based on this hypothesis, the increase in potential generated by the four operations now being planned (from 66 Mt. in the year 2000 to 123 Mt in the year 2010 for the four passes already mentioned) appears rather excessive and does not correspond to economic and financial criteria. The most optimistic view concerning the Swiss study, instead, estimates a volume of rail traffic of 90 Mt. in the year 2010. Based on such a hypothesis, carrying capacity in the year 2000 would appear to be less than hoped for, and clearly an effective intervention would be required so as to regain the approximately 25/30 Mt. 'market share' lost. In this case too, there is a clear need to consider

[1] Only few studies up to now have taken into consideration the impact of new trade relations with the Eastern European economies

more carefully the question of which and how many infrastructural interventions should be carried out.

It should be kept in mind that there are no long-term estimates concerning the recovery of efficiency and the carrying capacity of the existing network sections, on the basis of further improvements to railway lines and trains themselves. Nevertheless, it seems that only if rail transport is able to gain a new market share by inverting the current modal split trends, the new infrastructure projects will be able to maximize efficiency and service. In any case, the setting up of new routes and/or infrastructures appears to represent one of the first actions able to offer competitiveness to the rail network.

Table 1 synthesizes under the headings 2000 and 2010 the data presented analytically in this sub-section. Comparisons are based on the annual tonnage involved in demand and/or supply as regards the rail network for each pass. As already emphasized, forecasts concerning road traffic are not available but it is a common concern that potential capacity is adequate for any further development in this area. In fact., it does not seem plausible that the international road haulage sector will continue to expand at the same rate as it has done over the past few decades. In any case, transport policy is certainly oriented towards this direction.

2.1 Forecast for Single Axes: A Review of Existing Studies

In Table 2 the forecasts contained in the various studies are broken down into single traffic projects. Comparison is difficult both because of the different geographical areas involved and since the basis of the forecasts also varies, as there are several project hypotheses concerning the various mountain passes. In particular, no forecast considers the simultaneous implementation of the four major rail projects involving the Alpine chain and so no predictions have been made about the level of competitiveness between these passes (Frejus, Mt. Cenis, Simplon/Lotschberg, the St. Gottard and the Brenner). As these studies do however, consider the implementation of one, two and/or three projects concerning railway infrastructures, the market share open to the various means of transport favours rail traffic, considering that other modes (road and air transport) will passively accept their loss of this share.

As regards forecasts for the year 2010, the “Feasibility study for the Simplon and St Gottard passes and the pre-feasibility study for Villa Opicina pass” compares the Mt. Cenis project hypotheses with those of the Swiss passes and the Brenner. In all five hypotheses, traffic flows on these routes appear to be quite steady with approximately 47/48 Mt., which accounts for three-quarters of all traffic. The models suggested by the study vary also according to the type of ‘flow outlet’, that is, an alternative route devised and/or improved so as to avoid the traffic congestion on the roads leading into and out of Milan. These outlets have been called A "Pavia-Novara-Busto Arsizio-Saronno-Seregno-Bergamo-Treviglio” and B “Novara-Saronno-Bergamo-Treviglio-San Giuliano Lacchiarella”. It is interesting to note that solution A favours the western passes, while B favours the central ones. There is a difference of roughly 2 million tons passing from one route to another by means of the road network and various junctions in and around Bologna.

This study has been compared to the Swiss study “New Transalpine Railway Axes”. In order to do so, the same model used in the Swiss study to designate freight flows was adopted, the technique of “all - nothing” which forecasts freight flows on the basis of minimum carriage (that is the one taking the shortest time) instead of ‘growth designation'[2]. This comparison shows a considerable similarity among the various data, although it is closer to the less optimistic hypothesis put forward by the Swiss study. Both studies forecast a considerable market potential for the two new passes - for the Simplon 26.6 Mt. per year (25/38 in the low/high Swiss hypothesis) and 26.5/27.5 for the St Gottard (28.5/44 Mt. in the low/high Swiss hypothesis).

