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Pre- and end-haulage of containers in shipping chains: the neglected role of transaction costs in shippers' modal choices

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Abstract

Lots of studies have been devoted to shipper's modal choices since Baumol and Vinodt (1970) seminal papers. But, surprisingly, whereas institutional aspects play a determinant part in the structure of relationships in every supply chain, they are barely taken into account in academic papers (McGinnis, 1989; Jiang, 1998; Henscher and Puckett, 2005; Brooks *et al.*, 2012), particularly regarding transaction costs. Indeed, shippers' modal choices are often characterised by their inertia (Golicic et al, 2003), which cannot be explained without Transaction Costs Economics (or New Institutional Economics, see Ruester, 2010), as developed by Coase (1937) and Williamson (1985; 1996) seminal works. This paper aims at showing that transaction costs are partially responsible for the low modal share of container barge transport in French maritime ports (9% of TEU in Le Havre and 5% in Marseille in 2007). But instead of dealing with the transaction chain of container barging itself (Fischman and Lendjel, 2012), the paper focuses on shipper's decision making process. The paper finds empirical evidence of those costs in ECHO's survey (Guilbault *et al.*, 2008), focusing on shipments involving barging legs in containerized maritime chains. The last section discusses those results.

Keywords: pre- and end-haulage, shipper's modal choice, transaction cost economics, container barge transport

Introduction

As is well known, the modal share of container barge transport (CBT) in French maritime ports (9% of TEU in Le Havre and 5% in Marseille in 2007) is significantly lower than elsewhere in Europe (32% in Rotterdam and 33% in Antwerp). Yet, recent research on maritime ports hinterlands (Notteboom 2004 ; Frémont et al. 2007; Konings 2007 ; Minvielle 2007, Franc et Frémont 2008; Notteboom et Rodrigue 2009; Konings et al. 2010) points out the relevance of mass ground transport modes such as barge transport for enormous flows of containers to and from harbours, especially when a maritime port is located at the mouth of a river.

Some research and studies (Grégoire, 1983 ; Fischer *et al.*, 2003 ; Cour des Comptes, 2006; Frémont et Franc, 2008; ; Frémont *et al.*, 2009; Blum, 2010; Revet, 2011) indicate that the viscosity of CBT flows in France arises from several factors, generally concentrated around the seaport community. The following may thus be noted:

- The lack of maintenance and investment in infrastructures (Blum, 2010, pp. 61 and sq);
- There are high transshipment costs in waterway transport compared to trucking (Fischer *et al.*, 2003, Cour des Comptes, 2006).
- The productivity levels of other assets of the CBT chain affect also its competitiveness and attractiveness. Moreover, barges are subjected to unproductive waiting time for quay access, or before handling operations start and, of course, during loading and unloading ... (Beelen, 2011, p. 97).

But few studies address the specific coordination problems affecting CBT in French seaports, despite their influence in shippers' modal choices (Fremont, 2008). This paper aims at showing that transaction costs are partially responsible for this low modal share in France. But instead of dealing with the transaction chain of container barging itself (see e.g. Fischman and Lendjel, 2012), the paper focuses on shipper's decision making process.

A specific extraction from the ECHO¹ national survey data base (realized by INRETS in 2004) was done for this inquiry into shipper's role in inland shipping. Unfortunately, the very limited number of shipments involving barge transport that have been observed (70 over a total of 10 462 shipments in the survey, only 23 of which being containerized) in the survey does not permit their econometric treatment. Hence, the analysis of the data will be « qualitative », the proportions given - yet relevant – being not statistically representative.

Section 2 of the paper surveys the existing literature on shipper's choices and shows the theoretical relevance of transaction costs economics in this respect, following Brooks *et al.* (2012). In particular, barging transport involves higher transaction costs for a shipper than road haulage. Section 3 finds empirical grounds of this relevance in Echo's survey, focusing on shipments involving barging legs in containerized maritime chains. Section 4 discusses those findings.

The literature and the relevance of transaction costs approach of shipper's choice

Literature

Lots of studies have been devoted to shipper's modal choices since Baumol and Vinodt (1970) seminal papers. McGinnis (1989) survey of the literature numbered four different models of this phenomenon, besides numerous empirical articles: the classical economic model (Meyer *et al.*, 1959), the inventory-theoretic model (Baumol and Vinodt, 1970; Friedlaender and Spady, 1979; Sheffi *et. al.*, 1981), the trade-off model (Roberts, 1970) taking into account non-transportation costs (*i.e.* organization costs), and he added a

“constrained optimization model” (McGinnis *et al.*, 1981) quite close to the latter. At the end of his survey, McGinnis concluded that the great number of interacting variables involved in shipper’s choices is still puzzling for researchers and public policy makers. For example, recent articles have focused on the shipment size in the inventory-theoretic model in order to assess its influence on shippers’ logistics and transport costs (de Jong and Ben Akiva, 2007; Combes, 2011). A more recent survey of these models can be found in Hensher and Puckett (2005).

