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Fragmentation and maritime industry:

A theoretical framework

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Abstract

In the last half-century we have observed dramatic growth in international trade, but equally dramatic changes have occurred in the nature of the world trade. Among recent trends in the world trade is the process of fragmentation characterized by geographical dispersion of the production activity. Such an environment creates a strong need for efficient coordination mechanisms connecting separate blocks of the fragmented production process where transportation is one of such mechanisms.

This thesis focuses on transport sector and more specifically, maritime transport. The objective is to provide a theoretical framework aimed at determining how changes brought about by fragmentation affect shipping firms that serve transport needs of the fragmented industries. The problem is approached by identifying the key variables in the profit function of the shipping firm and describing central relationships between them.

The first part presents the phenomenon of fragmentation in order to provide an overview over changing patterns of institutional organization and structural shifts in the nature of the world economic order. Then, requirements to transportation systems stemming from the needs of the fragmented chains of production are defined. The second part is devoted to transport economics. It introduces the main variables in the profit function of the shipping firms distinguishing between bulk and liner segments. The final part synthesizes preceding parts and studies the effect of fragmentation on the revenue and costs of the maritime companies.

Part I: GLOBALIZATION AND FRAGMENTATION

1. Globalized economy

1.1 Introduction

Recent economic development has been characterized by globalization which in its simplest form refers to the increasing geographical scale of economic, social, and political interactions. These interactions include international trade and related traffic of imports and exports, the expanding mobility of capital and investment transaction. A more liberalized trade regime with lower or abolished tariffs and convergence of legal and regulatory systems promote a higher degree of interaction between countries and regions. Falling transportation costs are also said to contribute to the growing world trade. As a result, for many countries trade grows faster than GNP making the world increasingly integrated through trade.

These patterns of globalization accompanied by technological advances and lowered cost of services have shifted the structure of trade towards fragmentation of the production process. Fragmentation implies outsourcing amounts of the production process and represents a breakdown in the vertically integrated mode of production which can happen domestically or abroad. Many factors are said to account for fragmentation. It is argued that there is no single driving force but rather a conjunction of many forces acting simultaneously (Curzon Price 2001). Among them are wider markets, greater specialization, lower transport and communications costs, lower transaction costs, technological progress, lower efficient minimum scale of operations, more demanding customers, more numerous agglomerations generating greater externalities before getting congested, more efficient and demanding capital markets. These forces open up new opportunities for fragmentation both domestically and internationally.

It is evident that a modern economy is highly dependent upon transport as the circulation of goods and people within the global economy must be supported by transportation. International transportation systems experience increasing pressures to support the growing demands of international trade and the globalization of production and consumption. Goods transport is essentially concerned with the movement of natural resources and goods at different stages of the production process. It lays the foundation of the complex logistical process by which natural resources located in one area are transformed into products which consumers want at a different location.

Such a strong connection between the global economy and transportation suggests that changes in the global environment will inevitably reshape the operational environment of transport and logistics industries. The objective of this thesis is to study how increased trade flows coupled with other trends in the world economy affect the maritime industry and which consequences they imply for profitability of the shipping firms.

1.2 The phenomenon of fragmentation

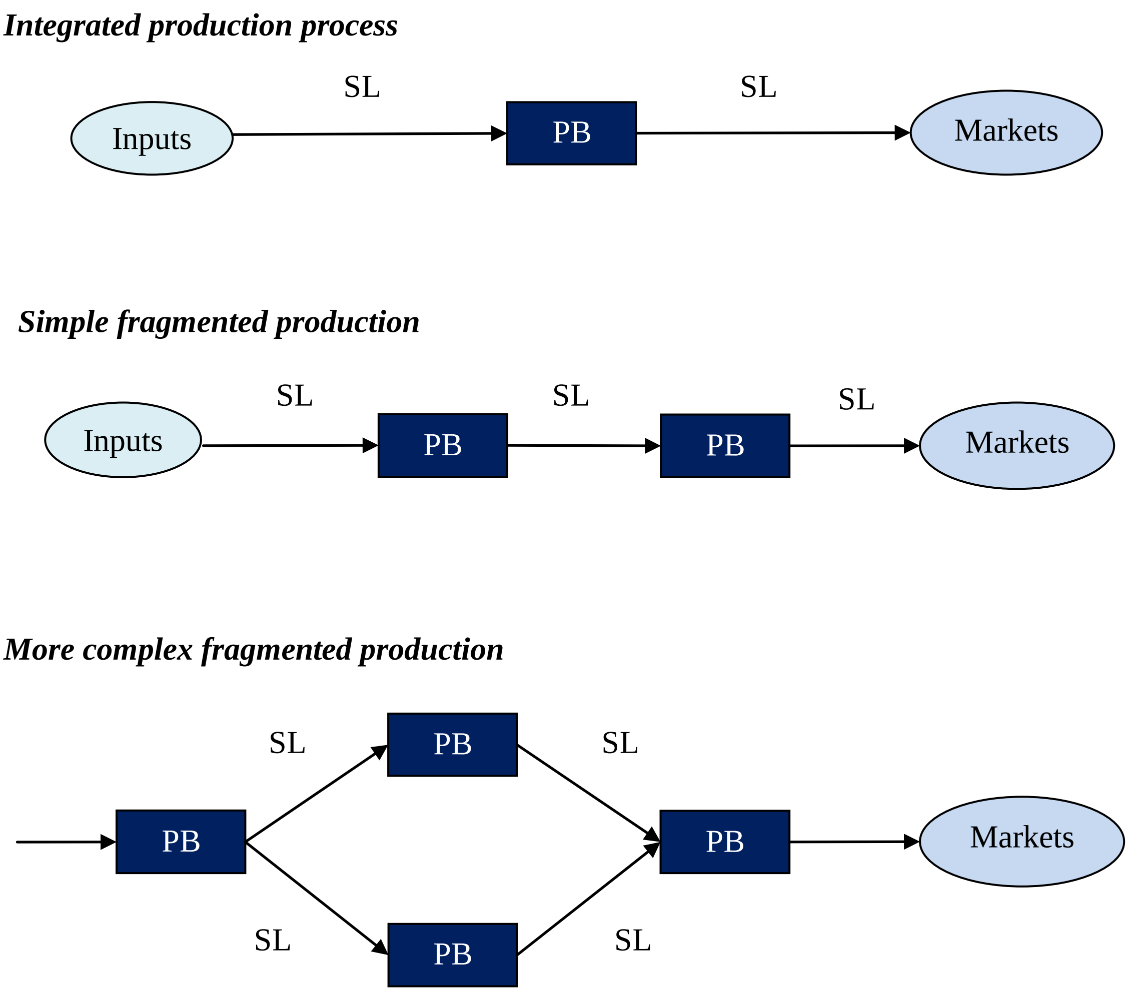
1.2.1 Introducing the concept

An important characteristic of the globalization of trade, and in particular of trade in manufactures, is an increased fragmentation of production.

The production process can be viewed as a series of sequential activities needed to convert raw materials into a final commodity. An integrated production process is characterized by inseparability of constituent activities which are performed in one single location. This is illustrated in the upper part of Figure 1. Fragmentation becomes possible once the various phases of the production process can be separated physically. Fragmentation generally means to divide a previously integrated production process into distinguishable blocks, or fragments, and move them to various locations that are most suitable for each activity. The activities can be performed independently and production blocks do not need to be situated in geographical proximity to one another. The middle and lower part of Figure 1 exhibit simple and more complex fragmented production respectively. Production blocks are connected to one another by service links which take on an important function in the fragmented production chain.

Physical separability of various stages of the production process is a prerequisite but not the only condition of successful and profitable fragmentation. Location of fragmented production blocks critically depends on advantages and disadvantages of each economic region. Exploiting differences among economic regions allows firms to minimize costs and possibly gain other benefits e.g. in form of strategic advantage.

Fragmentation applies not only to production process but also to distribution and consumption. In fact, any process aimed at producing a good or providing a service can be presented as a sequence of separate activities.