Comparison with other studies appears much more complex. In particular, the study commissioned by the Austrian authorities, when making predictions about the passes in direct competition with the Brenner, takes into consideration only the market share that could be gained by the latter, that is, that share which is ‘relevant to the Brenner’, while it does not consider the actual size of freight flows.

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[2] The growth technique is based on the demand for a network depending on distance and speed and the limited traffic capacity of the passes themselves.

One important problem emerging from the studies concerns the demand for the transport of goods between Italy and central and northern Europe and how such demand is distributed among the various Swiss passes and the Brenner. In 1992, according to data provided by the Italian State Railways, Switzerland saw the transit of 72% of such traffic, to a level of 25 Mt. This share was to a large degree influenced by Swiss restrictions on road haulage.

The NFTA study (see Note 4 in Table 2) forecasts by the year 2010 a ratio of 63.8 for Switzerland and a 36.2% share for the Bremrer. The Bren '92 study presents, on the other hand, the hypothesis of a total reversal of freight trends, assigning to the Brenner between 66 and 8 1% (reference is still however, made to Brermer traffic; see Note 2, Table 2). The study carried out by the Committee of Temporary Ministers of Transport, starting off from the basic hypotheses of the Austrian study, forecasts 40/50% for Switzerland and 60/50% for the Bremrer. Despite some diversity, there is in general however a fairly common basis for the existing forecasts.

3. POLICY ISSUES

Freight transport policy in Europe is based on a 'double-edged sword'. On the one hand, intermodal transport has to make the transport sector more competitive, while on the other hand environmental degradation has to be minimized. This provokes complicated trade-offs in a sustainable development perspective.

The policies initiated by the European Community and emphasized in many reports issued by the various bodies of the EU are based on three main principles:

- the promotion of a new division of the market share for means of transport so as to favour the railway network, through active policies aimed at combined transport and policies limiting the growth of the road transport sector;
- the development of new technologies encouraging the maximum exploitation of infrastructures, above all as far as environmental issues are concerned;
- the implementation of the principle that users should be requested to cover the actual costs of transport, whether these refer to external issues or to the infrastructures.

The most important innovation regards the hypothesis of a complete reversal as far as the road/rail market share is concerned. Rail is advocated as the means of transport most able to offer adequate infrastructure provisions so as to cover any future demand. Other points closely related to environmental issues and the quality of life have played a decisive role in the decision-making policies of the EU. The most appropriate and effective way to implement the much needed change has thus appeared to be the choice of combined transport, in which rail would play an important role.

The thorny question concerns now the setting-up of a European infrastructure required to back up a modem transport system, and in particular, the creation of a logistic network consisting of interports, goods distribution centres, rail, port and airport terminals that are well-integrated and linked to a telecommunications and computer network, hopefully at a European level. For freight carriers and the state railways, integration into a European system means assuming the role of integrated logistic operators covering the whole European network and also implies working for the common good rather that in direct competition. The method adopted by the Italian State Railways is important, but there is still a lot of scope for the rationalization and development of already existing structures, especially for the implementation of high-speed projects as laid down in the list of priorities compiled by the EU.

Problems concerning road transport appear to be particularly serious, considering that the sector, well-protected and in a favourable position in the past, must now radically change in order to conform to the free market imposed by the implementation of a domestic European market. In the future, this sector will be composed of a small number of companies, all of which will, however, have made large investments of capital, employ highly skilled labour and offer a wider variety of products and services.

Planning of the transport network must therefore be based on the quality and quantity of physical infrastructures and - during the process of change - must include strategic factors which are nowadays just as important or perhaps even more important (Uniontrasporti, 1995). These factors are well-defmed by the various European Commission directives and refer to the setting-up of co-operative networks, the coverage of actual transport costs, the integration of information exchanges, the acceptance of the principle of a tolerable level of development, and the inclusion of private capital in the implementation of the entire network project. All such policies should ensure a better environmental performance of the freight transport sector. The question is however, whether the supply of new modes of transport will be sufficient to induce modal shifts and more intermodal transport. Many economists have argued for a better use of market principles in the transport sector, e.g. by introducing an eco-tax on freight transport. The effectiveness of such policies depends on price elasticities, an issue which has hardly been investigated. Therefore, we will in the subsequent sections develop and estimate some European freight flow models, through which it is possible to assess the implications of eco-taxes.

