A 75% REDUCTION IN CO2 EMISSIONS BY 2050: IS FREIGHT TRANSPORT GOING TO CHANGE?

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ABSTRACT

Many studies (BEN-AKIVA, 2008 et alii; McKINNON, 2007; REDEFINE, 1999; LOPEZ-RUIZ, 2009) conclude that freight transport in Europe is defined by a highly concentrated production structure where, over the last two decades, a rise in overall transport distances has been observed. This increase in transport distances is explained by the growing mobility of high value-added products. In this manner, as European authorities decide to reduce overall emission levels, constraints aiming at CO2 reductions will certainly have effects on freight mobility and/or the production/distribution structure.

This paper aims at assessing the evolution of freight transport on a European level and looks into how carbon constraints on transport would imply changes in consumption behaviors that will have consequences on freight movements. This paper particularly develops the idea that by assessing the microeconomics of consumer's adaptation strategies, trend changes in European freight movements can be easily deduced.

Keywords: Greenhouse gas, long term, scenario, transport, sustainable development.

1. INTRODUCTION

Currently, transport activities in France are at the origin of 25% of the county's total energy consumption and are responsible for, at least, 30% of its carbon dioxide emissions. In essence, 80% of these emissions come from road transport and even tough we have seen the birth of new technologies in the transport sector and that we have witnessed a growing "social and entrepreneurial conscience", unfortunately, these environmentally friendly products and/or services have observed a very slow implementation.

In an effort to counteract global warming, many countries have decided to limit their global green house gases (GHG) emissions particularly in the transport sector. As a result, new automotive technology prospects have been increasingly presented as possible solutions to the need for drastic reductions in greenhouse gases. However, recent studies like those of: A. SCHEAFER, et al, (2009); D. SPERLING & N. LUTSEY (2009) and LET-ENERDATA (2008), have clearly underlined that technological progress cannot be effective if it is not accompanied by deep organizational and behavioral changes (especially if we are aiming at a very important reduction in emissions).

In this sate of matters, transport activities as we know them clearly pose an environmental problem that will most certainly lead to increasing constraints on overall mobility through public action. Consequently, there is a growing need in finding straightforward answers to questions such as: How will climate oriented policies affect freight mobility in the long term? But more importantly, how will changes in public policy influence freight transport services in the future?

In order to answer these questions, we will use the microeconomic framework of the micro-module of the TILT model (Transport Issues in the Long Term), developed in 2008 by the LET-ENERDATA consortium. The TILT model is centered on defined behavior types -in which the speed/GDP elasticity plays a key role- in order to determine demand estimations.

The TILT model has been designed to be a long-term equilibrium model by combining a macroeconomic and microeconomic structure in a backcasting approach that takes into account new motor technologies and facilitates sensitivity and impact assessments through five modules: A macroeconomic module, a microeconomic module, a vehicle fleet dynamic and a technology evolution module.

In LOPEZ-RUIZ (2009) this model was enriched to also be able to asses the system's sensitivity to public policies, the investment needs in infrastructure and the economic impact of different public policies whilst taking into account microeconomic choices. In this paper we will particularly focus on these microeconomic developments –put together in a module called IT-UP (Integrated Tools for Utility-based Planning)- in order to precisely analyze what different types of public policies might imply on the passenger choice model and how these changes might impact freight operations in the future.

2. THE MICROECONOMIC FRAMEWORK

The IT-UP module lets us understand how, according to macroeconomic past tendencies (characterized by the coupling between growth and mobility), future public policies will impact demand for transport services as well as trade-offs linked to behavioral change and infrastructure use on different geographical scales. Moreover, it enables the user to assess future adaptation strategies.

IT-UP is largely inspired by developments done on ant algorithms (DORIGO, et al 1999) and their application to freight and passenger transport (LOPEZ-RUIZ, 2009 and LOPEZ-RUIZ & CROZET, 2010). This module relies on the idea of a representative agent that optimizes its transport decisions by taking into account opportunity (defined as the sum of goods and services that can be consumed in a period of time -LINDER, 1970) and cost in respect to a certain level of service on infrastructure -measured through a lateness index (LOMAX, et al, 1997).

IT-UP considers that the lateness index is defined by the difference existing between normal transit time and real transit time. This last indicator is useful in factoring in speed, distance and time into the calculation of the choice model and has the convenience of being comparable between modes.