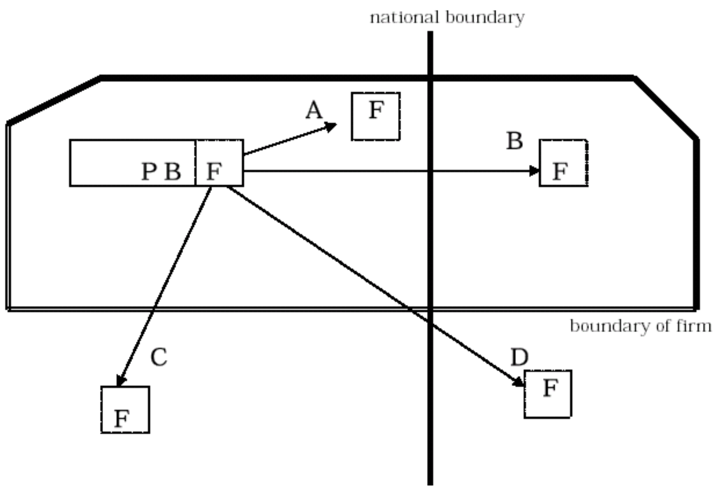


PB: production block
SL: service link

Figure 1. Fundamental concept of fragmentation
Source: Jones and Kierzkowski (2001)

1.2.2 Types of fragmentation

Fragmentation has a complex nature and in reality can appear in different forms. The term was first defined by Jones and Kierzkowski who focused mainly on whether production blocks are spatially separated or not. Since then a number of researchers addressed particular aspects of the phenomenon using own terminology. For instance, Feenstra (1998) refers to disintegration of the production process as a synonym of outsourcing that can happen domestically or abroad. Venables (1999) examines the consequences of falling transport costs for intermediate goods in the context of geographical dispersion of production blocks that lead to formation of vertical and horizontal MNEs. Hummels et al. (2001) study the effect of trade barrier reductions in vertically specialized trading chains extending over many countries with each country specializing in particular stages of production sequence. They refer to fragmentation as vertical specialization in which the use of imported inputs in producing goods is the key aspect of these vertical linkages. Grossman and Helpman (2001) study outsourcing decisions by resolving a trade-off between vertical integration and vertical specialization in terms of costs and benefits. Curzon Price (2001) explores fragmentation from the angle of geographical dispersion and outsourcing versus internalizing of firm's activities in order to identify sources of change for the phenomenon of fragmentation.



PB: production block
F: fragment of production process
A: domestic fragmentation
B: international fragmentation
C: domestic outsourcing
D: international outsourcing

Figure 2. Types of fragmentation
Source: Kimura and Takahashi (2004)

As it follows from the summary on the use of the term, vertical specialization, intra-product specialization, global production sharing, outsourcing and disintegration of the production process are often used as synonyms to fragmentation in the economic literature. However, each term captures a different aspect of the phenomenon. In order to summarize the definition and coverage of each terminology, Kimura and Takahashi (2004) classify fragmentation along two axes, according to whether it crosses the national border and whether it occurs within one firm. The former case is called spatial dimension and the latter is organizational dimension. The complex nature of fragmentation is illustrated in Figure 2 and Table 1 that replicate one another.

Spatial dimension

The spatial or geographical dimension refers to physical dispersion of production, when part of the chain of production is moved to a different geographical area with transactions taking place either within the same firm or between different economic actors in the open market.

Spatial dimension comprises domestic and international fragmentation when production blocks remain in one country or are spread across several countries respectively. Two extreme outcomes of this dimension are locally and internationally produced goods.

Organizational dimension

Whether transactions take place at arm's length between different economic actors, or within the same firm, refers to the organizational dimension. This dimension concerns corporate strategy rather than the organization of production process. In this dimension firms operate on the continuum running from vertically integrated ‘do-it-all-yourself’ type of firm to highly specialized enterprise which outsources all but its core activity. The result is integrated versus specialized firms depending on the extent to which firms adopt fragmentation.

<table>
<tr><td colspan="2" rowspan="2">Spatial
Organizational</td><td colspan="2">Crosses national border</td></tr>
<tr><td>No</td><td>Yes</td></tr>
<tr><td rowspan="2">Transactions</td><td>Within one firm</td><td>Domestic fragmentation</td><td>International fragmentation</td></tr>
<tr><td>Arm’s length</td><td>Domestic outsourcing</td><td>International outsourcing</td></tr>
</table>

Table 1. Types of fragmentation
Source: The table is based on Kimura and Takahashi (2004)

Both spatial and organizational dimension have advantages and disadvantages which are best illustrated by the example of multinational enterprises (MNEs).

1.3 Multinational Enterprises

1.3.1 Definition

Although spatial fragmentation, i.e. moving separate elements of the production process to different (usually lower cost) locations, does not necessarily involve multinationality (Venables 1999), MNEs bear major responsibility for this process.

MNE is a firm which owns a significant equity share of another company in a foreign country (Barba Navaretti et al. 2004). Generally, its activities are spread among home country and host country (countries). Activities in the host country are defined as foreign affiliate or subsidiaries and are acquired or expanded by means of foreign direct investment (FDI).

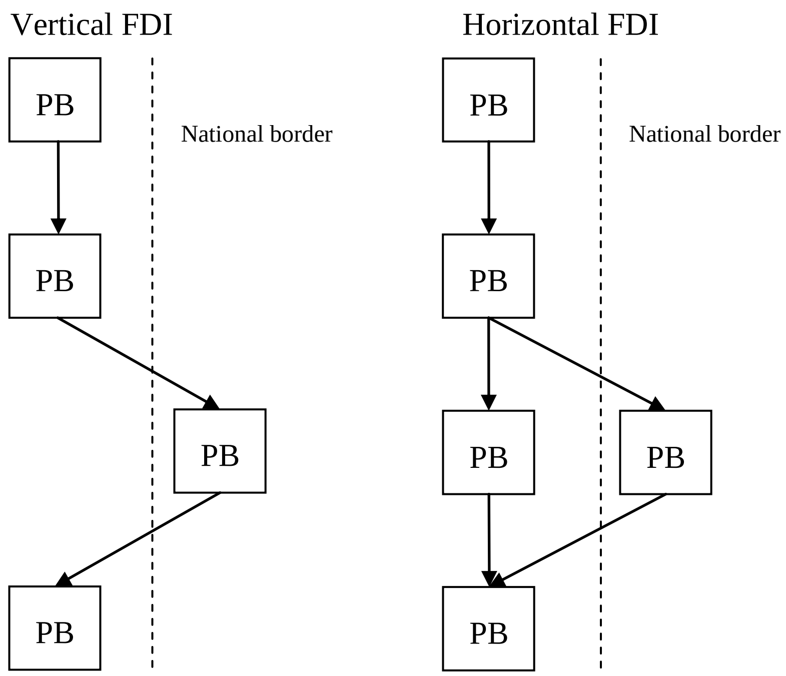


Figure 3. Horizontal and vertical FDI

The literature of international economics distinguishes between horizontal and vertical FDI. In vertical FDI fragmentation results in one or several activities being undertaken in a different location. The major motive behind vertical FDI is to find low-cost locations for parts of the production process and take advantage of factor price differences. A typical example of vertical FDI is a foreign affiliate operated from abroad. In contrast, in horizontal MNE at least some of the firms' activities are replicated in two places. Horizontal MNEs operate in multiple countries and each plant sells its products to the local market. Figure 3 illustrates the location of production blocks in case of vertical and horizontal FDI.

1.3.2 Multinational production and composition of frade

Venables (1999) studies the consequences of falling transport costs for fragmentation of production, formation of MNEs and the value of trade. His conclusion is that falling transport costs for intermediate goods trigger fragmentation. This process can give rise to both vertical and horizontal MNEs and increase as well as decrease the value of trade. The consequences depend on the relative factor intensities of upstream and downstream production.

In his model, Venables (1999) focuses on vertical and horizontal MNEs assuming that there is no outsourcing, i.e. all activities are performed within one firm. The firms operate in two economies, Home (capital abundant) and Foreign (labour abundant) characterized by perfectly competitive environment. Furthermore, firms have constant returns to scale and produce good YZ that consists of intermediate component Y (upstream) and final product Z (downstream). t_y is ad valorem[1] trade cost for shipping intermediate component Y. Shipment of Z also occurs at a certain cost. In addition, there is trade in commodity X whose main function is to maintain payments balance between two countries. I will exclude X from description of the model for simplicity and will rather focus on the fragmented good YZ.

Although the model does not include value-to-weight ratio of the goods, it may be used to analyze how international trade flows change in response to fragmentation. Its most useful application, from the viewpoint of this thesis, is the ability to predict value-to-weight ratio of the goods to be transported. The value-to-weight ratio is important because it is a variable in shippers' modal choice decision and a determinant of the importance that transport costs have for the shipper. This issue will be discussed later.

In order to be able to assess the change in composition of total trade, i.e. proportion of goods with high and low value-to-weight ratio, an assumption about value-to weight ratio is needed. I assume that Y component has a lower value-to-weight ratio than Z, and both Y and Z have a lower value-to-weight ratio than the final good YZ. This assumption is pure

[1] Ad valorem – by value (Lat) The cost of shipping according to the value of the good (Source: Wikipedia).

arbitrary as in reality the relative weight of goods and their value-to-weight vary considerably for each particular product category.

As mentioned earlier, when firms divide their production between countries they become either vertical or horizontal multinationals depending on factor endowments of production locations and factor intensities of upstream and downstream production. The model explores the effects of reducing t_y in two situations: when upstream production is labour intensive and when downstream production is labour intensive. These two cases have different consequences.

The starting point for the analysis is the base case when good YZ is fully manufactured in Home and then exported to Foreign. Thus, Home supplies both domestic and foreign market, and the value of trade is the value of YZ good shipped in one direction. The experiment starts when the cost of shipping Y, t_y, is gradually reduced until it becomes profitable to fragment production, geographically separating Y and Z production and moving labour intensive process to the labour abundant Foreign country. The degree of fragmentation will depend on t_y and the formation of vertical or horizontal MNEs as well as the value of trade will depend on the relative factor intensities of upstream and downstream production.