4. METHODOLOGY FOR EMPIRICAL APPLICATIONS TO EUROPEAN FREIGHT FLOWS

The final aim of the present paper is to investigate freight flow patterns in the Transalpine area from a multiregional perspective, by looking into the modal choice for these goods mainly from the viewpoint of time/freight costs. In this paper, two competing models, viz. a discrete choice model and a neural network model, wil be employed to map out the spatial flow patterns in an explanatory context. This offers also a possibility to compare the relative performance of those models. By considering that the Alpine chain 'ideally' divides Europe from Italy and Greece, a selection of Italian/Greek regions will be used to test the predictive power of the models concerned (inflows from Europe to Italy/Greece; outflows from Italy/Greece to Europe). Next, a sensitivity analysis will be carried out in order to investigate the expected consequences of a rise in time, due to, e.g., congestion factors as well as of a rise in transport costs, e.g. as a consequence of a European environmental tax on freight costs.

In the previous sections we outlined how, after the completion of the European market and with the widening of Europe towards easterly direction, mobility in general has drastically increased in Europe. In particular, cross-border transport has been at a rising edge with annual growth rates exceeding 10 percent, a process reinforced by the current globalisation trends. The integration of former segmented markets -and the related liberalisation in the European space- has led to drastic changes in both goods and passenger transport.

European networks and especially the Transalpine chains, are seen as the backbone of integration forces, while changes in the morphology of the networks are expected to generate system-wide impacts. Clearly, the emphasis on the potential of these networks for competitiveness and cohesion provokes various questions on the relative efficiency and substitutability of the different modes of this network. This issue is particularly important, as the competition between different modes and the social acceptability of modal choices are not only determined by the direct operational costs, but also by environmental externalities.

As a result, there is an increasing interest in the issue of intermodal competition and complementarity. For surface transport in Europe, especially the competitive position of rail vis-a-vis road is at stake. This holds increasingly also for commodity transport. It needs to be added however, that the analysis of freight transport in Europe is fraught with many difficulties, as freight is not a homogeneous commodity, but is composed of an extremely diversified set of goods with specific haulage requirements and logistic needs. This means that a commodity sector approach is necessary to analyse in depth implications of changes in network configurations. This approach will also be adopted in the present paper.

The present section aims to analyse interregional freight transport movements in Europe (108 regions) with particular reference to the Transalpine sector, as well as to forecast spatio-temporal flow patterns on the basis of new envirnmental-economic scenarios. For this purpose, a modal split analysis will be carried out by means of two statistical models, namely the logit model and the neural network model.

A widely adopted approach for modal split analysis is the logit model (see e.g. Ben-Akiva and Lerman, 1985). Recent experiments using logit models / spatial interaction models in order to map out the freight transport in Europe have been carried out by Tavasszy(1996), who showed the suitability of logit models also for the goods transport sector (where data are more 'fuzzy' and incomplete compared to the passenger sector). Since in our case two discrete choices - rail and road - will be considered, a binary logit model is adopted by considering, as attributes, the variables 'time' and 'cost' between the 108 zones.

Neural network (NN) analysis has in recent years become a popular analysis tool (see e.g. Reggiani et *al.,* 1997a). NNs have been widely applied to the area of transport engineering, in particular in relation to traffic control problems and accidents (see Hirnanen *et al.,* 1997). However, only a few experiments exists in the field of transport economics or transport route / mode / destination choice (see e.g. Nijkamp et *al.,* 1996a,b and Schintler and Olurotimi, 1997). Following the majority of applications on NNs, in our study a two-layer feedforward, totally connected NN will be used in order to analyse the freight transport modal split problem. The methodological structure of the main steps related to the application of a feedforward NN is described in Reggiani and Tritapepe (1997). In our application one possible NN architecture contains 4 input units which correspond to the attributes time and cost related to each transport mode (rail and road) and one output unit corresponding to the probability of choosing one mode[3] (e.g., the rail mode). Section 5 will offer empirical results obtained by applying an NN model to European freight flow data with particular attention to sensitivity/forecast analyses - based on environmental policy scenarios - concerning the Transalpine area.