In this manner, the proposed framework lets us asses the representative agent's choices that are coherent with the transport structure and its level of service. In the model, the value assigned to each choice (aij(t)) is calculated using the following equations:

Equation 1

$$a_{ij}(t) = \frac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{1 \in Ni}[\tau_{il}(t)]^{\alpha}[\eta_{il}]^{\beta}} \qquad \forall j \in N_i$$

Where:

Equation 2

$$\eta_{ij} = \frac{opportunity}{\text{cost}}$$

and

Equation 3

$$\tau_{ij}(t) = Lateness\ index(t)$$

and

Equation 4

$$opportunity = \frac{\sum goods\ \&\ services}{time}$$

Using this microeconomic framework, the inherent logic in technico-organizational public policy assessments in IT-UP, is linked to the idea that public policies are implemented as increasing/decreasing constraints on the overall system in view of getting to a certain objective (for example, a defined reduction in oil consumption). Consequently, this implies a wide variety of social effects on different levels and aspects that will modify the agent's decisions based on changes in transport cost, time, level of service, etc.

In this manner, by supposing that the utility of an agent is function to the opportunities it has - $u(opportunity)$ - IT-UP offers insight on the agent's utility for a certain trip according to a defined motive, a certain cost on a particular transport mode and –more importantly- consumption of goods and services.

In this manner, through this simple microeconomic model, we are capable of giving insight on how changes in passenger behavior linked to environmentally oriented public policies might influence passenger transportation demand in the future. In the following paragraphs we will develop our ideas on this point. In order to do that, we will use the basis of three long-term exploratory scenarios. In this paper we will not use the numerical results of the scenarios but only use them as a guide concerning the changes that can be expected from different types of public policies and how these changes will impact (in a general way) the system.

3. CLIMATE POLICY AND ITS IMPLICATIONS ON THE OVERALL GOODS MOVEMENTS STRATEGY

In 2008 LET-ENERDATA study proposed three backcasting scenarios in order to give insight on future transport options. This project required the specification of a desired future (-75% in emissions by 2050) and then different scenarios were specified by identifying the diverse equilibriums possible that allow the attainment of the specified future. From these possible equilibriums, the three that best depict the range of solutions available were chosen and presented. These three scenarios are:

- Business as usual (BAU) that promotes strict technology standards

- Promoting green multimodality

- Promoting the decoupling of transport activities and economic growth (GDP)

Without going into the specifics of each scenario, their results are obtained by modeling a mix of different policies aiming at sensible changes in transport behavior and new motor technologies. Each of these scenarios implies different characteristics and thus different types of results that are tightly linked to modal shares and demographic dynamics.

In the 2008 study, the BAU scenario is based on an inelastic market structure largely dependent on private vehicles and it aims at showing that reductions (-75% by 2050) in emissions cannot be solely obtained through the introduction of new hybrid motor technologies. In this scenario, public policies appear merely as accompanying policies in an ongoing trend of the system. The results in this scenario show the need for other options in strategies concerning emission reductions, more precisely the need to look for strategies involving changes in transport behavior. In the original study, a multimodality scenario and decoupling scenario are presented as possible solutions. In this paper, we will only use these two alternative scenarios, which offer insight on how behavior should adapt in order to obtain drastic reductions in GHG. We will build on these results and give insight on what these results mean on goods movements in the long term.

The LET-ENERDATA report presents a multimodality scenario that introduces public policies where constraints on speed and emissions come into play as a signal aiming at changing behavior patterns. In consequence this scenario implies an increase in road transport costs.

Consequently, the rise in road transport cost translates into a sharp increase in the use of rail and public transport for personal and freight mobility. This, in turn, implies that average speed in the system goes down and transport times go up while household and firm transport monetary budgets increase in a very sharp way (more or less depending on car use elasticity). This implies that the choice model would be influenced by rising costs in the transport sector: $\eta_{ij} = \frac{opportunity}{\Uparrow \text{cost}}$.Therefore, this scenario supposes that the population would accept paying more for slower overall speeds.

This situation seems particularly difficult because it translates into not only paying more but also spending more time on transport activities and thus loosing potential value added time that could be spent increasing revenue. Consequently, increasing the sum of goods and services (opportunities) linked to transport activities might help to counterbalance this situation for passengers.

In short, by rendering transport time more productive, a strong multimodality scenario aimed at drastic emissions reductions would have a better change of being accepted than a multimodality scenario where slower speeds and longer transport times would be imposed. Consequently, this situation implies the need for a change in the way that goods and services are distributed, proposed and consumed.

