A THEORETICAL ANALYSIS OF SHORT SEA SHIPPING AND INTERMODAL COMPETITION[1]

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Abstract

Despite the EU efforts promoting policies to encourage Short Sea Shipping (SSS) based on its advantages in terms of intermodality and environment, this mode has not yet reached a significant market share as compared to land transport. In this paper we establish a thesis which suggests that funding programmes, such as Marco Polo I and II, have not offered the right incentives to promote SSS, and some aspects, as the key role of port infrastructure and its characteristics, have not been taken into consideration. In order to prove this thesis, we use a theoretical intermodal competition model between alternative modes – road transport vs. SSS– departing from the traditional transport cost models. After this analysis we reach the conclusion that EU needs to focus on ports and the whole transport system efficiency in order to reach an effective competition in freight transport market.

Keywords: Short Sea Shipping; intermodal competition; European freight transport market.

JEL Codes: L91, R41, R48.

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1. Introduction

In recent years, EU policies have been conscious about the damages that road transport generates to society in terms of external costs (Medda and Trujillo, 2009). Problems such as congestion, pollution and other environmental aspects have encouraged the need of developing a regardful transport policy. Furthermore, some competition issues have come up with respect to the unbalanced modal split in freight transport market, where road transport (a mode that does not internalize the external costs it produces) absorbs around half of the total market.

According the EU goals, Short Sea Shipping (SSS) should constitute an alternative to road transport, either as a part of an intermodal transport chain or as a full substitutive mode, depending on each specific corridor. European Commission has considered that this mode of transport offers a set of advantages that no other mode can provide in EU, especially in terms of environment, fact that has been supported by previous literature (Medda and Trujillo, 2009).

Taking into consideration the SSS advantages and its potential role in intermodal freight European transport, EU has developed a number of different policies in the recent years, with the aim of reaching a real intermodal competition, through different measures and tools. EU programmes such as the Pilot Action for Combined Transport (PACT), Marco Polo I and II, Galileo and Trans-European Transport Network (TEN-T) have been designed (with slight differences among them, in terms of period of time and specific objectives), in last term, to promote different (and socially preferred) modes of transport and intermodality. All these programmes have been promoting SSS, by giving aids to companies *with a project to transfer freight from road to rail or short-sea shipping routes or inland waterways*[2].

Nevertheless, with a total budget of €895 millions (considering the three aforementioned programmes), EU measures have not reached the proposed goals. Regarding to the modal split, it does not seem that big differences have

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[2] See more in http://ec.europa.eu/transport/infrastructure/index_en.htm

been made with EU policies. In 1995, road transport represented the 42.1% of total freight transport in EU-27, and sea transport the 37.5%. In 2009, these figures changed to 46.6 and 36.8% respectively. That is, while road transport has increased its market share, sea transport has practiced a decrease, so the difference between both competitors has risen (from 4.6% to 9.8%).

It could even be considered that road has improved its position in the freight market. In fact, it is the only mode of transport that has augmented its market share in the last decade, not considering the external costs that it produces (Medda and Trujillo, 2009). What it is more significant (and worrying) is that, during the sub period 2000-2009, road transport has increased 11.4%, whereas sea transport has practiced an increase of 1.7%. This results show a virtually insignificant impact of the Marco Polo I and II programmes implemented over the previous years.

In order to determine why these programmes and measures have not reached their objectives, it is necessary to analyze how they have been implemented. As Marco Polo official information about the programme establishes, "*Funding is in the form of an outright grant. It is not a loan to be repaid later. Applicants must meet a series of conditions to obtain a grant. Grants cover a share of costs associated with the launch and operation of a new modal-shift project, but must be supported by results"* Aids and funds have been given to companies which shift cargo from road to SSS (considering sea transport case), but there is no incentives to promote efficiency in SSS activities to make it more attractive to companies. In this paper, we establish the hypothesis that the role of port (as node) infrastructure and its characteristics in an intermodal chain are essentials to get a real shift, and EU needs to promote efficiency to the total system instead of giving grants directly to companies. In other words, the issue has to be addressed considering not only some parts of the problem as EU has been doing so far (i.e., companies), but also the whole system through the promotion of a high level of efficiency.