Surprisingly, whereas institutional aspects play a determinant part in the structure of relationships in every supply chain (Button, 2005), they are barely taken into account in academic papers. As stressed by Williamson (1985) on a theoretical dimension, any transaction is a ‘transfer across a technologically separable interface’ (Williamson, 1996, p. 58) that takes place between two entities. If so, how could the transport transaction between a shipper and a carrier be exempt of transaction costs? Recently, Hensher and Puckett (2005) stated that commodity-based models and vehicule-trip-based models were mainly used without any reference to transaction costs effects on shipper’s modal choices (See also Brooks *et al.*, 2012). As stressed by these authors, this could mislead the understanding of supply chains whose nature is based on interactions of interdependent agents and, thus, relies on transaction costs. Indeed, shippers’ modal choices are often characterised by their inertia (Golicic *et al.*, 2003), or “structural inelasticity” (Rich *et al.*, 2011). If the latter explained this inelasticity by the “lack of alternative freight networks from origin to destination” (*idem*), and connected it with the “last-mile” problem, this explanation doesn’t imply the inexistence of interconnections between networks for each couple of origin-destination. As stressed by Fogel (1962) in his assessment of the importance of railroad in the American economic growth, there is always alternative ways to achieve a transport. Interconnecting network inevitably increases the number of sub-transactions needed to achieve a transport. Raising this number involves an increase of transaction costs. Hence, trying to catch shipper’s choice leads to use transaction costs economics (or New Institutional Economics, see Ruester, 2010), as developed by Coase (1937) and Williamson (1985; 1996).

Actually, this approach leads to change the usual lecture of shipper’s behaviour. Instead of transposing passenger travel choice models to freight transport (as Hensher and Puckett (2005) point out) by considering the shipper as a single and isolated agent choosing between abstract modes of transport (as depicted by Baumol and Vinodt (1970), for instance), this new literature tackles with collaborative process networks necessarily at stake when dealing with interactions between shippers and carriers in a given institutional environment (see Panayides, 2002; Golicic *et al.*, 2003; Holmstrom *et al.*, 2003; Rose and Hensher, 2004).

Mainly based on transaction costs economics (TCE), this new approach adopts a different body of assumptions on the economic behaviour of agents. Instead of dealing with perfect information and full rationality, agents have to deal with imperfect information, with limited cognitive skills to treat it, *i.e.* a “bounded rationality” (Simon, 1961). Agents may always be opportunistic (Williamson, 1975) in order to promote their self-interest or their strategic advantage with a limited understanding of their consequences. This opportunism can be passive (“lack of dedication in performing to the best of one’s competences”) or active (“lying, stealing and cheating to expropriate advantage from a partner”) (Woolthuis *et al.*, 2005). These assumptions lead to introduce a behavioural uncertainty (in addition to the uncertainty of the institutional environment) in any transaction. Taking into account the level of interdependence (asset specificity and frequency of the transaction) between parties for a given transaction leads to the analysis of the relevance of governance structure (market, hierarchy, hybrid) to minimize transaction costs.

As regard the shipper’s choice in this body of literature, whereas numerous papers deal with the opportunity to internalize the transport chain (see *e. g.* Baker and Hubbard (2003)

and Nickerson and Silverman (2003) about road haulage and Pirrong (1993) and Hall and Olivier (2005) about shipping), few of them tackle with the question of the modal choice. Though, as barge container transport is a different transaction from those of road or rail transport of container, they obviously involve different transaction costs, even in a given country. Transaction costs need thus to be taken into account in order to understand the shippers' choices, as stressed by Panayidès:

“the governance structure will depend upon three factors: the cost of production, the transaction costs, and the strategic costs and the benefits associated with the different governance structures” (Panayidès, 2002, p. 405).

Focusing on container transport, this paper assumed that the shipper has no interest to internalize this transaction. A container is designed to be used recurrently to carry quite any kind of cargo that can be unitized. Thanks to its standardisation, its very advantage lies in the increase of the frequency of transaction due to the diversification of clients. Container standardisation lowering transaction costs promotes the positive effects of the market governance structure, *i.e.* scale and scope economies due to the aggregation of diverse demands (Williamson 1985, p. 92; 1996, p. 66). Hence, container transport is a transaction that should not be internalized by any shipper (Fischman and Lendjel, 2012). Indeed, the unit cost of container transport will be less for a shipper if the fixed costs of the transport are shared between several shippers. Thus, whatever the frequency of transactions is, no shipper is encouraged to internalize container barge transport owed to administration costs it generates and the loss of scale and scope economies reached by the market.

Assuming that the governance structure of this transaction is not hierarchical, *ex-ante* and *ex-post* transaction costs are to be listed according to the mode of transport used, before focusing on container barge transport. These costs of search, writing and enforcing contracts differ according several factors.

***Ex-ante* costs**

Ex-ante costs are related to the search of potential trading partners, their freight rate, time spent negotiating and writing contracts. In the transport sector, those costs are more important than in other sectors.

Search costs

Search is inherent to the nature of the service of transport for dispersed assets (vehicles and drivers) are needed at any given moment and place. As Baker and Hubbard stressed it about road haulage,

“[t]he demand for trucking services and the supply of truck capacity are highly differentiated. Shippers' demands are specific with respect to time, location, and equipment requirements. Likewise, truck capacity is idiosyncratic with respect to its geographic location and the characteristics of the trailer” (Baker and Hubbard, 2003, p. 554).