Relatively *labour intensive upstream* activities give incentive to move them to labour abundant Foreign country provided sufficiently low t_y. At a certain level of t_y all quantities of Y will be produced in Foreign, while the final assembly (YZ production) remains in Home. Such organization of production refers to vertical multinationality. Though YZ exports from Home to Foreign remain at the same level, the total value of trade increases due to high proportion of Y shipped in both directions; first from Foreign to Home as an input for the next stage of production, and then back from Home to Foreign, embodied in the final output YZ. Assumption about lower value-to-weight ratio of Y compared to Z means that the proportion of less valuable goods in the total trade volume increases. The percentage of high and low value goods in the total trade will depend on the volume of Y traded, which in turn, depends on the cost of shipping Y, t_y.

Conversely, in the second case *downstream activity* is assumed to be *labour intensive* relative to upstream. This suggests moving Z production to labour abundant Foreign, while Home as a capital abundant country hosts Y production. Consequently, all Y production is retained in Home and some of Z production is moved to Foreign. The reason for not moving *all* Z production to Foreign is the costs of shipping Z. This means that Foreign Z production only reaches the level at which it is sufficient to supply the Foreign market, while the Home market is served entirely by Home production. Essentially then, downstream assembly (YZ) is divided between Home and Foreign, taking place in the location where the product is consumed. Such replication of production refers to horizontal multinationality. As a result, Home produces the quantity of YZ needed to supply the Home market and intermediate component Y for both Home and Foreign production. Foreign country produces component Z needed to satisfy demand in the Foreign market and imports intermediate Y from Home for the final assembly YZ. Since the final assembly in Foreign fully depends on availability of intermediate good Y, costs of shipping Y, t_y, play an essential role in the decision to fragment production process.

When production relocates to supply each market locally, trade in Z component goes to zero. Trade between Home and Foreign is reduced from the final good YZ to intermediate component Y. Assuming that YZ has higher value-to-weight than Y, such shift denotes the reduction of the value of goods traded and decrease of the value-to-weight ratio.

Variables:

- Y – upstream
- Z – downstream
- YZ – final good
- H – home country (capital abundant)
- F – foreign country (labour abundant)

Assumption: value-to-weight Y < value-to-weight Z < value-to-weight YZ

Factor intensities	Labour intensive <u>upstream</u> (K/L)y < (K/L)z	Labour intensive <u>downstream</u> (K/L)y > (K/L)z
MNE	Vertical	Horizontal
Trade flows	Higher fraction of Y is shipped in both directions (from H to F as input to YZ and, from F to H as part of the final good YZ)	Trade in final products is replaced with trade in intermediates
Value of trade	Increases	Reduces
Value-to-weight	More products with lower value/weight ratio.	Shift from trade in high value to low value goods. Lower value/weight ratio.

Table 2. Fragmentation and multinational production
Source: The table is based on Venables (1999)

To summarize, fragmentation is possible due to different factor intensities of different stages of production, but the process is first triggered by reduction of t_y, the cost of shipping the intermediate component Y. The effect of reducing cost of shipping depends on the relative capital intensities of upstream and downstream production. If upstream activities are labour intensive, vertical MNEs develop and the volume of world trade increases. If downstream activities are labour intensive, firms become horizontal MNEs, just moving some of their final assembly to the country in which it is sold. This reduces the value of trade as trade in final products is replaced with trade in intermediates.

As for the consequences for the value-to-weight, the conclusion fully depends on the assumption about the value-to-weight of the components in question. However, the main purpose was to illustrate the possibility to predict the value of trade on the basis of the model by Venables (1999). Table 2 provides an overview of the consequences.

1.3.3 Costs and benefits of fragmentation

Spatial dimension

A firm that chooses to split off some of its activity from an otherwise integrated production process, faces some trade-offs in terms of costs and benefits presented in Table 3. The major benefits of such decision come from factor cost differences among countries and better market access. The shortcomings are foregone economies of scale and economies of integration.

	Horizontal	Vertical
Costs	Disintegration costs Plant-level returns to scale foregone	Disintegration costs
Benefits	Market access: Saving trade costs Strategic advantage	Factor cost saving

Table 3. Spatial fragmentation: costs and benefits to the firm
Source: Barba Navaretti et al. (2004)

Costs of geographical dispersion

Firms typically benefit from economies of scale at firm level and at plant level. Firm-level economies of scale are usually associated with intangible assets and are related to such activities as R&D, brand development, finance operations and headquarters staff of the firm. When the firm splits some of its activity, it retains firm-level economies of scale but sacrifices plant-level economies of scale. Therefore, multinationality is likely to be induced by high firm-level economies of scale in combination with low plant-level economies of scale. It is argued that sectors in which firm-level economies of scale are important prefer to serve foreign markets through subsidiaries than through exports (Barba Navaretti et al. 2004). As for plant-level economies of scale, their influence is investment specific, depending on whether it concerns vertical or horizontal FDI. Plant-level economies of scale are expected to discourage horizontal FDI as the splitting up of firm's activities leads to the loss of efficiency on the plant floor. However, for vertical FDI, plant-level economies of scale sometimes favour the fragmentation of production because in vertical FDI the activities are not split up but moved to another location.

Concentration of the firm's activities in one place offers benefits in form of economies of integration that refer to e.g. technical efficiency and savings from low scale of coordinating operations. An example of economies of integration from Barba Navaretti et al. (2004) is steel production, where disintegration means that steel cools during transportation and has to be reheated at the subsequent stage. In addition to the loss of technical efficiency, disintegration also brings about trade costs and costs stemming from growing complexity of the value chain. In the fragmented environment, these costs are referred to as service link costs. Service link costs are addressed in Chapter 2.

Benefits of geographical dispersion

Geographical dispersion of the firm's activities pursues two goals, namely possibility to exploit differences in factor endowments and factor costs across countries, and better access to market.

Since each production process requires production factors in different proportion, fragmentation allows for better resource allocation and a closer match of factor intensities and factor productivities for each stage of production. However, factor costs constitute a higher share of total costs in the upstream production stages and therefore tend to play more important role for location decisions in the upstream.

Better market access is the second purpose of geographical fragmentation. When supplying foreign markets, the firm faces a choice between exports and subsidiaries. The size and importance of the market is undoubtedly of prime concern for market access. By moving production closer to the market, the firm avoids trade costs and barriers that accompany exports and reduces the marginal cost of supplying the market. The marginal cost curve represents the firm's short-run supply curve. Any reductions in the marginal cost will change market equilibrium and will cause a change in the competitor's behaviour. Therefore, presence in the local market is of strategic importance as it shapes firm's interactions with competitors.

In summary, access to low-cost inputs and market access are the major driving forces behind geographical fragmentation. Access to low-cost inputs is the main motivation of vertical FDI, while horizontal FDI are more concerned with better market access.

Spatial fragmentation: domestic versus international

Whether geographical dispersion will occur domestically or internationally depends on a range of factors. On the one hand, international fragmentation is potentially more beneficial as differences in productivity and factor prices across countries are larger. On the other hand, necessary costs for international fragmentation are higher due to geographical distance and variety of restrictive trade policies and domestic regulations. However, international fragmentation has proliferated by virtue of recent advances in transportation and telecommunications technologies, reduction in barriers to trade and investment that have reduced the cost of cross-border production sharing.

Organizational dimension

Costs and benefits

The company's choice between internalizing, (i.e. performing the activities within one firm) and outsourcing refers to the organizational dimension of fragmentation, and each option has its advantages and disadvantages. Internalizing brings direct costs of performing an activity (like plant-specific fixed costs) and a cost of not using the comparative advantage of a local producer who may have better information about local conditions such as labour skills, demand conditions and administrative procedures that enables him to produce more cheaply than the MNE.

The advantage of internalizing is saved costs of market relations that consist of transaction costs, imperfect information and contractual incompleteness.

Contractual incompleteness occurs when it is not possible to write a contract that would specify every eventuality that may arise between two parties. This causes a hold-up problem which manifests in suboptimal investments on the supplier's side and inefficient scale of production. The supplier might fear that his commitment in the form of e.g. investment necessary to produce output will put him in an unfavourable position by weakening his bargaining power, while the MNE may avoid its obligations due to contractual incompleteness. In such case, the supplier's decisions are likely to be suboptimal reducing the total return from outsourcing for the MNE.

In turn, when relying on market transactions the MNE runs the risk of dissipation of its intangible assets such as technical know-how, reputation and knowledge capital. As for knowledge capital, the firm might choose to keep it internal if it is too costly to transfer it to third parties or if this transfer will jeopardize firm's comparative advantage. If the knowledge constitutes the core competence of the company and is simultaneously vulnerable to theft, the company is better off when protecting it and internalizing the activities. In case of reputation, the problem arises from too few incentives that the third party may have to maintain the goodwill of the MNE.

Outsourcing is associated with agency costs as it necessitates monitoring the third party whose actions cannot be perfectly observed. When firms expand internationally, the informational asymmetry between parties increases, and the agency problems become more acute. When agency costs are particularly relevant, the firms are likely to expand by means of subsidiaries rather than specialized agents.