If we follow the same line of reasoning in a decoupling scenario, the logic of adaptation changes drastically. A decoupling scenario is very influenced by proximity services, the public policies at play are largely related to spatial planning and infrastructure investment (LOPEZ-RUIZ, 2010) and the main trade-off at play is directly linked to localization strategies and production organization aimed at decoupling transport distances form GDP growth.

In the original LET-ENERDATA scenario, these policies entail a densification of main cities and production sites which would in turn; translate into a sharp increase in the use of urban and regional road networks.

Unlike the multimodality scenario, transport cost characteristics in a decoupling logic lead to more stable transport money budgets because transport distances grow at a slower pace. In this case, if there is a sharp increase in transport times and/or cost, the normal response would be a very fast increase in demand for proximity solutions (accompanied by a demand of on-board services also, but in a minor way) as consumer behavior is modified. This would imply new types of consumptions logics and services linked to changes both on the production side and the distribution side.

Indeed, since constraints are even higher than in a multimodality scenario, opportunities must increase even more in order to counterbalance overall distance reductions (more than can be offered by simply rendering transport times more productive).

This difference in the adaptation logic for passengers finds its explanation on the fact that, a decoupling scenario implies very high use of proximity public transport and this will most certainly decrease price elasticity of demand (PED) in public transportation and thus cause a shift in market power. This change in market power will most undoubtedly profit users (who, in this configuration, would be paying a big price for the greater good) instead of transport operators. It is the shift in market power that should have an impact on how opportunities are conceived by users and planners. Thereby, the development of transport networks based on an “opportunities in a certain time” (accessibility) would have to give way to a logic based on “time it takes to access opportunities”.

On one hand we will have certain products that require time to be consumed and our choices will still be based on a trade-off involving time, cost and opportunity. On the other hand, in order to counterbalance higher costs and lower travel distances, new proximity strategies will push to a new trade-off in certain goods and services where the time it takes to access them will be of the essence $\eta_{ij} = \frac{opportunity}{\text{cost}}$

As a result of the changes, freight transport strategies will undoubtedly have to follow not only passenger's adaptation to carbon constraints but also how distributors and producers will adapt to new growing needs stemming from changes in passenger behavior.

In this manner, the biggest difference behind an emission reduction strategy involving multimodality and a strategy involving decoupling lies in passenger's time management strategies. If we are looking into multimodality we are certainly talking about a time management strategy that would render transport time more productive (which means increasing transport-linked opportunities for passengers e.g. internet connections on trains, hairstylist or on-board working rooms) whilst in a decoupling scenario the time management strategy should be one increasing the opportunities linked to a certain accessibility level (by faster access speeds and/or lower access distances and or increasing availability to passengers, e.g. increasing the number of public pools in a city or creating a fast access service to pool facilities or even re-localizing production and distribution sites).

4. CLOSING REMARKS

It is widely known that whilst public policy might be aimed at reducing GHG emissions and its effects on the environment, the impacts of these actions will be different for passenger and freight transport. Through this paper we have aimed at showing how these differences will operate according to different public policy strategies and how this will impact consumption behavior in the long term. In this sense, we can see that the past tendencies for freight organization are more likely to continue for a few decades.

On a regional and interregional level "low-emission high speed transport" for passengers is something that already exists and that will most certainly be promoted as a solution to GHG reduction objectives. On an urban level, the fact that most big cities in Europe are well equipped in public transport will most certainly bring about big changes on how public transport is conceived and how it might be better utilized especially by increasing productivity through onboard services and goods. This in turn implies that goods movements linked to distribution activities will probably increase on the urban and regional level but with no significant changes on how the productions system is organized.

In this manner, freight transport strategies will probably appear as a part of the solution. Indeed, by acting as an adaptation enabler for passenger transport, freight transportation services will be a key element for fully integrated passenger/freight strategies that will be necessary in order to gain whilst continuing to open new markets for new types of behaviors and to renew dynamism on European markets.

The actual lack of interoperability and/or flexibility and/or reliability of non-road modes will most certainly play a very big part in the continued success of road transport in Europe. Even though all of these problems need to be overcome before we can start talking about serious CO2 reductions in the freight sector, it will most certainly take more than a decade before they start to be seriously addressed and in order to start dreaming of a serious freight GHG reduction strategy. Nevertheless, as passenger needs evolve (more or less depending on the carbon constraint), new consumption behaviors will force adaptation on certain freight services.

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