The structure of this paper is as follows: first, in section 2 we analyze the European experience in SSS, especially considering their promotional policies and the current intermodal competition in EU freight transport market. Then, in section 3, a theoretical model of freight transport market competition is developed in order to test, in section 4, different SSS-intermodality promotional policies, to observe their impacts on market shares. Finally, our conclusions are presented in section 5.

2. Short Sea Shipping: the European experience

Around 70% of European industrial production is located within 150-200 km from the sea (Paixao and Marlow, 2002). This data give us an idea of how straightforward sea transport may be integrated in an intermodal freight transport chain, according to European geography. As these authors sustain, the capacity of sea transport as corridor itself is unlimited, there is no congestion and, therefore, the fact that a new shipper uses a specific corridor does not generate delays to other shippers (without considering the role of ports, as we do in our theoretical model). These characteristics make the differences between SSS and its major competitor in freight market, road transport. Moreover, considering environmental aspects, it is proved how SSS reduces air pollution so it is considered as an environmentally friendly mode of transport (Medda and Trujillo, 2010; Paixo and Marlow, 2002).

Previous literature has deeply analyzed the main advantages, disadvantages and goals of SSS. Baird (2002) highlights some natural advantages of sea transport, specially considering that *sea transport capacity may be increased, substantially and speedily, through the addition of more ships, or larger ships, or faster ships, whereas to expand roadway or railway capacity requires very expensive adjustments to infrastructure, new legislation, etc.* (pp.290). Although most studies show SSS as advantageous, some authors defend different disadvantages. Douet and Cappuccilli (2011) show how misknowledge of SSS markets has led to the overestimation of the modal shift from road to sea transport potential. They argue that some routes benefited from EU programmes are captive markets where there is no road option, so there is no modal shift. However, this aspect represents a critic to EU SSS promotion policies, not to the real nature of SSS as an alternative mode of transport. Nevertheless, the objective of this paper is not to analyze the SSS advantages and disadvantages[3], but to analyze the variables and also policies that may interfere on the reaching of a substantial role in intermodal transport chain.

European Commission has carried out several studies highlighting the role of SSS in transport competition. According to them, *SSS can help rebalance the modal split, bypass land bottlenecks, and it is safe and sustainable* (COM, 2003). The *Programme for the promotion of Short Sea Shipping* (COM, 2003) established, in line with the previous reasons, some legislative, operational and technical actions (composed by 14 measures), that have been (and will be) developed last years in order to promote SSS in the EU (for instance, there are *SSS Promotion Centres* in 13 countries currently).

Previously, the Pilot Action for Combined Transport (PACT), which nature comprised the SSS promotion as part of an intermodal chain, had financed 167 projects during the period 1992-2000, with a budget of €53 millions (Brooks and Frost, 2004). PACT was superseded in 2001 by Marco Polo I programme, which main objective was to bring sustainable freight transport, avoiding road transport, by encouraging rail, sea and inland waterways transport. According to European Commission "*the new Marco Polo programme will make a substantial contribution to converting intermodality into a reality in Europe"* (COM, 2003). Over the period 2003-2009, 125 projects involving more than 500 companies received funding from this programme, with a budget of €102 millions. Last, Marco Polo I has been superseded by Marco Polo II, with a budget of €740 millions for the period 2007-2013.[4] Regarding to SSS and intermodality, there are other European projects that may contribute to their developments (Grosso et al, 2009), such as the Galileo program and, specially, the Trans-European Transport Network (TEN-T), which objective consist of *establishing a single, multimodal network that integrates land, sea and air transport networks throughout the Union*.[5]

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[3] Medda and Trujillo (2010) analyze the situation of SSS in Europe, considering not only its advantages and disadvantages, but also goals and future perspectives.

[4] See more data in http://ec.europa.eu/transport/marcopolo/index_en.htm

[5]See more in http://ec.europa.eu/transport/infrastructure/index_en.htm

On the attempt to understand SSS competitiveness and potential, its cost structure must be carefully considered. Around 40-60% of SSS overall transit costs are caused by port charges (Pettersen, 2004, pp.139). Nevertheless, the role of ports in SSS promotion has been under-considered. Previous EU promotional policies have focused on aiming companies to transfer cargo from road to sea. That is the case of Marco Polo programmes, which give grants to companies in order to cover *a share of costs associated with the launch and operation of a new modal-shift project*[6], and these funds are not to be refund later. However, none of these programmes have focused on improving port efficiency as a way to increase the modal shift from road to sea transport. As some authors point out, in order to reach the policy goal is important to increase its efficiency by reducing cargo-handling or waiting times (Koi Yu Ng, 2009; Pettersen, 2004).