The “load matching problem” involves high *ex-ante* costs, even within regular services, such as container transport. Structural imbalance of flows adds imperfect organization to the sequence of trips due to the importance of these costs. In those decentralized markets (*i.e.*, each transport can be considered as a specific sub-market), information costs are high and explain the prominent role of third-party brokers who are reaching scale economies in search processes. Their importance may hence be approximated by their fees, but is likely to differ according to transport modes. Indeed, taking into account that this sub-transaction may be internalized by transport operators, its importance relies on the number of potential operators in the search for a specific match: the lower their number, the cheaper the search costs. In France, the number of operators is estimated at 800 in inland water transport, 19 in rail freight transport, 37 500 in road haulage and 3 800 in freight forwarding (CCTN, 2012). Thanks to information technologies (IT), freight forwarders' networks and reputation assets, the time

spent for matching is significantly shortenedⁱⁱ. But it still remains significant enough to justify the need for a third party such as freight forwarders.

Search time is also shortened if the shipment is sent on a regular basis, within a global contract framework with a partner. Scale economies occur here as anywhere and explain the existence of freight forwarders.

One may suppose that the number of stakeholders involved in a transport adds to the length of the search process. A container carried by barge, for instance, needs usually a pre- or post-haulage. The search process by a shipper or a freight forwarder depends on the level of integration of the transport chain. As detailed in section 3, container barge transport chains are more complex than the others. A specific extraction from the ECHO national survey database (realized by INRETS in 2004) shows that 100% of the 23 container barge transport shipments found in the survey (from a total of 10 462 shipments involved in the survey) were outsourced and involved at least three operators. Hence, the container barge transport belongs to a larger chain usually more complex to organize than the other transport chains, as only 7% of the shipments – parcels excluded – involve at least three operators (Guilbault et al. 2008, p. 108 ; Bréhier and Gavaud 2009, p. 8).

Insert Figure 1

Finally, the search costs of relevant information probably vary according to the market situation. For example, the economic crisis of 2008-2009 has probably had the effect of increasing search costs for barge operators. Conversely, a strong growth with a positive net demand would probably increase shippers search costs. For instance, availability of a container and a truck depends also of the actual net demand at a given moment for this specific service. The relationship between search costs and the net demand of transport could be approximated by a logistics curve (Fig. 1). As such, competition can be considered as a negative externality for shippers when the net demand for transport is positive and conversely. Indeed, the time loss incurred by a shipper in searching increases with the importance of positive net demand of transport.

Negotiation and contracting

Costs of negotiation and writing contracts are probably lower in France than elsewhere. Since 1986, “standard contracts” (“*contrats types*” in French) prevail in road haulage and river transport. Orientation Law Inland Transport (LOTI) of 30 December 1982 has indeed enacted a set of *contrats types*, enforced in 1986 by a decree, designed for land transport. Regulatory, a *contrat type* is however supplementary (“*supplétif*”), that is to say its clauses apply as of right in the absence of any explicit written contract between the parties. The *contrat type* avoids to redefine and renegotiate fairly standard clauses of transportation contracts. It leaves at the same time freedom of contract between the parties and preserves the consensual nature of the commercial contract. Economists have studied little those contracts, despite the fact that this French specificity is quite envied abroad. Fischman and Lendjel (2011) show that, as any contract, it’s used to economize transaction costs in order to preserve the advantages of the market governance structure.

A *contrat type* can be defined by four criteria. It is

1. a coordination mechanism between the parties (Brousseau et Glachant, 2000);
2. an arrangement of the transaction negotiated and defined in advance by all the actors - or their representatives -;
3. a device to define a standard for a given transaction for all actors in a given territory;

4. a device with a "residual" character, which therefore requires parties in a transaction in the absence of express written contract. As such, it is necessarily driven and enforced by government.

Supplementary in nature, *contrats types* allow agents with a bounded rationality to avoid to redefine the "best" (or conventional) clauses of a contract and thus save its drafting costs. Available for any mode of transport, those contracts dwindle contracting costs which have no reason to differ according to the modes of transport.

But the level of negotiation could be different. From a neo-institutionalism point of view, asymmetry of market power does not come from the number of competitors, but from transaction costs related to the size of parties. The ECHO survey shows that here is a behavioral asymmetry between large (over 500 employees) and small (fewer than 20 employees) shippers (Bréhier *et al.*, 2009, p. 24). Basically, small shippers seek out large carriers, mainly because of their reputation assets (the "big names") owned precisely to attract customers wishing to minimize their search costs. Conversely, large shippers seek out small and medium carriers (less than 100 employees), as the volume and frequency of transactions at stake are almost vital for them, often because of investments they dedicate accordingly. The asymmetric size and the induced dependency pave the way to possible opportunistic behavior.