Table 4 summarizes the main costs of using the market.

Type of transaction	Type of FDI	Problem	Consequence
Transferring intangible assets	Horizontal Vertical	○ Imperfect appropriability of knowledge ○ Imperfect appropriability of reputation	○ Dissipation of proprietary knowledge ○ Dissipation of goodwill
Carrying out one stage of production	Vertical	○ Hold-up with incomplete contracts ○ Agency costs with incomplete information	○ Inefficient scale of production/sales ○ Underinvestment

Table 4. Organizational dimension: the cost of arm's length transactions
Source: Barba Navaretti et al. (2004)

Organizational dimension: managerial versus market coordination

Curzon Price (2001) visualizes the trade-off between outsourcing and internalization by focusing on transactions cost (Figure 4).

The activities of the firm result in a certain number of transactions that need to be coordinated, and coordination costs are positively correlated with the number of transactions. The coordination can be executed by management or by market.

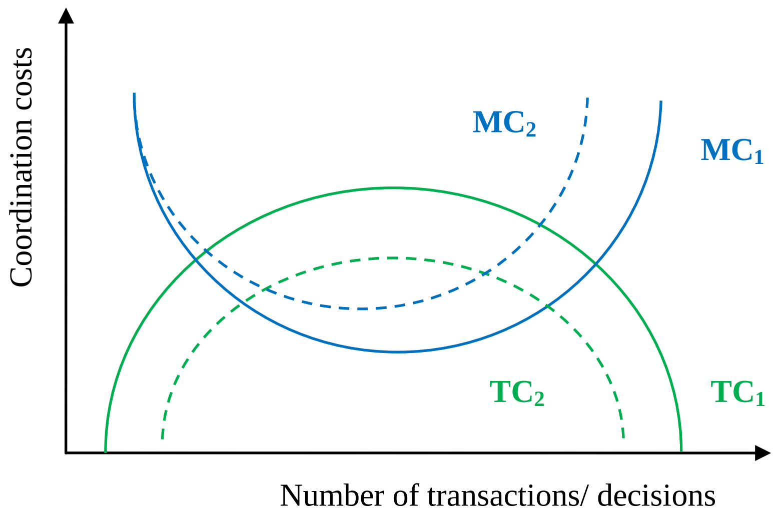


Figure 4. Management versus market
Source: Curzon Price (2001)

MC_1 is a cost of managerial coordination, and TC_1 is a cost of market transactions. The market coordination is preferred for low and high number of transactions, while managerial coordination is efficient between the two extremes. Recent trends in the transactional environment move the costs of managerial and market transactions to MC_2 and TC_2 respectively, thereby reducing the area of managerial efficiency and encouraging use of market mechanisms.

Market is an efficient coordinating and monitoring system, but its major disadvantage in the context of fragmentation is transaction costs. The transaction costs of market coordination (TC) is a non-linear function, low for few transactions, rising as the number of repetitive decisions increases, but falling again over a certain number of new decisions. There is a possibility to save transaction costs by internalizing activities and coordinating them within one firm through management, but only up to a point because of diminishing returns to management. The cost for managerial coordination (MC) is high for new and complex decisions. It starts to decline when the number of decisions rises and managers become more familiar with the tasks and acquire experience and training. The costs rise again as the growing complexity due to large number of transactions reduces the efficiency of management. This implies that the curve for management cost of coordination is concave-shaped.

Combined together, costs of market coordination and managerial coordination suggest that the market coordination is preferred at both ends of the transactions spectrum, while managerial coordination is efficient between the two extremes. Thus, the choice between arm's length transactions and transactions within one firm depends on the interaction of management cost and cost of market coordination.

Recent trends in the transactional environment move the border between areas of market and managerial efficiency. Trade liberalization, falling transport costs, development of cheap and reliable electronic communication and international outsourcing by which inputs are available worldwide at lower price, contribute to reduction of market transaction costs. In terms of Figure 4, the TC function shifts downwards to TC_2, reducing the area of efficient coordination by management. Such drop in market transaction costs will reduce the advantage of internalizing activities within the firm, and therefore reduce the size of the firm. This trend to downsize is reinforced by the fact that customers become more and more demanding. The industry's response to higher requirements is mass customization made possible by market mechanisms. Mass customization implies that each product is available in numerous variants. Only markets can handle such a degree of specialization and differentiation. This trend can be represented by a shift to the left of the right-hand side of the MC_1 curve to MC_2: managerial costs start rising at a lower level of transactions, further reducing the area over which firms are more efficient than markets as coordinators. Firms gradually shift to market coordination, and the number of arm’s length transactions prevails over internal transactions resulting in a higher extent of organizational fragmentation.

1.3.4 Determinants of FDI and location decisions

In their decisions concerning the type of FDI (vertical or horizontal) firms face certain trade-offs. Avoiding trade costs through horizontal FDI implies foregoing economies of scale, as production is distributed across several plants. Exploiting international differences in factor prices through vertical FDI means incurring costs of geographically disintegrated production.

The benefits and costs of each decision are the variables that resolve these trade-offs and determine the type of FDI. The variables fall into two distinct groups: pertaining to firms or industries and pertaining to countries. These variables were discussed in the section above and are summarized in Table 4 that anticipates the influence of different factors on the firm's decision to expand by horizontal or vertical FDI.

Determinants	Predictions by type of investment	
	Horizontal	Vertical
Related to types of firms or industries		
Firm-level economies of scale	+	+
Plant-level economies of scale	-	?
Product-specific trade costs	+	-
Costs to disintegrate stages of production	-	-
Differences in factor intensity across production stages	?	+
Related to types of countries		
Trade costs (distance, trade barriers, etc.)	+	-
Market size	+	?
Factor cost differentials	?	+

Table 5. Determinants of FDI
Source: Barba Navaretti et al. (2004)

The decision to invest abroad is followed by another important decision, namely location of FDI. The major variable in the location decision is agglomeration or industrial clustering. Barba Navaretti et al. (2004) conclude from the literature that there is some evidence that agglomeration plays a role in determining the location of FDI. They point out several reasons why MNE choose to join industrial cluster. These are benefits from knowledge spillovers, better markets for specialized factors, forward and backward linkages between customer and supplier firms. Also, the uncertainty that foreign firms experience in their investment decisions might give incentive to follow predecessors in location choice. Technology sourcing is an important motive as the concentration of firms with advanced technology will induce knowledge spillovers and facilitate access to foreign technologies. One more benefit from clustering is lower service link cost and especially cost of transport.

MNEs are not just beneficiaries but also active participants in agglomeration process. The entry of a foreign firm is often accompanied by the entry of suppliers. This is especially true for developing countries, where foreign firms have strong competitiveness vis-a-vis local firms in terms of technological capability and access to credit and market. Therefore, the entry of foreign firms attracts local actors. Gradually, more firms become involved in the agglomeration and large industrial clusters of foreign and domestic firms emerge in a particular area. Then such clusters form international production/distribution networks (Kimura, Takahashi, 2004).

1.3.5 Global Production Networks and transportation

Previous sections present fragmented production as a chain of operations required to produce and distribute a good or a service. As its name suggests, a production chain is strictly linear. However, these essentially linear structures of production chains form complex networks of inter-firm relationships. It was mentioned that MNEs are active participants in the cross-border production sharing and therefore are major contributors to formation of global networks. Such networks are referred to as production/distribution networks, global production networks (GPN), or global commodity chains (GCC). GPNs represent functionally integrated networks of production, trade, and service activities that cover all stages in a supply chain, from the transformation of raw materials through intermediate manufacturing stages to the delivery of a finished good to a market. Hesse and Rodrigue (2006) argue that the value-generation process in GPNs is interdependent with the distributional capabilities of global freight forwarders, emphasizing the role of transportation as an integral part of the value-generation process within GPNs. The increasing importance of the transportation and logistics industries is explained by the fact that the spatial and organizational fragmentation of manufacturing is accompanied by flows of information, commodities, parts, and finished goods. Together with attempts at reducing inventories they lead to smaller, more frequent and synchronized shipments. Such shifts in value chains place intense pressures on transport systems to support these flows and require a high level of command of logistics and freight distribution.

In terms of fragmentation framework exhibited in Figure 1, transportation belongs to service activities, or service links. Service links are discussed in more detail in the next chapter.

2. Service links

2.1 Cost of service links

Geographical separation of production fragments necessitates a coordination mechanism that would link remotely located production blocks and ensure that they interact in the proper manner. This auxiliary function is performed by service links that comprise such activities as transportation, insurance, telecommunications, quality control, and management coordination. Obviously, these coordination activities are associated with certain costs.

Fragmentation theory claims that firms choose fragmentation when (i) production costs in production blocks can be reduced and (ii) service link costs for connecting production blocks are not too high in comparison to production costs savings (Kimura et al. 2007). This logic is exhibited in Table 6. On the one hand, the reduction in production costs comes from differences in location advantages. Location advantages include factor prices, agglomeration effects, infrastructure services, and policy environment. On the other hand, service link costs must be low enough not to cancel production cost advantages (Kimura et al. 2007).