5. EMPIRICAL RESULTS AND ENVIRONMENTAL SCENARIOS FOR EUROPEAN FREIGHT FLOWS

In this section we will describe experiments with the logit and the neural network approach, by assessing the most likely European freight flows configuration and next by estimating the likely consequences of the introduction of a European eco-tax on freight transport. We will first present the data base, then the flow estimates and finally the results of the scenario experiments.

5.1 The data

The data set[4] contains the freight flows and the attributes related to each link between 108 European regions' for the year 1986. The attributes considered are *'time'* and *'cost'* between each link (ij) with reference to each transport mode. In particular, each observation of the data set pertains to variables related to each link (ij). Furthermore, the flow distribution in the matrices concerned refers to one particular kind of goods, viz. food.

Since 108 areas have been considered, the data set should ideally contain 11664 observations (according to the previous remarks on our observations). However, our data set

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[3] The choice probability of the other mode is just the complement
[4] The data set has been kindly provided by NEA Transport Research and Training, Rijswijk
[5] The map and list of regions is displayed in Reggiani *et al.* (1997b).

contains finally 4409 observations because of the following considerations (by analysing the data set):

. the intra-area freight flows are zero;

· for each link, only the transport movements towards one direction $i \rightarrow j$ have been considered;

. only the links where the flows and the attributes (of both road and rail) are different from zero have been considered (i.e., empty cells are excluded).

The data set has been randomly subdivided into three sub-sets:

- a *training set* containing 2992 observations, i.e. about 68% of the data-set;
- a *cross-validation set* containing 447 observations, i.e. about 10% of the data-set;
- a *test set* containing 970 observations, i.e. about 22% of the data-set.

5.2 The spatial forecasting: comparison of the logit and neural network approach

In this subsection, the spatial forecasting performance of the two alternative approaches adopted will be compared and evaluated, on the basis of the calibration/learning procedure carried out in Reggiani *et al.*, (1997b).

By using the test set, which was not used for the calibration procedure, in our procedure both the binary logit and the neural network model have been employed to predict the freight flows for link (ij). This performance has been evaluated using the statistical indicator ARV (Average Relative Variance) which reads as follows:

$$ARV = \frac{\sum (y - \hat{y})^2}{\sum (y - \bar{y})^2} \qquad (1)$$

where y= the observed transport flow using road, $\hat{y}$ = the transport flow using road, as predicted by the adopted model and $\bar{y}$= the average of the observed transport flow using road (see Fischer and Gopal, 1994).

According to the above ARV indicator, the NN approach for forecasting spatial flows performs overall slightly better than the logit approach (see Table 3). An extrapolation of the 'test set' results with reference to Italy and **Greece** (inflows to Europe/outflows from Europe) is displayed in Table 4 and 5 (see next subsection).

Table 3. Comparison of Loait and NN performance

	ARV
NN	0.176
Logit	0.185

5.3 Eco-tax policy scenarios for European freight transport

As mentioned above, freight transport causes high social costs, which ideally would have to be charged to the transportation sector. We will now investigate the consequences of varying the transportation time/costs for freight flows. A sensitivity analysis of the previous results based on some environmental-economic scenarios will now be carried out in this section by using again both the binary logit model and the NN model. Two such scenarios will be used; they will concisely be discussed here. Later on, we will present the results related to this sensitivity analysis for the logit and the neural network approach.