However, despite being conscious that SSS is more profitable to the whole society (and, with the right signals, to companies), and being promoted by EU, SSS has not reach a significant market share comparing to road transport. In this paper we establish the hypothesis which suggests that funding programmes, such as Marco Polo I and II, has not offered the right incentives to promote SSS, and aspects like the key role of port infrastructure and its characteristics, has not been considered. We assert that EU needs to focus on them in order to develop a competitive intermodal freight transport chain that reduces road transport market share (and, consequently, its disadvantages).

3. A theoretical model for freight transport market competition

According to Eurostat data, SSS represented 62% of the total European sea transport in 2009 (with differences among countries). Considering the region of partner ports, Mediterranean and North Sea comprise 29.7 and 26.4%, following by Baltic Sea, which constitutes 19.6%. Regarding to the type of cargo for all sea regions, liquid bulk represents the most frequent in SSS operations,

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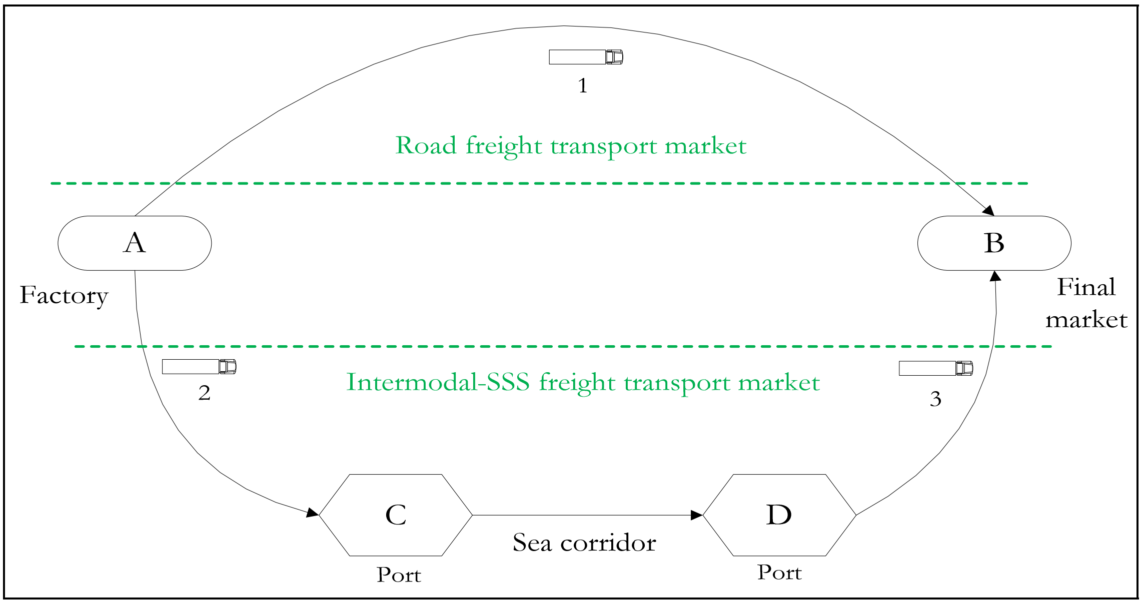
[6] See more in http://ec.europa.eu/transport/marcopolo/about/index_en.htm

with a share ranging between 40 and 69% of total cargo among different sea regions. Last, the top 20 listed ports accounted for 36% of total EU-27 SSS of goods, being Rotterdam (The Netherlands) the most important one with a 7.5% of share of total EU-27 SSS operations.

Using this data, it is possible to develop a theoretical model for intermodal competition between alternative modes – road transport vs. SSS– in a single corridor, departing from traditional transport cost models. The model shows the interaction of two alternatives modes in freight transport market. Figure 3.1 represents this freight transport market in a specific corridor. There are two alternatives: first option consists of going from factory (A) to final market (B) by using shipper 1. We consider this option as road freight transport market. Second option consists of going from factory (A) to Port C by shipper 2, then from there to port D and, finally, from this port to final market (B) by using shipper 3 (that is, a door-to-door system). We consider this option as Intermodal-SSS freight transport market.