2.1.1 Components of service link costs

Service link costs comprise multiple components listed in Table 6. The costs are divided into main categories: trade costs, investment costs, communication costs, coordination costs, agglomeration costs. Agglomeration affects service link costs and at the same time is a part of location advantages, and is therefore included in both groups. All the components raise transaction costs within networks and hence determine the extent of fragmentation and the scope of international production/distribution networks.

The first category of service link costs is **trade costs**, whose division into subcategories is based on Anderson and Wincoop (2004). They claim that direct evidence on trade costs come from costs imposed by policy (tariffs, quotas) and costs imposed by the environment (transportation, insurance, etc). Information costs, contract enforcement, costs of use of different currencies, legal costs and local distribution costs are mainly associated with wholesale and retail distribution activities of the firm going multinational. Transportation costs will be given more attention in Chapter 3, while this chapter is devoted to service links in general.

	Category	Subcategory	Details
Service link costs	**Trade costs**	**Transportation costs**	Direct: freight charges, insurance. Indirect: preparation costs, time costs = inventory-holding + depreciation cost
		Policy barriers	Tariff and non-tariff
		Information costs	Search cost for suppliers and buyers
		Contract enforcement costs	Direct and indirect costs
		Costs associated with the use of different currencies	Exchange rate volatility, risk hedge and uncertainty
		Legal and regulatory costs	Cost of legal and regulatory procedures
		Local distribution costs	Cost of utilization of local infrastructure
	Investment costs	Policy barriers	FDI discriminating measures
		Information costs	Search cost for suppliers
		Contract enforcement costs	Direct and indirect costs
		Legal and regulatory costs	Cost of legal and regulatory procedures
	Communications costs		Telecommunications, internet fee
	Coordination costs	Timeliness	Indirect costs due to delayed deliveries
		Uncertainty	Due to coordination of activities from production to shipment
	Agglomeration	Networking	IT networking, business networking
		Cluster of suppliers	Access to suppliers
Location Advan-tages		Cluster of homogenious firms	Externality
		Distribution costs	Reductions possible by increasing returns
		Concentration of similar types of labour	Availability of workers by virtue of agglomeration effects
	Low production costs	Running costs	Low level of wages, factor abundance, access to imported intermediate with low tariff rate
		Fixed costs	Access to inexpensive infrastructure
	Proximity to large markets		Large number of customers
	Other geographical features		E.g. port availability for transit trade

Table 6. Location advantages and components of service link costs
Source: Kimura and Takahashi (2004)

The second category is **investment costs**. A firm that locates production blocks abroad, is adversely affected by policy barriers and problems related to FDI as a part of service link cost. The last but not the least are **communication and coordination costs**. These costs usually accompany the simultaneous operation of production blocks in several countries. Some of these two cost categories have been reduced by virtue of recent technological advances, while others remain due to their nature (Kimura, Takahashi 2004).

Service link costs possess two important features. First, components of service link costs can be divided into fixed costs and running costs. For example, transportation and telecommunication costs are mostly running costs, while information costs and policy barriers to investment have strong nature of fixed costs. Second, the importance of service link costs significantly varies across goods traded. If intermediate goods are traded many times within a network, trade costs become more important for trade in parts and components than trade in other goods (Kimura, Takahashi 2004).

2.1.2 Service link model

A simple diagram (Figure 5) incorporates service link costs into the basic discussion of fragmentation. It shows the relationship between the degree of fragmentation, the cost of production and output levels. The model is based on an important assumption about scale economies. The fragmentation scenario allows for two possible locations of scale economies; production blocks and service links. It is argued that increasing returns to scale are to be found in the service link sectors rather than on the plant floor. In the simplified version of the scenario, production blocks exhibit constant returns to scale. As for the service links, the costs do not rise in proportion to levels of output due to the fixed element invariant to the output level. Such cost behaviour provides strong increasing returns to scale in service links.

In Figure 5 rays 1-4 represent the cost of four production processes. These production processes are different with respect to integration/disintegration of production and returns to scale. The slope of each ray is the aggregate marginal costs of the respective production process. Ray 1 refers to a fully integrated production process and reveals the costs of production undertaken in a single production block exhibiting constant returns to scale. As all production is concentrated in one location, there is no need in coordination mechanism. The service link costs are zero, and the ray starts in the origin. When two domestic locations are selected to take advantage of geographic differences in factor prices and productivities, domestic fragmentation occurs, and the cost of production moves to ray 2. Domestic fragmentation lowers aggregate marginal costs (the slope of ray 2 is less steep than the one of ray 1), but introduces service link costs that are captured in the diagram by the interval 0-A. Such fragmentation is cost-effective only for output levels exceeding A'.

Rays 3 and 4 illustrate alternative processes when *foreign* sources become involved in the production sequence in order to take advantage of differences in international factor prices. International fragmentation decreases marginal costs even more, but raises the costs of connective service links. It becomes profitable only if the extra costs of service link activities are offset by the lower marginal costs obtained by a closer match of factor intensities with factor productivities for each fragment.

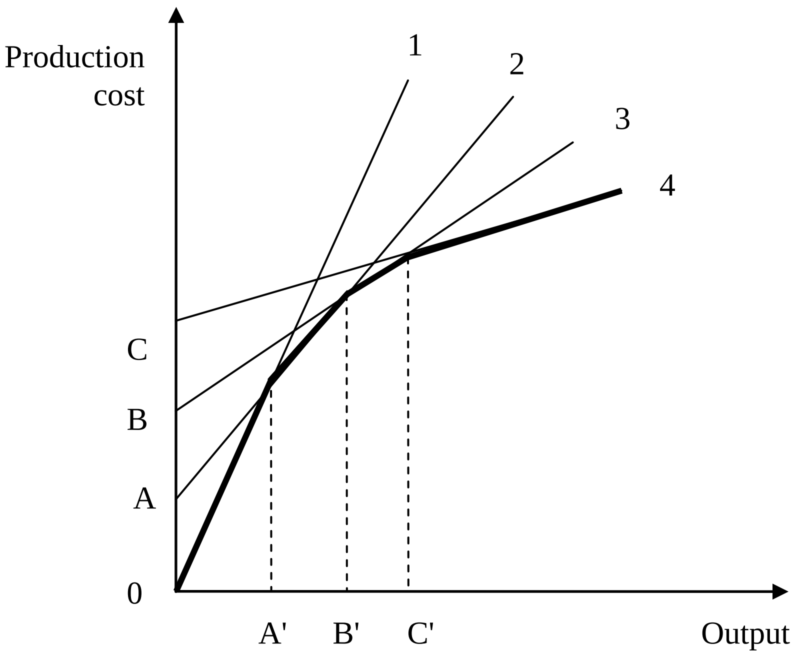


Figure 5. Fragmentation and the cost of production
Source: Jones, Kierzkowski (2005)

Ray 1 refers to the costs of fully integrated production process, while rays 2-4 are the costs of production processes with various levels of fragmentation. The slope of each ray is the aggregate marginal cost of production. Transition from ray 1 to ray 2 becomes profitable once the output level reaches A'. At this point service link costs 0-A are compensated by lower marginal cost of production. The bold line exhibits a minimum cost schedule.

In general, the balance between decreased marginal costs and increased service link costs determines whether fragmentation will take place at all and whether it will expand to the next level.

In the aggregate, average costs of production decrease with output for a given pattern of fragmentation, i.e. along one ray, and marginal costs of total production drop at each intersection of production cost rays. These intersections are the points where the degree of fragmentation increases which occurs at output levels A', B', C' in Figure 5. Such increases in the degree of fragmentation form integrated minimum cost schedule indicated by the bold line at the outer border of rays of production. The integrated minimum cost schedule exhibits increasing returns to scale with increases in the degree of fragmentation occurring at output levels A', B', C'.

2.2 Interplay between main variables

Figure 5 suggests that two factors induce transition to a higher degree of fragmentation; higher level of output and reductions in the costs of service links. The relationships are presented in two separate sections, 2.2.1 and 2.2.2.

The discussion is based on the assumption about positive correlation between the level of output and the volume of trade. Indeed, the firm’s output is limited by demand in the market(s) it supplies. In order to increase the level of output the firm needs access to other markets which is possible by means of trade. Trade permits the firm to reach distant markets and thus expand the volume of production. Also, instead of waiting for the offers, the firm might act proactively and search for opportunities to increase the volume of production by expansion of its geographical market. Such behaviour induces more trade flows between locations of production and consumption resulting in higher volume of trade.

2.2.1 Fragmentation and output

There is interdependence between produced volume and degree of fragmentation.