At present, because of severe problems on the road transport network (for example, congestion), governments are trying to reduce the road usage by imposing policy measures that serve to increase the cost of road usage (see Verhoef, 1996). An example of a Pigouvian policy for coping with environmental externalities is the recently increased tax on fuel in the Netherlands. In so doing, the usage of the road transport network is made less attractive than other transport networks. In the light of these recent developments, two scenarios have been developed and considered for an sensitivity analysis; these are based on the observations in the test set. In Scenario 1 we assume an increase in transportation time for congestion problems around 10%. In Scenario 2 we assume that a uniform European tax policy for freight transport is also adopted and that the cost attribute related to the road mode is increased by 10 % for all links (ij) (in addition to the previous increase of time).

The conditional predictions for the regions under analysis are presented in Tables 4 and 5 for the binary logit and the neural network model, respectively. The relative prediction error (see Tables 4 and 5) is defined as the difference between the predicted flow and the real flow as a percentage of the real flow. These tables indicate that the binary logit model is relatively more sensitive to changes in the time/cost attribute than the NN model.

It is interesting to note that in the NN case, and particularly in the case of inflows from Europe to Italy and Greece, the model shows -in the mean value- a clear increase of flows, despite the cost/time increase. This result may be plausible by taking into account the increasing amount of interaction among regional economies. It would certainly be relevant to compare these results with more updated data in order to better evaluate the 'forecasting' analysis of the two models, since we have used -as a starting point- a test set related to the year 1986.

However, the above results may be considered plausible , in the absence of updated data that would be able to test our hypothesis of a 10% increase in the cost/time, given the good performance of the calibration / test phase (see Table 3). Moreover, these results may offer a 'range of values' to policy actors aiming to evaluate the impact of cost changes on flows, given the intrinsic limits of both adopted models.

On the one hand, the large amount of data at an aggregate level, hampers a behavioural perspective inherent in logit models. On the other hand, the type of architecture adopted in NN models seems critical for the validity of the results. Consequently, the results of our model may be used as a benchmark for the results of other models, by offering a more 'flexible' range of output results to policy actors.

Tables 4 and 5 about here

6. CONCLUDING REMARKS

A sustainable development of the European economic calls for a balanced development of commodity transport in the context of both efficiency goals and environmental objectives. The trend to favour intermodality in Europe provokes various intricate research questions on European freight flows. This paper has tried to offer analytical support to a better understanding of the forces at hand and of the consequences of policies.

The first part of the paper has aimed to highlight the relevant role of the Alpine chain in the framework of existing scenarios and forecasts on freight flows in Europe. It emerged that a 'global' policy perspective should take into account the potential and role of Transalpine freight transport, particularly with reference to the major four passes in the Alps.

The second part of the present paper has been empirically oriented, aiming to depict transport flows of commodities in an inter-regional European setting with reference to the Alpine crossing area. Based on an extensive data set, various estimates of the impacts of time/costs on transport movements have been made. The test results show that both the logit and the NN approach are giving fairly favourable results. In general, NN models seem to perform slightly better. It is certainly opportune to investigate more thoroughly the differences in background of these two research paradigms. Recent results show a compatibility between feedforward NNs and binary logit models (see Schintler and Olurotimi, 1997), feedforward NNs and spatial interaction models (see Fischer and Gopal, 1994) and feedforward NNs and logistic regression models (see Schumacher et *al.,* 1996).

Both the logit model and the NN appear to offer interesting and policy-relevant estimates of the changes in modal split of commodity transport in Europe, as a result of eco-taxes on the freight flows between various regions in Europe. It is clear that this analysis calls for more experiments, for instance, region-specific eco-taxes, corridor taxes etc.. Thus, this paper opens up a variety of new research ideas on sustainable development of the transport sector.