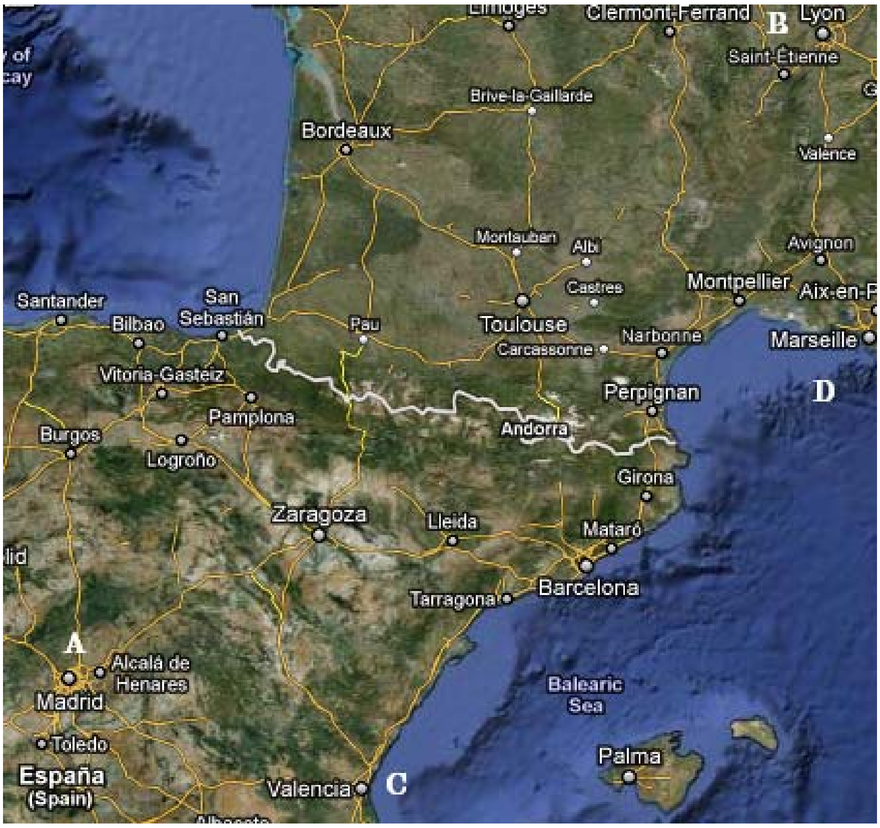
Figure 3.1. Theoretical freight transport market. A single corridor



Source: Own elaboration

A suitable example of this theoretical corridor in EU could be the following: let us consider a company which has to transfer cargo from Madrid (Spain, A) to Lyon (France, B). The first option is to do this directly by road, by crossing Pyrenees, but this is not the only option. This company could use an intermodal transport chain, by using Valencia (Spain, C) and Marseilla (France, D) ports, as it is shown in figure 3.2.

Figure 3.2. Madrid-Lyon corridor. An example.



Source: Google maps.

This example fits into the UE SSS promotional policies requirements (it also has to satisfy some cargo and cost conditions[7]): a corridor that links two different European countries where there is an alternative to shift cargo from road to sea, as Marco Polo II requires.

Therefore, to develop a theoretical modelization of a corridor like the previous one, let us consider the different agents involved in each market. In road transport option, there is only one agent: shipper 1. In intermodal-SSS option, we consider sea-shipper, shipper 2 and 3 and port authorities. In this model we do not consider producers and consumers, due to the fact that they are the same among alternatives, and we suppose that their producer and consumer decisions are not affected by the freight transport market. It has to be

[7] See specific conditions in http://ec.europa.eu/transport/marcopolo/index_en.htm

mentioned that the model consider a specific market size and, therefore, the modal split in it.

From above, we will consider the generalized cost of each alternative, that is, the whole cost that includes not only monetary cost (price) but also time costs, in order to get a better performance of cost functions, considering the traditional transport cost models. The generalized cost functions of one unit of product (e.g. TEU) of each alternative are:

$$GC_{road} = (p + z) \cdot d_{AB} + v_i \left[t_{road}^{AB} + t_{road}^{a} \right]$$

$$GC_{sss} = (p + z) \cdot (d_{BD} + d_{AC}) + \left(\frac{cai}{Q} \right) \cdot d_{CD} + v_i \left[t_{road}^{BD} + t_{road}^{AC} + 2t_{road}^{a} + t_{sss}^{CD} + \eta \right]$$

where

$$t_{mode}^{OD} = \frac{d_{OD}}{S_{mode}}$$

and

- p: price per kilometer.
- z: taxes per kilometer.
- d_{OD}: distance between origin O and destination D.
- v_i: value of time of company i.
- cai: carriage all in (includes loading, unloading, drive to the storage)
- Q: quantity
- S_{mode}: average speed on mode m.
- t_{road}^{a} : road access time.
- η : Port inefficiency.