Impact of fragmentation on output level

Fragmentation works as a catalyst increasing the volume of trade, and this for several reasons. First, fragmentation results in trade in parts and components that enter the world trade in addition to manufactured and finished goods. As more items become tradable in the market, the total volume of trade expands. Second, the fact that large flows of parts and components cross border several times during the manufacturing process generates even more trade flows. Third, fragmentation and component specialization eliminate the need for firms or countries to gain competency in all aspects of production. Once international production/distribution networks involve many countries, and each country specializes in narrower parts of the vertical production chain, participating countries start both exporting and importing parts and components taking advantage of price differences. Developing countries that generally lack advantage in the integrated manufacturing process get opportunity to specialize on just one facet of production and participate in production networks. By allowing developing countries to join production networks, fragmentation contributes to enlargement of markets. Forth, fragmentation expands the customer/supplier range of the firm by making more distant markets available. As markets expand, firms in one country supply not only own industry but also get access to foreign producers as well, and volume levels rise. Fifth, such offshore procurement can improve the competitiveness of an industry whose end products face competition from imports. Industry competitiveness rises, and with it employment, wages and output (Jones and Kierzkowski 2001).

Summing up, fragmentation promotes trade by increasing volumes, opening new markets and allowing more products and firms to enter the world trading system. This conclusion about trade volume might seem to conflict with earlier conclusion based on the model by Venables (1999). The difference is explained by the fact that Venables (1999) studies fragmentation from a narrower point of view. He excludes outsourcing and limits the situation to relationship between cost of shipping, fragmentation and formation of vertical and horizontal MNEs, while Jones and Kierzkowski (2001) take a more general approach and regard fragmentation in a broader context in connection with other variables such as outsourcing, country specialization, competitiveness of the industry, enlargement and availability of markets, the number of firms involved, etc.

Impact of output level on degree of fragmentation

Intuitively, greater level of output permitted by world trade should contribute to further fragmentation. In terms of Figure 5 increase in level of output induces shift to the next ray of production in order to stay on the minimum cost schedule. However, the effect of output level on the extent of fragmentation is ambiguous depending on the national or international scale.

Level of output affects degree of fragmentation through trade. In this case it is important to distinguish between fragmentation on national and international scale. When the benefits of agglomeration exceed those of fragmentation, the firms find it more profitable to locate close to each other. In this case, trade promotes concentration of productive activity, as goods produced in one place can be consumed in another and distance to market loses some of its importance. Any changes that reduce the cost of trading can be expected to lead to yet greater degrees of concentration, often in urban areas with good road and port facilities. Therefore, it is natural to associate increase in levels of trade with an agglomeration of economic activity *nationally*. However, at the international level increased trade coupled with possibilities to fragment production process will permit more countries to join the chain of production. This will be reflected in dispersal of productive activity *internationally*. The effect is supported by increasing return in service links.

In other words, trade may encourage national agglomeration and simultaneously dispersion of production worldwide.

2.2.2 Service-link costs and degree of fragmentation

Apart from the volume of trade, service-link cost is an important determinant of the extent of fragmentation. The functionality of production chain and optimal degree of fragmentation clearly depend on the cost, speed and efficiency of service link operations. Increased fragmentation is associated with higher service-link costs because the number of interactions and the complexity of the fragmented network rise with a number of components. Coordination of a more complex network requires more resources and thus is more costly. This is true particularly for the international service links which are more expensive to establish and more complex to operate in comparison to the domestic ones. However, cost increases due to augmenting number of production blocks whose location steadily involves more countries are mitigated by significant economies of scale in service links coupled with learning effects and enhanced efficiency. International coordination costs have been significantly reduced by recent technological innovations, liberalization of international trade in services, unification of legal and regulatory systems, and increased freedom of establishment. These cost reductions created stronger incentives for international fragmentation. In terms of Figure 5 reductions in the costs of service links both domestic and international, are represented by downward shift of production rays 2-4 and smaller intervals 0-A, 0-B, 0-C.

Isolated, reduced service-link costs promote greater degrees of fragmentation for any given output level. However, it is important to take into account the effect of trade volume on the national and international level. As discussed in the preceding section, trade may encourage national agglomeration and simultaneously dispersion of production worldwide, and reduced service-link costs will support any of the processes.

Availability of service links is also a crucial element for development of fragmented technologies. In the absence of properly functioning service links the firms are unlikely to invest in the fragmented technologies as the benefits from fragmentation will be wiped out by unacceptably high service-link costs. Conversely, readily available service links may encourage the development of fragmented technologies that will gradually replace integrated technologies.

2.3 Transport as a service link

It was inferred that trade plays an important role in determining degree of fragmentation and shaping the geography of production. Trade offers great benefits yet it is not costless. Anderson and Wincoop (2004) define trade costs as “all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself”. They comprise transport costs (both freight and time costs), policy barriers (tariff and non-tariff), information costs, contract enforcement costs, costs of using different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail) (See table 6).

In addition to trade costs, timeliness gradually gains more importance as it will be discussed later. Anderson and Wincoop (2004) place timeliness under coordination costs. However, timeliness is one of the requirements to transport set by modern production chains and it is logical to include it in the presentation of trade costs.

This thesis is concerned with consequences of fragmentation for the transport sector and therefore is focused on transport as a service link. In conventional (integrated) production process the role of transport is to link the final products with the market. In a fragmented environment, in addition to connection between production and market, transport is present at the manufacturing stage. Transportation helps the product along on its way to the market by connecting production blocks within the chains of production. Transport addresses mainly spatial dimension of fragmentation as its primary role is to cope with distance. As the fragmented production is impossible without physical movement of components between production blocks, transport becomes an integrated part of the system.

Part II: TRANSPORT ECONOMICS

3. Transport market

3.1 Main concepts

3.1.1 Definition of transport

According to Quinet (1993) transport as a marketable good is defined as 'a carriage of an object of given specifications, e.g. weight, size, or a person, from A to B in a given time, under given conditions of safety, reliability or comfort'. In other words, the type of cargo, transit time, place of departure and destination point, and service quality are the attributes of transport. These attributes determine the value of transport to the consumer and its cost to the supplier.

3.1.2 Features of the transport market

As any other market, the transport market is an interface between supply and demand. However, a number of specific features make it more complex than the market for most goods. To begin with, much of the sector's activity is not subject to the market forces and is regulated by government. Government regulation lies, however, outside the scope of this paper whose main focus is the freight distribution market where market forces come into play, and price and quantities are determined by the interaction of supply and demand.

Second, transport market is a time specific market. Transport cannot be stocked and has to be supplied at the point of time it is required by consumers. This characteristic creates difficulties for matching supply with demand both in the short and in the long run.

Third, there is no single market but a wide range of transport markets according to the *type of freight* carried. For instance, the shipping market comprises bulk and liner shipping. As different types of freight set very different requirements to transportation system, each transport market has its particular characteristics as well as supply and demand structure. These multiple markets are interlinked on the demand side by the possibility of substitution, e.g. between modes, and on the supply side by the possibility of switching inputs from one market to another.

Segments and actors in the shipping market

The shipping market is a specific market for transport services, with shipping companies[1] on the supply side and shippers[2] on the demand side of the market. Both shipping companies and shippers are actors in the transport market, where price and quantity for the transportation services is determined by interaction of supply and demand. Various variables on the macroeconomic level such as the world economy, political events, world fleet, etc influence supply and demand (Stopford 1997:115). These variables on a global scale are not under direct control of the actors in the shipping market. I will look at the interactions between supply and demand from the perspective of the individual shipping company (supply) and of the individual industrial firm (demand). Only fragmentation as a global trend in the world economy is taken into consideration, while the rest of macroeconomic variables are left outside the scope of this paper.

One peculiarity of the shipping industry is the division into two quite different sectors, the bulk shipping industry and the liner shipping industry. Fink et al. (2001) define *liner shipping* as 'maritime transport of commodities by regular lines that publish in advance their call in different harbours'. *Tramp shipping* 'refers to transport performed irregularly, depending on the momentary demand'. The division is marked by the type of cargo which determines the size of cargo parcel and the type of shipping operation. The principle for bulk cargo is 'one ship, one cargo', as it appears on the market in shiploads, while general cargo consists of many consignments, too small to fill a ship, that have to be packed with other cargo for transport. Transportation of many small parcels involves different administrative tasks such as dealing with shippers, handling documentation and planning the ship loading operations, therefore liner companies need a large shore-based staff. The bulk shipping industry, in contrast, handles fewer, but much larger cargoes which do not require a large shore-based administrative stuff, but the few decisions that have to be made, e.g. debt or equity financing, new investments, choice between old and new tonnage, etc. are of crucial importance (Stopford 1997).

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1 Shipping companies and shipowners are used as synonyms in this thesis.

2 Shippers, users (of transport) services are used as synonyms.

Liner and bulk shipping companies operate at opposite ends of the unit cost function. The bulk shipping industry is built around minimizing unit cost, while the liner shipping industry is more concerned with speed, reliability and quality of service (Stopford 1997).

3.2 Transport costs

Transport economics and international trade use different definitions of transport costs.

3.2.1 International trade

One of the definitions is provided by the U.S. Department of Transportation. Transport cost is ‘all freight, insurance and other charges (excluding import duties) incurred in bringing the merchandise from alongside the carrier at the port of export and placing it alongside the carrier at the first US port of entry’. Transport costs may also include charges for port services and inland transportation. (Fink et al. 2001:15).