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Table 1 Comparison between Demand/Supply for the Rail Mode - at the Alpin Passes - in the Years 2000 and 2010 (Millions of tons)

Pass	*Demand 2000**	*Supply 2000*	*Demand 2010°*	*Supply 2010*
Ventimiglia	4.6	5	3.9/5.1	5
Fréjus/Mt. Cenis	12.2	12	7.8/25.2	14-15
Simplon	4.6	8/9	8.1/37.9	19
St Gottard	14.8	24	10.6/43.8	50
Brenner	7.2	22	7.1/28.2	40
Tarvisio	6.4	8/9	3.1/3.8	9
Villa Opicina	3.8	8/9	7.4/7.8	9
TOTAL	53.6	87/90	48/123.6	146/147

Notes: *Feasibility study carried out for the Simplon and St. Gottard passes
‘Pre-feasibility study carried out for the Villa Opicina pass

Table 2 The Demand at the Alpine Passes* (Millions of tons)

		Ventimiglia	Fréjus/Monc.	Simplon	St Gottard	Brenner	Tarvisio	Villa Opicina	TOTAL	Road	TOTAL	Simplon/St.Gottard
FS 2000		4.6	12.2	4.6	14.8	7.2	6.47	3.8	53.6	68.4	122	19.4
FS A m+s+b	1	5.1	9.1	19.1	10.6	8.2	3.8	7.4	63.3	66.7	130	29.7
FS B m+s		3.9	9.8	17.7	11.1	9.8	3.5	7.5	63.3	66.7	130	28.8
FS C m+g+b		5.0	8.0	10.1	20.4	8.9	3.1	7.8	63.3	66.7	130	30.5
FS D m+g		5.1	7.8	9.8	21.0	8.7	3.1	7.8	63.3	66.7	130	30.8
FS E m+g+b		3.9	10.3	8.1	20.4	9.7	3.3	7.6	63.3	66.7	130	28.3
BREN'92	2			19.4	19.9/20.2	28.2			48.1			
FS A B	3		12.1	26.6	1.6/2.4	6.0/7.0			47			28.5
FS C D E			12/13	2.3	25.7/26.7	6.0/7.0			47			28.5
NTFA s+b	4		12.0/24.4	24.8/37.9	1.6/16.4	26.2/7.1			43.5/90	29/28	71.5/129	29.1/66
NTFA g+b			12.3/25.2	0.6/15.1	28.5/43.8	5.0/21.7			43.5/90	29/28	71.5/129	29.1/66
FS-SNCF	5		11.5/16.6									
CFA 2020	6	2.8/3.0	12.6/14	9.2/11	22.8/44	15.1/30	8.5/7.0	3.8	71/109	65/27	136	32/53

NOTES:
m= Mt Cenis, s= Simplon, g= St Gottard, b= Brenner.

* Forecasts for 2010, when the year is not mentioned explicitly

Footnotes to Table 2

1 Istra - Italferr - Sis - Tav Spa "Feasibility study for the Simplon and St Gottard passes and prefeasibility study for the Villa Opicina pass" (1992) - shown as FS - routes in 2010 are as follows:

A- New high-speed line Turin/Lyon
New high-speed line Simplon Brig - Arona - Novara (average speed of in-service trains 200 km/h)
Outlet A - Pavia - Novara - Saronno - Bergamo - Treviglio
New high-speed line Brenner

B- New high-speed line Turin-Lyon
New high-speed line Sempione Brig - Domodossola - Milano (average speed of in-service trains 150 km/h)
Outlet B - Novara - Saronno - Bergamo - Treviglio - San Giuliano - Lacchiarella
Brenner line (improvements and alterations to Gabarit C)

C- New high-speed line Turin-Lyon
New high-speed line St Gottard: Chiasso - Como - Lainate - Milan
Outlet A: Pavia - Novara - Saronno - Bergamo - Treviglio
New high-speed line Brenner

D- New high-speed line Turin-Lyon
New high-speed line St Gottard: Chiasso - Como - Monza - Milan
Outlet B: Novara - Saronno - Bergamo - Treviglio - San Giuliano - Lacchiarella
New high-speed line Brenner

E- New high-speed line Turin-Lyon
New high-speed line St Gottard: Lugano - Varese - Gallarate - Rho - Milan
Outlet B: Novara - Saronno - Bergamo - Treviglio - San Giuliano - Lacchiarella
New high-speed line Brenner

2. The Austrian Federal Ministry of Transport and Public Works Brermer Pass study, known as Bren '92. This survey analyzes only traffic flows which may be relevant to the Brenner Pass. Traffic flow rates provided for the Simplon and St Gottard passes are therefore those which jointly represent competition for the Austrian pass. The estimate of 20.2 Mt. given for the St Gottard refers to the hypothesis that only the main line to the Brenner will be built.