Pre-adaptation to the transaction

Finally, *ex-ante* costs include also organizational settings necessary to prepare a transaction. On that respect, modes of transport are not equal for a shipper. The matching problem explains probably why the waiting time (or so-called "pre-advise" time) to deliver a container to the sender's warehouse for an outbound trip is longer for a barge than for a truck. This was indeed a curious difference observed in CMA-CGM's door-to-door service in March 2011. The pre-advise time to position (always by truck) a container at sender's place (in France) is four days for a barge, instead of two days for a full-truck trip to Le Havre or Marseille/Fos-sur-mer. This pre-advise time even reaches eight days (instead of three if it's a full-truck trip) if the destination is Rotterdam. And curiously, even if those waiting times are twice longer than the commercial lead-time to carry a container to a given port, they are usually not taken into account in most of shipper's modal choice models (see for instance, Brooks *et al.*, 2012). Knowing that only four barge operators (and six services) are available on the Seine River (Fischman and Lendjel, 2012), those conditions specific to CMA-CGM's subsidiary dedicated to combined transport – Greenmodal (formerly RSC) – are probably similar for the other operators.

Another example can be found in rail freight sector. Fret SNCF, the main French rail operator, asks its customers to follow a cumbersome procedure to use their new isolated wagon offer (MLMC).

"Customers estimate the wagons needed a year ahead, adjust the number two months and one month in advance, and then divide up the shipments day by day one week before transport. If less than 90% of the ordered wagons are used, the retractions are billed, and below 80% there is a surcharge. A bonus is applied, however, if revenues exceed the contract amount".ⁱⁱⁱ

This procedure is logic for the freight operator, but disregard the broad diffusion of lean production and just-in-time among shippers, where buffer stocks tend to diminish, shipments tend to be fragmented and to increase in number (Guilbault *et al.*, 2008). As pointed out by the supply chain manager of a chemical company in an interview, this procedure leads to an increase of organizational costs. First, it leads to involve more the recipient in the planning process of delivery by asking them to plan their needs for 2 months. Second, Fret SnCF has transferred to its clients the task to predict their flows and to feed its online interface with those planned flows. Meanwhile, the shipper could still ask for a couple of wagons in addition to a planned command, but this remains subject to acceptance by Fret SNCF. There

is no guarantee either as regard the delivery time in this case. Conversely, it is not possible to cancel wagons without important penalty. The rigidity of the supply is part of *ex-ante* transaction costs supported by a shipper when using railway for its shipments.

This entails organizational consequences for shippers' modal choices, especially in their planning process, their warehouse management, etc. A shipper does not bear the same organizational costs with trucking as with barging.

Ex-post costs

Ex-post costs come from maladaptation, monitoring, renegotiation and breach of contract. The contract creates a bilateral dependency – a “lock-in” - between the parties that needs to be managed and enforced through monitoring mechanisms. As stressed by Williamson, there is a “fundamental transformation” from an *ex-ante* competition where the identity of the parties does not matter to the *ex-post* bilateral dependency where their identity is of prominent importance. In the case of container transport, one could expect a weak dependency between the shipper and the carrier because of the standard character of the involved assets. But, as stressed Pirrong following Masten, Meehan and Snyder (1991), “time and space factors in shipping markets may create “temporal specificities” that encourage costly haggling between shippers and carriers over quasi rents if they rely on spot contracts” (Pirrong, 1993, p. 937). This prevails also for ground pre/post-routing in container transport. The value of goods carried by container declines with the transit time; and any barge positioned to meet a given located demand incurs loss of time and money for this purpose and could miss a better opportunity. This mutual dependency gives rise to temporal specificity (*idem.*). According to Pirrong (*ibid.*, p. 945), temporal specificity is insubstantial in case of spot contract. But the time sensibility of the shipper usually leads him to choose road haulage instead of barge transport to save two days in the global transit time. And Pirrong's paper only tackles with bulk shipping and not with container shipping lines.

As is well known, many *ex-post* problems could arise:

- unexpected delay of the arrival date of the container at the shipper's warehouse;
- unexpected delay of the pick-up date of the container at the shipper's warehouse;
- damaged container or, more important, damaged cargo at consignee's warehouse; knowing the probability of a damage relies on the number of transshipments, multimodal transport incurs a higher risk of damage than full-truck trip to/from the port.
- Unsuitable container in any of its characteristics;
- container missing the planned ship;
- container sent by error to another destination;
- loss of the container;
- time to pick up a container in a maritime container terminal and associated demurrage costs;
- security costs
- Etc.

But, regarding shippers' modal choices, only predictable *ex-post* costs are here to be taken into account. Hence, unexpected maladaptation, renegotiation and breach of contract are *a priori* out of the scope of this study. Among remaining *ex-post* costs, monitoring and incentive are the most important aspects to tackle with.

Monitoring and incentive are important when it comes to respecting delivery commitment. For instance, unexpected delays are frequent in railway in France due to the priority granted to passenger trains. According to *Réseau Ferré de France* (RFF, the French provider of rail access), 70.1% of freight trains arrived on time in 2011^{iv}. Fret SNCF recently introduced a new clause in his isolated wagon offer that warrants delivery times (80% on time

and 90% on day +1) and reliability (accompanied by financial compensation in case of delay)^v. As stressed by Brooks *et al.* (2012), the reliability matters in shippers' choices and could explain part of the low modal share of railway in ground transport of goods. Note that, in that respect, inland waterway transport is often considered as the most reliable mode of transport, even compared to road haulage. But regarding security and safety, railway is considered as a reliable mode of transport^{vi}, and in any case, more reliable than road haulage. Hence, monitoring costs are similar for a shipper whatever the mode of transport, but not the probability of unexpected delays.