It is common to use freight rates or the difference between CIF[1] and FOB[2] prices as an approximation of transport costs (Clark et al. 2003). However, transport costs for the user and for the transport provider are not the same. Transport operator provides a given transport service and incurs a certain cost. The operator’s cost plus operator’s margin will constitute the transport cost for the user.

	Transport provider
Operator’s cost	(Cost)
+ Operator’s margin	(Profit)
= Cost for the user	(Revenue ≈ CIF/FOB)

CIF-FOB difference is paid by shippers to the transport company (shipping company or other companies involved in case of intermodal shipment) for the transport service provided, and thus constitutes the expense for the former and the gross revenue for the latter.

Anderson and Wincoop (2004) distinguish between direct and indirect *transport costs for the user*. Direct transport costs include freight charges and insurance which is customary to the freight charge. Indirect transport user costs include preparation costs associated with

[1] CIF: cost, insurance, freight, i.e. the cost of a good delivered to the importing country.

[2] FOB: free on board, i.e. the cost of a good, excluding insurance, freight and payments for other services involved in moving the good from the exporting to the importing country. (Incoterms 2000)

shipment size (full container load vs. partial loads), holding cost for the goods in transit, inventory cost due to buffering the variability of delivery dates, and the like. Hummels (2001) groups holding cost for the goods in transit and inventory cost into inventory-holding cost. Inventory-holding cost coupled with depreciation cost due to time lag between the order and delivery of the good to the market, represent time costs. As it will be shown later, time costs is an important variable in some decisions taken by shippers.

3.2.2 Transport economics

Transport economics presents a different picture of transport costs by placing them in a wider perspective that takes into account social costs and externalities. It is argued that the concept of transport costs goes far beyond the monetary and non-monetary cost for users and costs of providing transport services for operators. Table 7 provides a schematic outline of the different types of cost involved in transport according to who bears them, who causes them, and also according to whether they are tradable or not, internally or externally.

The total transport costs comprise external and internal costs. External costs are the costs incurred in addition to the costs borne by users and suppliers of transport services and infrastructure. They include environmental costs as well as the costs of congestion, accidents, and use of space. Internal costs include infrastructure costs and private costs such as fuel, maintenance, repairs, insurance, taxes, and depreciation. The table is replicated in order to give an overall picture of costs incurred in connection with transportation. Since the current work is concerned with an individual average shipping firm, only internal private costs will be regarded.

Total costs	External costs	Environmental costs	Fauna and flora
			Energy
			Noise
			Pollution of air, water and soil
			Landscape
			Vibration
		Congestion	
		Accidents	
		Use of space	
	Internal costs	Infrastructure costs	
		Private costs	Fuel
			Maintenance
			Repairs
			Insurance
			Taxes
			Depreciation

Table 7. Structure of transport costs
Source: Quinet and Vickerman (2004)

4. Transport supply

In general, the supply of any good or service depends on the cost of production, the selling price and the profitability of other services supplied jointly. These variables apply to all transport sectors including shipping.

Supply of shipping services will undoubtedly depend on the profitability of the business. Stopford (1997) distinguishes three elements of financial performance of a shipping company:

- the **revenue** received from chartering/operating the ship
- the **cost** of running a ship
- the method of **financing** the business (capital repayments and interest payments)

Such decisions as the choice between old and new tonnage, single-purpose or multi-purpose tonnage, time charter or spot market, as well as debt or equity financing obviously strongly affect the performance of shipping companies. However, I will leave policy and strategic issues outside and focus on the way the interactions between shippers and shipping companies affect the maritime business.

I choose profit function as the basis for the discussion about the impact of fragmentation on the maritime industry. The starting point for the analysis is a simplified profit function of an average company: **revenue - costs = profit**.

In order to see the changes in profit it is necessary to analyze how revenue and costs are influenced by trade environment and requirements to the transport system. The sum of changes in the revenue and cost will show the total effect on profit, i.e. whether profit has fallen or risen.

1. The first step is the analysis of the revenue. Revenue reflects the shipping company's possibility to charge higher prices and capture consumer surplus. The major revenue source of the shipping firm is its operational activities which are set up on demand from shippers, therefore the analysis of demand is a necessary part of the assessment of revenue changes. The relevant question is how fragmentation (and other trends in the world economy) change requirements and demand pattern for shipping services.

2. The second step is to look at the costs by decomposing them and analyzing how different features of the fragmented environment influence cost elements. Since lower costs will result in higher profit (other things being equal), it is important to identify the factors that influence the cost of providing a service incurred by a shipping firm.

4.1 Revenue

The shipping companies are trading in four shipping markets; freight market, sale and purchase, newbuilding market and demolition market, with revenue generated in all of the markets but the newbuilding. Although asset play on the sale and purchase market is a significant revenue source, the main cash inflow is still freight revenue (Stopford 1997: 79).

Francois and Wooton (2001) develop an analytical model of trade showing the relationship between the shipping market structure, trade regime and the freight revenue generated by shipping companies. The model suits to analyse the revenue side of the equation. It is applicable for both bulk shipping and liner shipping regardless of different mechanisms prevailing in these two markets.

4.1.1 Shipping margin model

It was mentioned in the introduction that transport costs are usually measured as a CIF-FOB difference and might serve as an estimator of the company's revenue. Francois and Wooton call the difference between CIF and FOB prices a *shipping margin*, where FOB is the commodity price in the country of origin, and CIF is the commodity price in the country of destination subtracted import tariffs.

Shipping margin

price paid by importers CIF
- price paid by exporters FOB
= **shipping margin** (i.e. revenue for the operator = transport cost for the user)
- operator’s costs
= accounting profit
- opportunity costs
= economic profit

The shipping margin should be high enough to cover the costs of the shipping firm and simultaneously provide sufficient return on investment.

Description of the model

According to the model, the shipping margin depends on trade liberalization and on the level of competition in the maritime industry. The model shows how interrelation between these two factors influences the size of the shipping margin.

There is trade in a commodity between two markets. The commodity is produced in the export market and then shipped in quantity $\boldsymbol{q}$ to the import market. Producers of the good are assumed to be small, perfectly competitive firms located in one or several countries. They face increasing marginal costs and pay a FOB price equal to $\boldsymbol{p_p}$. Transportation service between the export and the import market is provided by the shipping industry at a price $\boldsymbol{\sigma}$, the shipping margin (which is the difference between CIF and FOB prices). In addition, the good is subject to an import barrier in the form of ad valorem (cost of shipping according to the value of the good) tariff $\boldsymbol{t}$. Consequently, consumers in the foreign market pay the price that exceeds FOB price as a result of both the shipping margin and the tariff:

$$p_c = (p_p + \sigma)(1 + t).$$

The model assumes that the shipping firms are identical and compete in quantities (Cournot competition), and that the real costs of shipping, namely freight and insurance, are constant. It also assumes only one stage of intermediation, namely shipping. Therefore, implications of having several intermediaries in moving the good from producer to consumer are not considered.

Variables:

- q – the quantity of the traded commodity
- σ – shipping margin
- t – import tariff
- p_p – FOB/ price paid by producers of the good
- p_s – CIF price
- p_c – price paid by consumers in the destination

(1) Effects of trade regime

In their article, Francois and Wooton (2001) characterize liberal trade environment by low or zero tariffs and simulate the effect of tariff rate on the shipping margin. The tariff rate affects the trading situation through the consumer price. As the tariff is reduced, the consumer price declines resulting in the rise of the quantity traded. This rise in demand results in a higher price being received by producers. With a competitive shipping industry, the beneficiaries of trade liberalization would be the exporting producers and the consumers in the importing country. With a less-than-perfectly competitive shipping industry, the benefits of the trade liberalization are not fully passed through to producers and consumers. The shipowners are able to take advantage of the more liberal trade regime, replacing the part of the tax wedge by a greater monopolistic mark-up. As the tariff continues to fall, the shipping firms receive a larger margin over their marginal costs, resulting in increasingly large profits. Whether shipowners or producers and consumers will benefit from the liberalized trade regime depends on the market structure of the shipping industry.