In the road transport generalized cost function, we consider the monetary cost (price and taxes) of carrying a TEU from A to B (in our example, from Madrid to Lyon), plus the whole time cost of the same distance. In the SSS-intermodality one, we consider the monetary cost of shipper 2 and 3 (from Madrid to Valencia and from Marseille to Lyon, respectively) and carriage all in per unit of product, and also the time cost of the whole distance (for each mode used in the intermodal chain). It has to be mentioned that parameter z is included in order to show all types of taxes that can be consider in each transport activity. It could also comprise the internalization tax of externalities caused by each mode, the only way for a firm to consider the damages that it generates to society[8]. Let now focus on parameter η. This parameter comprises waiting times, documentary and administrative procedures, etc.; i.e., all those characteristics that affect the efficiency of a port. They are related to time considerations, so it is a part of time cost and consequently it is affected by the value of time of the company considered. In other words, some companies could be more eager to suffer delays on their shipping activities than others, depending on different characteristics, specially whether products are perishables,. That is the main reason why port inefficiency is in the time part of generalized cost (and, consequently, affected by the time value). We have to mention that this model reflects the private company decision, so external costs (not internalized) are not considered in cost functions. As it has been mentioned, external costs could be introduced in this model through taxes (z), and therefore we would be using a social cost perspective. Each company i will choose the mode that minimizes its cost, that is:

$$m \left| CG_{\mathrm{mode}} = \min \left\{ CG_1, \ldots, CG_M \right\} \right.$$

As it was mentioned above, different companies have different time values, depending on characteristics as product perishability, mainly. This feature may lead to companies with a very high time value, due to the fact that they have to transport products with a low perishability, and some others with a very low time value, that are willing to accept long waiting times in exchange for a lower monetary cost. This is, basically, the reason why some companies may consider a mode as more advantageous for its purposes than others.

Here, we suppose that firms will have a time value situated in an interval between 0 and 1, in order to solve the model.

[8] This type of internalization measure, known as *Pigouvian tax* (Pigou, 1932), is designed to correct a market distortion when there are negative externalities that, without it, would not be considered by private companies.

$$v_i = f(\text{product and company characteristics}) \in (0,1)$$

Taking into consideration this assumption, we know the proportion of companies that will choose each mode, by calculating a value (i.e., a company) where there is no difference between choosing one or another mode.

$$GC_{road} = GC_{sss}$$

$$(p+z)\cdot d_{AB} + v_i\left[t_{road}^{AB} + t_{road}^{a}\right] = (p+z)\cdot(d_{BD} + d_{AC}) + \left(\frac{cai}{Q}\right)\cdot d_{CD} + v_i\left[t_{road}^{BD} + t_{road}^{AC} + 2t_{road}^{a} + t_{sss}^{CD} + \eta\right]$$

Using this rule of indifference, it is possible to obtain the proportion of companies of each mode, that is: v* and 1-v*.

$$v^* = \frac{(p+z)\cdot(d_{BD} + d_{AC} - d_{AB}) + \left(\frac{cai}{Q}\right)\cdot d_{CD}}{\left[t_{road}^{AB} - t_{road}^{BD} - t_{road}^{AC} - t_{road}^{a} - t_{sss}^{CD} - \eta\right]}$$