3. The Italian State Railways study to which the model of traffic designation 'all - nothing' was applied, is based only on the passes Modane/Fréjus, Simplon, St Gottard and Brenner. The same technique was used and the same geographical areas covered by the Swiss study NFTA, thus allowing a homogeneous comparison.

4. The Swiss Ministry of Transport and Energy study "New Transalpine Railway Axes" - known as NFTA - provides two hypothetical alternatives: A (a high economic growth rate and a favourable situation for rail traffic) and B (a lower rate of economic growth and a favourable situation for road transport).

5. Italian and French State Railways study: "New links between Turin and Lyon". This study of transalpine routes carried out in 1993 and known as FS-SNCF - presents hypothetical data referring to the moment when the operation in question has actually been carried out. Should this intervention not have taken place, the forecast is 9.4 Mt per year.

5. Committee of Alpine Railways "Summing-up report" October '94 - known as CFA. This study presents two hypothetical market shares as regards means of transport: High 80 rail/20 road and Low 52 rail/48 road (numbers given in percentages).

Table 4 Outflows from Europe’ to Italy/Greece (mode transport: road; good category: food; year: 1986)

REGIONS	Real Flows	Estimated flows		Scenario 1 (time + 10%)		Scenario 2 ((time/cost)+ 10%)		Estimated flows rel. pred. err.		Scenario 1 rel. pred. err.		Scenario 2 rel. pred. err.	
		LOGIT	NN	LOGIT	NN	LOGIT	NN	Logit(%)	NN(%)	Logit(%)	NN(%)	Logit(%)	NN(%)
Thessaloniki	443 80	38636	43297	22564	42904	29176	43115	-12.94	-2.44	-49.16	-3.33	-34.26	-2.85
Athens	52047	43557	51038	16050	50565	39341	50693	-16.31	-1.94	-69.16	-2.85	-24.41	-2.60
Patras	53626	46130	52145	25265	52340	35481	52603	-13.98	-2.76	-52.89	-2.40	-33.84	-1.91
Heraklion	56930	53420	56916	50317	57730	30332	57824	-6.17	-0.02	-11.62	1.41	-46.72	1.57
Turin	259075	379966	398615	343890	401170	220704	401352	46.66	53.86	32.74	54.85	-14.81	54.92
Milan	414190	350049	432237	386103	432723	208729	432999	-15.49	4.36	-6.78	4.47	-49.61	4.54
Venice	53795	40932	56748	47947	56775	26790	56851	-23.91	5.49	-10.87	5.54	-50.20	5.68
Bologna	365183	355578	377438	365225	378716	192796	379190	-2.63	3.36	0.01	3.71	-47.21	3.84
Florence	178632	157254	185540	164387	181798	101032	182357	-11.97	3.87	-7.97	1.77	-43.44	2.09
Ancona	43653	42143	43540	42401	43617	22771	43574	-3.46	-0.26	-2.87	-0.08	-47.84	-0.18
Pescara	119774	113282	115746	107433	116100	64002	116021	-5.42	-3.36	-10.30	-3.07	-46.56	-3.13
Rome	35705	31264	34076	30840	34466	18261	34464	-12.44	-4.56	-13.63	-3.47	-48.86	-3.48
Naples	183553	188948	194825	140320	197702	122312	197946	2.94	6.14	-23.55	7.71	-33.36	7.84
Bari	105824	93432	99806	99633	101972	52125	102277	-11.71	-5.69	-5.85	-3.64	-50.74	-3.35
Reggio C.	29960	29558	28841	21101	28566	20258	28608	-1.34	-3.73	-29.57	-4.65	-32.38	-4.51
Palermo	126464	114747	124608	90232	126808	75681	127036	-9.27	-1.47	-28.65	0.27	-40.16	0.45
Cagliari	64435	57372	64633	64478	64336	31155	64503	-10.96	0.31	0.07	-0.15	-51.65	0.11
M*								-6.38	3.01	-17.06	3.30	-40.94	3.47
MA**								12.21	6.10	20.92	6.08	40.94	6.06

Notes to table 4:

- Spain and Portugal have not been considered.