Ex-post costs in transport have been studied in shipping (Pirrong, 1993), road haulage (Nickerson and Silverman, 2003; Allam and Lendjel, 2007), rail transport (Yvrande-Billon and Ménard, 2005) and inland waterway transport (Fischman and Lendjel, 2012).

Theoretically, *ex ante* and *ex post* costs affect significantly shippers' modal choices.

Evidence on transaction costs in barging for shippers

Empirical grounds of the importance of transaction costs in shippers' choices can be found in a specific extraction from the ECHO national survey data base (realized by INRETS in 2004; see Guilbault *et al.*, 2008) which was done for this inquiry. The purpose here is to focus only on barge transport. 70 shipments involving barge transport have been observed in the survey (70 over a total of 10 462 shipments in the survey), only 25 of which were containerized, 13 with twenty-foot containers and 12 with forty feet containers. Due to the huge gap with shipments sent by road (78.2% of the total of shipments), container barge shipments (0.7%) need to be isolated for the sake of their analysis, even if they cannot be statistically representative. Those 25 shipments are all maritime outbound chains (100%), with a river leg in their pre-haulage transports and, mainly (64%), a terminal road haulage.

Relevant variables

Several questions were included in the four questionnaires (the pre-questionnaire of the establishment (PQ), the establishment questionnaire (EQ), the shipment questionnaire (SQ), the path questionnaire (PaQ)) cope with determinants of shipper's choices. Some of them were designed to catch transaction costs. Following Williamson 1996, a transaction can be characterized in three dimensions by its attributes: asset specificity (*i.e.*, level of loss associated to alternate use of assets involved in the transaction, or re-deployability's level of the asset), frequency (number of times a transaction occur in a given period), uncertainty (related to the environment of the transaction and to the behaviour of parties in condition of bilateral dependency). Those attributes determine *ex-ante* and *ex-post* transaction costs incurred in a given transaction.

As regard asset specificity, several variables in ECHO's survey can be listed. Williamson (1996, p. 59) identifies six kinds of asset specificity: site specificity, physical asset specificity, human asset specificity, dedicated asset, reputation asset, temporal specificity.

- Site specificity: the presence of dedicated to or owned assets by the shipper in the chosen port (SQ, 30a); geographical proximity of the chosen port (*idem.*); availability of a parking to load/unload goods in/from a truck (EQ, e33); operational connected rail tracks at shipper's warehouse (EQ, e35a); access to an operational waterway dock at shipper's warehouse (*idem.*); access to an operational maritime dock at the shipper's warehouse (*ibid.*);
- Physical asset specificity: means of communication used (SQ, q4a) and possessed (EQ, e26a); transport specific requirements for the shipment (SQ, q12); the possession of specialized assets by the carrier (SQ, q28);

Barging transaction costs in France

- Human asset specificity: the level of qualification of the labour force (but this question cannot really assess the existence of human asset specificity in the specific transaction at stake) (EQ, e7);
- Dedicated assets: shipper's possession of its own fleet (PQ, p15) or managing a dedicated fleet (EQ, e38; SQ, q20); the prior provision of equipment (SQ, q28)
- Reputation asset: the number of employees (PQ, Effetcen); recourse to a third party (freight forwarder) (SQ, q24; q25); criterion of choice of the mode of transport used (SQ, qt28);
- Temporal specificity; the prior availability of required material (SQ, q28); maximum delivery time agreed (SQ, q9); the shipper's internal delay of treatment of the order (SQ, q10); reliability of delay (SQ, q28); number of days of production corresponding to the stock outgoing products (EQ, e14)

A question about the reason of the non-choice of the alternative mode of transport could unveil the constrained dimension of the choice operated by the shipper. "What are the main failed criteria that explain you did not accept this alternative or that you have considered that there was no other way possible?" (SQ, qt30)

As regard frequency, the number of shipments occurring in a year (SQ, q6) and their tonnage (SQ, q7) are specified in the shipment questionnaire.

Uncertainty is a more difficult dimension to assess through the ECHO's survey, especially due to the importance of behavioral uncertainty that has to be distinguished from the environmental uncertainty. The use of tracking system (SQ, q4a; EQ, e26a) may approximate monitoring costs to diminish the behavioral uncertainty. The number of intermediaries has also to be taken into consideration (quantity of establishments – and thus of questionnaires - involved for a given shipment). Finally, waiting time to connect two modes of transport (mainly in ports) may introduce uncertainty in time delivery to market (PaQ, t1 et t6).

Those variables are to be confronted with governance structures used (EQ, e28; SQ, q23). Here, focusing on the few barge transport shipments, the paper tackle with actual barge container transport chains chosen by shippers in 2004. That means that transaction costs were sufficiently low to let the shipper buy the cheapest mode of transport.