If

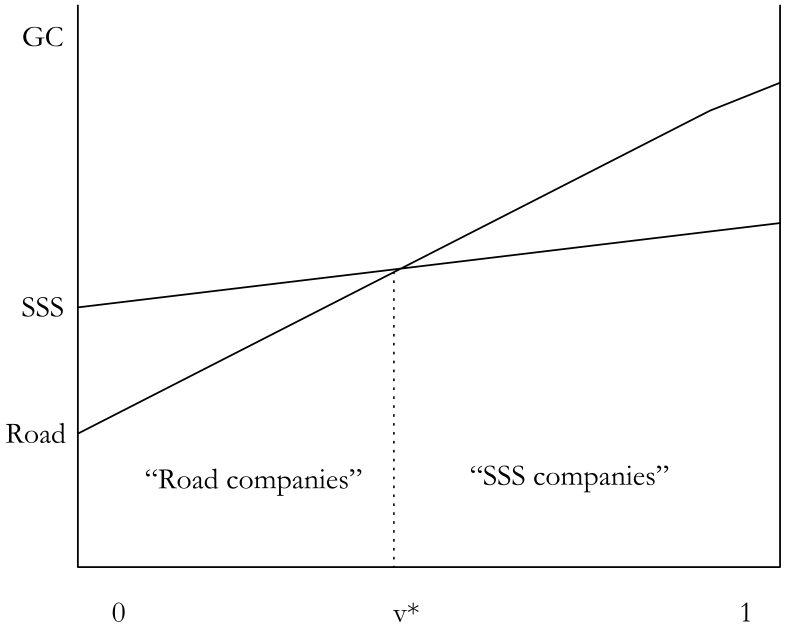
$$(p+z)\cdot d_{AB} < (p+z)\cdot(d_{BD} + d_{AC}) + \left(\frac{cai}{Q}\right)\cdot d_{CD}$$

that is, the intercept of road transport cost function is smaller than the intercept of SSS transport cost function, then:

$$v^* = \text{Proportion of companies on road.}$$
$$1 - v^* = \text{Proportion of companies on } SSS.$$

(and reverse if the intercept of road transport cost function is bigger than the intercept of SSS transport cost function, then)

Figure 3.3. Generalized cost functions



Source: Own elaboration based on Dixit and Nalebuff (1992)

With the above model for a given market size, we have calculated the proportion of companies that choose each mode. However, we do not consider that companies in a market have different sizes, and it is quite naïve to consider different firms as equals. A most important concept is the market share of each mode, and to know this, it is necessary to discover the distribution of firm sizes considering a specific corridor or market.

Therefore, in order to calculate market shares, it is necessary to approach the real distribution of firm sizes. It would be necessary to determine, in an empirical work, the right distribution to consider market shares instead of proportion of companies that choose each mode. However, through our theoretical analysis, we will see how different European policies may affect companies and their decisions about modal choice.

3.1. European Transport policies. SSS-intermodality promotion

As data and literature review show, SSS is promoted by the EU through the previously mentioned Marco Polo I and II programmes. Their objective is to increase the market share of SSS as a part of an intermodal transport chain, and therefore to increase the level of competition in this market, and also to reduce problems such as congestion and other external costs that road transport generates by giving grants to companies which transfer cargo from road to SSS routes.

Using the previous model, we will test here how different policies may affect to the theoretical modal split in order to find the best tool to reach the EU goal. Concretely, three different policies are analyzed: first, the traditional tool to make a company to internalize its external costs, that is, through taxes. Second, it will be tested the current EU policy of giving grants to companies to shift cargo from road transport to SSS. Last, an increase in port efficiency is considered. For all this, let calculate the different impacts of each policy, as shown the following expressions:

a. Increasing road transport taxes

Increasing road transport taxes is considered as a way to make road transport internalize the external costs that it produces. This measure it is considered as one of the easiest tools to increase the level of competition between road transport and SSS.

$$\frac{\delta v^*}{\delta z} = \frac{d_{BD} + d_{AC} - d_{AB}}{\left[t_{road}^{AB} - t_{road}^{BD} - t_{road}^{AC} - t_{road}^{a} - t_{sss}^{CD} - \eta\right]}$$

In practice, an increase in road transport taxes decrease the market share of this mode. However, as the above expression shows, this reduction is conditioned by the relationship between times and port inefficiency. It is straightforward to prove how the impact of this policy is less effective when port inefficiency is high.

b. Funding "carriage all in" cost

Some EU policies and programmes have consisted of giving grants (with do not have to be refund later) to firms that shift cargo from road to sea, as it has been said in previous sections. Marco Polo I and II programmes are proof of that. This measure could be seen by the firm, in essence, as a reduction of shipping costs. Therefore, this type of measures is analyzed in our model is a reduction of "carriage all in" cost.

$$\frac{\delta v^*}{\delta\left(cai/Q\right)} = \frac{1}{\left[t_{road}^{AB} - t_{road}^{BD} - t_{road}^{AC} - t_{road}^{a} - t_{sss}^{CD} - \eta\right]}$$