* M = mean value of the variations from the real data.

** MA = mean value of the absolute variations from the real data.

Table 5 Inflows to Europe' from Italy/Greece (mode transport: road; good category: food; year: 1986)

REGIONS	Real Flows	Estimated flows		Scenario 1 (time + 10%)		Scenario 2 ((time/cost)+ 10%)		Estimated flows rel. pred. err.		Scenario 1 rel. pred. err.		Scenario 2 rel. pred. err.	
		LOGIT	NN	LOGIT	NN	LOGIT	NN	Logit(%)	NN(%)	Logit(%)	NN(%)	Logit(%)	NN(%)
Thessaloniki	19764	16122	19274	6649	19324	16283	19488	-18.43	-2.48	-66.36	-2.23	-17.61	-1.40
Athens	25965	29120	28287	6813	2843 1	26213	28501	12.15	8.94	-73.76	9.50	0.96	9.77
Patras	22569	13082	22478	8713	22101	16846	22155	-42.04	-0.40	-61.39	-2.07	-25.36	-1.83
Heraklion	18622	17711	19104	12340	19055	12086	19052	-4.89	2.59	-33.73	2.33	-35.10	2.31
Turin	820;281	724980	780102	774691	793751	400811	796122	-11.62	-4.90	-5.56	-3.23	-51.14	-2.95
Milan	3980845	3137979	3835833	3880482	3874579	1808444	3887546	-21.17	-3.64	-2.52	-2.67	-54.57	-2.34
Venice	922574	648524	864446	886303	830692	392430	831592	-29.70	-6.30	-3.93	-9.96	-57.46	-9.86
Bologna	7213650	5821584	6442638	7057064	6247481	3258554	6257957	-19.30	-10.69	-2.17	-13.39	-54.83	-13.25
Florence	1143048	1055770	1044481	1102063	1014918	559767	1011246	-7.64	-8.62	-3.59	-11.21	-5 1.03	-11.53
Ancona	1035352	992532	931062	991756	892805	518466	893153	-4.14	-10.07	-4.21	-13.77	-49.92	-13.73
Pescara	683626	628053	624495	642061	616435	339372	615614	-8.13	-8.65	-6.08	-9.83	-50.36	-9.95
Rome	351976	313587	318727	329765	304467	172024	301735	-10.91	-9.45	-6.31	-13.50	-51.13	-14.27
Naples	1258182	1167890	1155432	1190396	1135565	624124	1129908	-7.18	-8.17	-5.39	-9.75	-50.39	-10.20
Bari	2442992	2086402	2279118	2385679	2202194	1120275	2186937	-14.60	-6.71	-2.35	-9.86	-54.14	-10.48
Reggio C.	222407	211238	209597	205187	202594	113536	201097	-5.02	-5.76	-7.74	-8.91	-48.95	-9.58
Palermo	703347	614024	668120	567622	646903	389092	645495	-12.70	-5.01	-19.30	-8.03	-44.68	-8.23
Cagliari	48357	48196	46894	48921	45347	24706	45661	-0.33	-3.03	1.17	-6.22	-48.91	-5.58
M*								-12.10	-4.84	-17.8	-6.6	-43.80	-6.65
MA**								13.53	6.20	17.97	8.03	43.91	8.07

Notes to table 5 :

- Spain and Portugal have not been considered.

* M = mean value of the variations from the real data.

** MA = mean value of the absolute variations from the real data.