Results

Before assessing transaction costs, one should characterize goods and the shipments at stake. Few goods have constrained the choice of shippers by their characteristics. Only one container carried a dangerous good and one was considered as fragile. None of them needed specific characteristics such as reefer container or other kind. This means that only 2 shipments (8%) were considered as deserving a special treatment. This result is coherent with the governance structure chosen (market) by shippers here and the use of containerized transport. Several results help to characterize the transaction attributes and transaction costs.

Transit time, waiting time and temporal specificity

Almost all these shipments were transported on the Rhine River, only one on the Seine River and five on the Rhône River. The total distance is, for every shipment, greater than 1000 km with a shipping leg. The river trip is on average 6.3% of the total distance (and less than 10% in more than three trips in four). Similarly, travel time on river is on average 11% of the total transit time, a duration less than twice the average waiting time at the port (23% of total transit time). The survey does not mention the time between order and delivery of the service (for example, the time required to position the container at the shipper's warehouse). Hence, with an average of 30 days, the transit time factor does not seem to be in itself an

obstacle to the use of river transport in the shipment of containers. But waiting time is a more probable factor that gives rise to uncertainty of the delivery time.

Time also matters in shippers' internal procedure of ordering or booking a shipment (SQ, Q10). Huge differences appear for shipments involving a container barge transport: from 4 hours to a maximum of 120 days (and an average of 57.6 days)!! Even if those results are not statistically representative, organizational costs can thus be very important for a shipper. The same gap exists for the maximal delivery time (with an average of 43.6 days)...

But curiously, when asking shippers about their main criteria for a shipment, time seems less important than expected. The main criterion for shippers was, of course, the "cost of transport", far beyond (60%) the other criteria. But interestingly, the time factor ("transport transit time"), usually considered as the second main factor, was relevant for 5 shipments only (20%), as the "reliability of delays" or the "frequency of departures" (8%). Likewise, the "flexibility" is only important for 3 shipments. Other items such as "the possession of specialized assets by the carrier" or "the prior availability of a required material", indicator of asset specificity, were not quoted by shippers using container barge transport.

Site specificity

When a shipper specifies his choice of a given maritime port, his first two criteria are its proximity (33%) and the frequency of arrival/departures of shipping lines to the desired destination (33%). The last criterion means that a port will be chosen due to its network effects (number of interconnections provided). Both criteria unveil the existence of site specificity for 66% of shipments involving a barge transport leg. The latter requires first a maritime port connected to a river and second a high frequency. This means primarily that barging cannot be chosen by a shipper without taking into consideration the whole chain involved. But the second criterion related to the frequency of departures of shipping lines reveals also time sensitivity for 33% of those shipments. Hence, any delay occurring during the barging leg can be managed/fixed through the help of a high frequency of departure of shipping lines. As already stressed by Pirrong (1993), the availability of a ship for a shipper depends on its location. The lock-in situation will be stronger if the ship has to be positioned in the middle of nowhere instead of in a big port where opportunities are multiple. Site specificity is closely related to temporal specificity.

As regard river port, five shippers (20% of the shipments) do possess private river docks that enforce their choice of river transport. These shippers are cereal collection companies that send (generally abroad) grains, malt, cornmeal and are usual users of barge transport. Using a container barge transport entails minimal transaction costs for them: they already know all operators and frequently charter them. They own silos, handling equipment and sometimes their own barges. The same transactional characteristics are met in the cement industry, the other big user of barge transport. Cement has a twofold distinction of being bulky and taking prompt. The first feature involves large volumes of transportation of raw components of concrete (sand, clinker,..) and of rubble removal. Most major cement companies (Calcia-Italcementi, Cemex, Holcim, Lafarge ...) have established their concrete plants on river banks (and / or railway sidings) to minimize their transportation costs. Regular needs for concrete production entail long-term contracts (or concessions) for the long-term use of riverbanks. It is the same for concrete plants and their handling equipment. Second, short drying time implies a very short period of use of the concrete produced in a plant (Eccles, 1981). This constraint introduces a high degree of temporal specificity in the transport chain of concrete (Masten *et al.*, 1991). It implies to have concrete plants installed near city centers in order to have a longer use of concrete. The temporal specificity justifies the establishment of plants in the heart of cities, and feeds back the site specificity (close to the point of delivery of raw materials to the concrete plant) of river docks.

Those shippers cannot be representative, but help to understand that transaction costs associated with container barge transport are significantly lower for them than for others, because they are already big users of inland waterway transport. Sending a container by barge is a peripheral transaction for them, distinct from their usual shipments by barge. As those shippers are using quite all modes of transport, it is easy for them to compare freight rates. But, in this small world, good relationships with bargemen are essential for the smooth run of shippers' transport chains. Hence, *ex-ante* and *ex-post* costs are reduced.

When a shipper is not located in the vicinity of a river, the site specificity of the inland port vanishes progressively. The majority (two-thirds of shipments) of container barge transports involves a pre-haulage by road. In this case, road distance to port is mostly short: 72% of pre-haulage by road are less than 50 kilometers (and all the more small compared to the average distance of total transport of 6 840km of the sample). Only 4 shipments (16%) were concerned by the impact of the conditions of land access in the choice of the port. As regard container barge transport, the choice of a port is not related to the presence or existence of specific equipment and industrial arrangement. This aspect was important for only 2 shipments (8%). Likewise, there is no dedicated relationship with the freight forwarder and/or the logistics provider located in the port that could influence the choice of the port.