It is expected that the above expression is positive, so an increase in carriage price increase road transport market share. As previous policy, not only time structure affects this expression, but also port inefficiency. The impact on market shares of carriage price changes are conditioned by the level of efficiency of ports C and D (in our example, Valencia and Marseille ports). Once again, it is possible to prove how the impact of this policy is less effective when port inefficiency is high.

c. Improving port efficiency

Last, let us consider the impact of an improvement in port efficiency. As it was defined, in this model this parameter comprises waiting times, documentary and administrative procedures, etc. i.e., all those characteristics that affect the efficiency of a port. In this line here it is calculated the impact on results of an improvement of this procedures, so port efficiency is increased.

$$\frac{\delta v^*}{\delta\eta} = \frac{\left(p+z\right)\cdot\left(d_{BD} + d_{AC} - d_{AB}\right) + \left(\frac{cai}{Q}\right)\cdot d_{CD}}{\left[t_{road}^{AB} - t_{road}^{BD} - t_{road}^{AC} - t_{road}^{a} - t_{sss}^{CD} - \eta\right]^2}$$

In practice, an improvement in port may increase SSS-intermodality market share, so previous expression is likely positive. This policy will be affected by the total transport cost structure, as times, price, taxes or carriage, as it was expected. A more detailed result could be reach through an empirical estimation of this model in a specific corridor.

From the previous analysis, it has been shown how every single policy is conditioned by the whole system. Results of implementing a unique policy in order to promote SSS-intermodal transport chain depend not only on variables such as distances and speeds (where there is not possible to introduce major changes), but also on port efficiency. Therefore, as results show, policies that try to internalize road transport costs and shift cargo from road to sea transport must be accompanied by the improvement of port procedures and infrastructure in order to reach a real competition in freight transport market.

4. Conclusions

In this theoretical work, it has been analyzed the intermodal competition between road and sea transport in the european freight transport market. Due to the fact that road transport does not internalize the whole cost it causes to the society (congestion, pollution, other environmental damages, etc), at the time, there is not high level of competition between these two modes.

Previous facts has encouraged the EU to promote SSS instead of road transport. EU programmes such as the PACT, Marco Polo I and II have been developed in order to reach a real competition between road and SSS, by giving funds to firms that shift cargo from road to sea transport. In last decades, it has been designated around €895 millions (considering previous three programmes budgets) to reach this goal.

Nevertheless, despite these policies, road transport, -which represented the 42.1% of total freight transport in EU-27-, and sea transport - 37.5% in 1995-, has changed to 46.6% and 36.8% respectively, in 2009. That is, while road transport has increased its market share, sea transport has experienced a decrease, so the difference between both competitors has increased from 4.6% to 9.8%, even with EU promotional policies and efforts.

Therefore, if goals have not been reached, is logical to find that measures have not been the most suitable ones to deal with the issue. In this theoretical analysis, it has been proved how system is interconected. The impact of a specfic policy is conditioned by different variables which have to be considered in order to achieve the greatest efficiency possible. Furthermore, EU policies have not considered that firms have different valuations of time, so in terms of modal shift it would be more appropriate to take this into consideration due to the fact that each firm has not the same incentives as others to use EU aids (some of them could prefer longer times with a lower monetary cost, while others could not) and therefore, to shift cargo from road to sea transport.

System efficiency has not been taken into consideration by EU. That is specially the case of ports, the nodes of SSS activities although the key role they have on SSS competitiviness. The efficiency of these nodes is essential to increase to competitiviness of SSS, through improving waiting times, documentary and administrative procesures, and, in the end, acting as efficient corridor doors. EU needs to consider this reallity, and promote port efficiency if final goal is to encourage SSS as a real road transport competitor.

Our theoretical model shows how the implementation of current policies is highly conditioned by the port efficiency, so giving aids to companies to shift cargo from road to sea transport, and not promoting port efficiency could be considered a virtual waste of money. To sum up, EU should not be financing firms to reach the desired modal shift, but making SSS more atractive, through the promotion of system efficiency and with a combined road internalization costs measure. This would offer the right incentives to firms, that would see by themselves how SSS is more profitable in cases where actually it is. In conclusion, EU should address the “issue” globally, considering the whole system when designing the proper measures.

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