All these results mean that barge transport is very dependent to the presence of an inland port in the vicinity (less of 50 km) of the shipper. Those aspects clearly impede any development of barging transport for a shipper, as confirmed in an interview of Mr. S. Faure, in charge of Oxylane's east-European supply chain^{vii}.

Governance structure

The contractual conditions of the shipments depicted in the survey help to characterize their governance structures and their associated costs.

First, the shipper is usually (78%) the principal of the container barge transport chain, but not systematically. The recipient organizes 17.4% of the shipments and sometimes co-organizes it with the shipper (4.3%).

Second, the shipment is isolated in general (96%) from the other shipments sent by a shipper. But half (52%) of those single-purpose shipments have been sent in a preset program of orders with the buyer. Those shipments have a regularity that creates a mutual dependency between the consignor and the consignee. This seems to be a characteristic of inland waterway transport. Guilbault *et al.* (2008, p. 167) has stressed that 76% of all shipments by barge (70 shipments) are sent in the frame of a preset program of orders. But, this means also that a container is less frequently sent in a preset program of orders than the other shipments by barge. A comparison with shipments sent by other modes of transport shows a lower share of preset program of orders (43%) than for container barge transports (52%).

Third, the organization of the transport chain of the shipment is sometimes (40%) internalized by the shipper, but mainly achieved by a third party (60%). The merchant haulage is the dominant way of organizing those chains, but the carrier haulage concerned one quarter of the shipments. As stated earlier, barge container transport chains are complex chains that involve at least 3 "participants" ("*intervenants*", *i.e.* operators) besides the shipper. The ECHO survey identifies several configurations of subcontracting chains (Guilbault *et al.*, 2008). Their comparison with container barge transport chains in the table 1 helps to point out the singularity of these chains for a shipper. In ECHO survey, only 6.75% of the whole shipments were involving more than 2 operators, whereas it is the case in 100% of containerized shipments by barge. Actually, 69.6% of those shipments involved 3 or more operators (instead of 2) with multiple subcontracting. Moreover, on average, 5.8 operators (recipient excluded) are involved in a shipment with a container barging leg, with a maximum of 11 operators in one case! The average distance of the total transport plays probably its part

in the singularity of container barging chains, involving a larger network of operators than usually needed for local or national transports. As the quality of information decreases with the distance (estimated either in kilometer and/or in number of operators), *ex-ante* and *ex-post* costs should increase accordingly. The multiplicity of operators and of subcontracting can't but give higher transaction costs than in other chains. A shipment through barging implies at least 3 contracts that have to be dealt between the shipper and the operators, instead of one in road haulage, even though, the remuneration of the forwarder ("*honoraire*" or "fee") was mainly considered as unimportant by shippers (72%).

According to Guilbault *et al.* (2008), a typology of those chains can be drawn. In those complex chains, one (or more) leading operator - directly mandated by the shipper or the recipient - entrusts part or all of the operations he is in charge to one or more operators. The transaction of container transport, as understood as a transfer of a service "across a technologically separable interface" (Williamson 1996, p. 58), is subdivided in several sub-transactions. Each sub-transaction includes an organizational part and a performing part, each of them being subcontracted or not. Subcontracting is understood here broadly as a sequence of mandates for the same service between operators (Guilbault *et al.* 2008, p. 107). It includes a sequence between a broker or a freight forwarder (searching and organizing) and a carrier (performing the transport) or between 2 carriers (subcontracting *stricto sensu*, where the leading carrier organizes the transport and ask the subcontractor to perform all or part of the transport).

Insert Table 1

Class 5 of Guilbault's typology is characterized by simple outsourcing relationships (where each one does not mandate more than one operator) between operators. Those "linear subcontracting chains" represent up 3% of the whole shipments of ECHO survey, instead of 30% in container barge transport chains (see Table 1). Class 6 includes relations of subcontracting named "in arborescence" where at least one operator (the leading one mandated by the shipper) appoints several other operators to perform all or part of the transport operations. Those chains are dominant in container barging (70%) whereas they represent only 4% of the whole shipments of the ECHO Survey. Those contractual chains are also frequently used in maritime chains where they represent up 21% of the shipments. On a contractual plan, the high number of stakeholders entails a chain of liability that is difficult to identify in case of claim. *Ex-posts* costs (monitoring, claims, delays, etc.) are likely to be greater than in simpler chains such as with road haulage. This may also explain the reluctance of French shippers to use container barge transport chains for their shipments.

Concluding remarks

Transaction costs matters when coming to choose between alternate modes of transport for a shipper. This neglected dimension may explain the difficulties met by usual models to fully assess and predict shippers' choices. Container barge transport is significantly affected by those costs as shown in the specific extraction of the ECHO survey done for this inquiry. Evidently, this sector has significantly improved its supply since 2004, year of the survey. And the rapid growth of this small segment of barge transport may invalidate those conclusions. It stresses the need for a new ECHO survey to complete the surveys of 1988 and 2004.

Maritime operators are impacted by those costs, when it comes to dealing with the growth of container traffic in congested ports. The level of integration of the container barging chain is a possible answer (Notteboom and Rodrigue, 2009). Indeed, the number of operators involved in a barging chain can't but raise *ex-ante* and *ex-post* transaction costs. And contrary to maritime transport which is the dominant mode of transport for a shipper wishing to send goods abroad, barge transport is the smallest mode of transport in France.

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Those transactional barriers should be recognized by the government, especially if it wants to encourage the development of sustainable transport chains such as barging.

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Figures and Tables

Figure 1

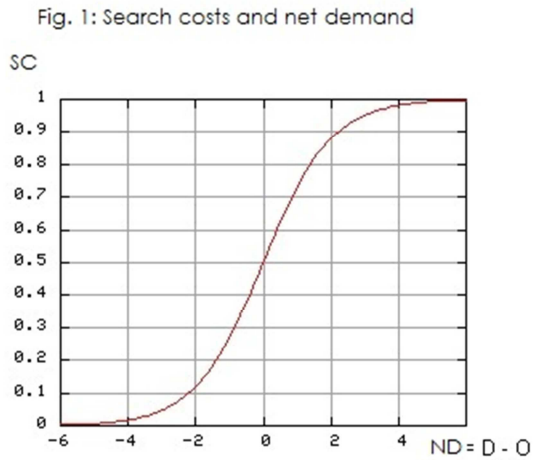


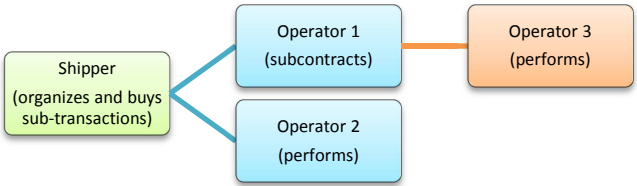
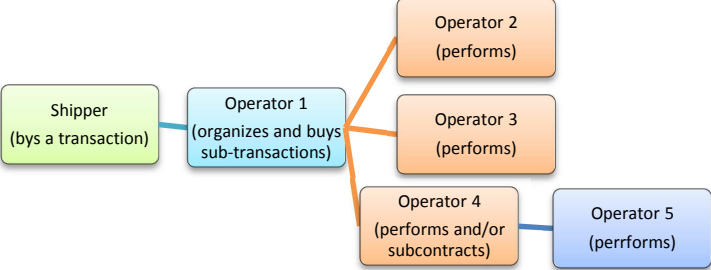
Table 1

Table 1: contractual configuration of transport chains (based on Guilbault *et al.*,

2008, p. 108)

| Typology | Examples | % of shipments in the whole ECHO Survey | % in container barge transport |
|--|----------|---|--------------------------------|
| 1. Own account | | 30.68% | 0% |
| 2. One operator | | 33.7% | 0% |
| 3. Several operator without subcontracting | | 1.59% | 0% |
| 4. 2 operators, simple subcontracting | | 10.09% | 0% |

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| | | | |
|---|--|-------|-------|
| <p>5. More than 2 operators, simple subcontracting or linear subcontracting</p> |  <pre> graph LR Shipper[Shipper (organizes and buys sub-transactions)] --> Op1[Operator 1 (subcontracts)] Shipper --> Op2[Operator 2 (performs)] Op1 --> Op3[Operator 3 (performs)] </pre> | 2.59% | 30.4% |
| <p>6. More than 2 operators, multiple subcontracting</p> |  <pre> graph LR Shipper[Shipper (bys a transaction)] --> Op1[Operator 1 (organizes and buys sub-transactions)] Op1 --> Op2[Operator 2 (performs)] Op1 --> Op3[Operator 3 (performs)] Op1 --> Op4[Operator 4 (performs and/or subcontracts)] Op4 --> Op5[Operator 5 (performs)] </pre> | 4.15% | 69.6% |

ⁱ ECHO (“Envois - CHargeurs - Opérateurs de transport”) is a national survey designed to understand shipper’s practices and whose measurement unit is the shipment sent by a shipper. For a summary of the ECHO survey’s results, see Guilbault *et al.*, 2008. The very few observed shipments (70) involving a barge transport in the survey do not permit a quantitative analysis. Hence, our analysis of the data is « qualitative » and the proportions given cannot be statistically representative in the insight of the small sample size. Yet, they are not irrelevant.

ⁱⁱ Baker and Hubbard (2003) have already assessed the effects of IT on the size of firms in trucking.

ⁱⁱⁱ <http://fret.sncf.com/fret/lang-fr/>. Last check: 25/02/2013

^{iv} <http://www.usinenouvelle.com/article/rff-observe-la-regularite-des-trains-a-la-loupe.N161661>. Last check: 25/02/2013.

^v <http://fret.sncf.com/fret/lang-fr/>. Last check: 25/02/2013.

^{vi} http://fret.sncf.com/fret/fret_sncf_transporteur_d_avenir/530-securete.html. Last check: 25/02/2013

^{vii} Interview realized in Paris, December the 19th of 2012.