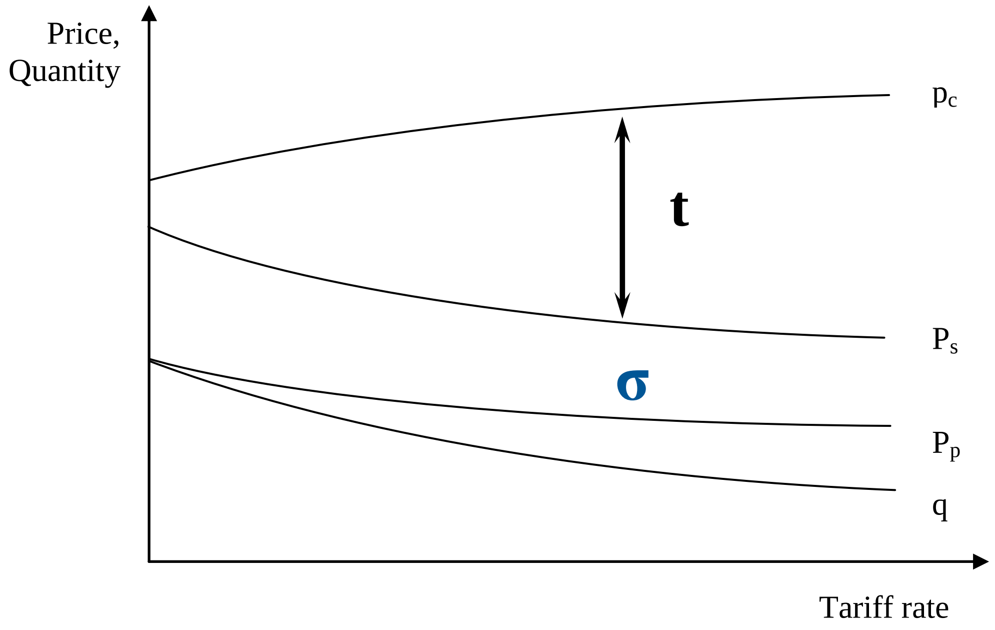

Figure 6. Effects of trade regime
Source: Francois and Wooton (2001)

Lower tariff rate ***t*** results in higher exported quantity ***q***, higher price paid by producers, $\boldsymbol{p_p}$, and lower price paid by consumers in the importing country, $\boldsymbol{p_c}$. With less-than-perfectly competitive shipping industry, shipowners are able to replace a part of the tax wedge ***t*** by a greater monopolistic markup resulting in higher shipping margin **σ**.

Figure 6 illustrates the relationship between tariff rate, the shipping margin and the price paid by producers and consumers. It depicts a duopolized shipping industry. The figures for different numbers of shipping firms are qualitatively very similar, except the case when shipping industry is fully competitive with all the benefits of trade liberalization shared by producers and consumers and with zero profits for the shipping firm.

(2) Effects of increased competition in the maritime industry

The number of firms is chosen as an indicator of the level of competition in the shipping industry. When the number of firms rises, the market share of each incumbent firm declines. The firms will perceive their market demand to be more elastic and will consequently behave more competitively. In the perfectly competitive industry the shipping margin equals the marginal cost of shipping. Conversely, when the number of firms decreases, the industry will become more concentrated and the remaining firms will exercise the increased power from a growing market share. As the shipping industry shifts from behaving as perfect competitors to acting as a monopolist, the consumers pay an increasing price and the volume shipped declines. The growing gap between the producer and consumer price is the margin captured by shippers, and this rises monotonically as the industry becomes increasingly concentrated. The shipping margin reaches its upper limit when the shipping firm exploits its market power with both consumers and producers. Figure 7 shows the effects of changing level of competition on prices, quantities and profits.

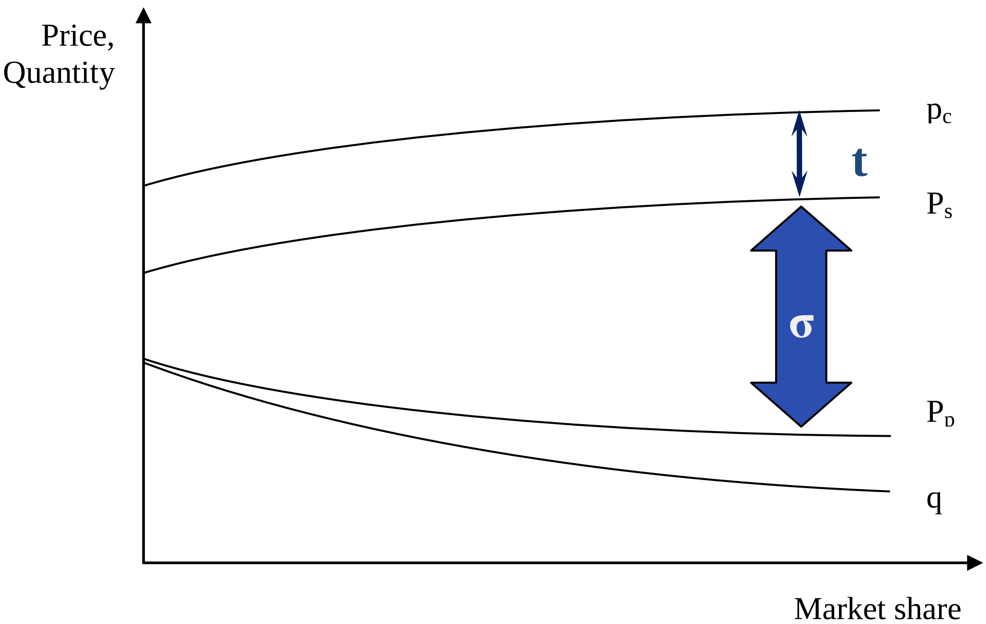

Figure 7. Effects of market share
Source: Francois and Wooton (2001)

As the shipping industry shifts from perfect competition towards monopoly, shipowners can exercise the increased power from growing market share. The shipping margin, σ rises monotonically as the industry becomes increasingly concentrated.

Figure 8 illustrates the combined effect of the concentration of the shipping industry and the tariff rate on the shipping margin. The more concentrated the industry and the lower the tariff barrier, the greater is the shipping margin.

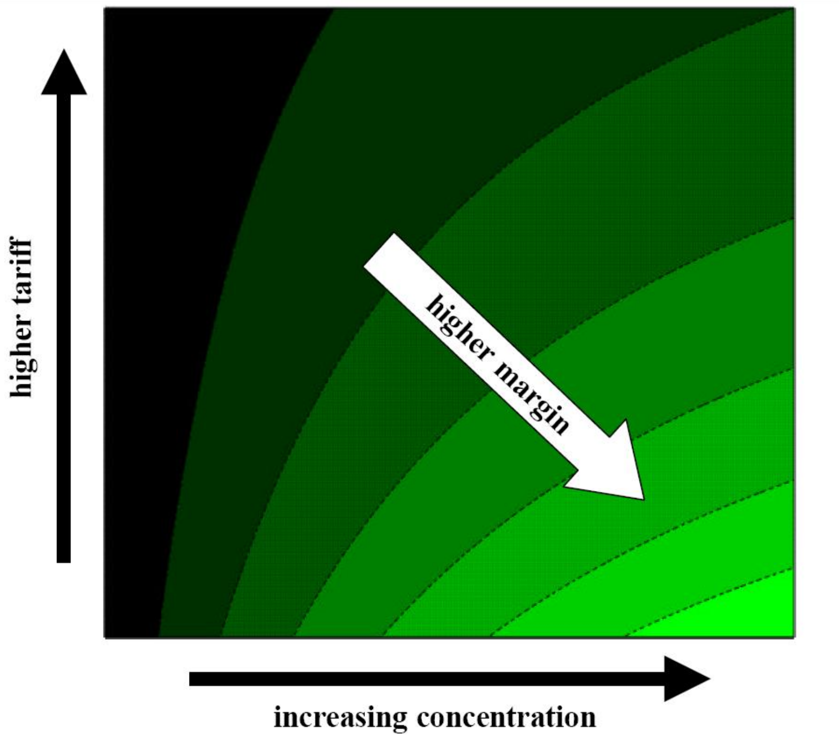

Figure 8. Industry concentration, trade liberalization and the shipping margin
Source: Francois and Wooton (2001)

The shipping margin is the result of interplay of two main variables; tariff rate and concentration in the shipping industry. The more concentrated the industry and the lower the tariff barrier, the greater is the shipping margin.

4.1.2 Extension of the model

In their article, Francois and Wooton (2001) limit the discussion of trade liberalization to tariff rates. The effect of competition is expressed through the number of firms reflecting the competitive environment in the shipping market. However, it follows implicitly that the competitive environment is connected to the market power and market structure. In current work, I will extend the model presented by Francois and Wooton (2001) to include other variable related to the liberalization of trade and concentration in the shipping industry.

Trade liberalization

Generally, liberal trade environment is characterized by low barriers to trade. Following the classification of trade costs given by Anderson and Wincoop (2004), barriers to trade include border barriers and policy barriers in the form of tariff and non-tariff barriers. Border barriers are associated with crossing of national borders and are split into five types; language, currency, information, and contracting costs and insecurity barriers.

Although trade liberalization finds expression in different forms as it follows from Anderson and Wincoop (2004), I regard only such aspects as tariff rates and liberalization in the market for services.

Observation of tariff rates serves two purposes. First, according to the model by Francois and Wooton, tariff rate influences the size of the shipping margin. Second, tariffs influence the importance of transport costs in the world trade according to Clark et al. (2003) and Hummels (2007: 6) who argue that lower tariffs amplify the importance of transport costs in the world trade. Indeed, the fraction of transportation in total trade costs is rising when other trade barriers such as tariffs become less important.

Trade liberalization also concerns the market for services (Jones and Kierzkowski 2001). Its implications for the level of competition in the maritime industry will be discussed in the chapter 7.

Industry concentration and market power

Francois and Wooton (2001) argue that the shipping firm can enlarge its shipping margin wedge (between the price paid by producers, p_p, and the price paid by consumers, p_c, in Figure 7) at the expense of producers and/or consumers by virtue of its market power. They distinguish between two elements constituent in the market power of the shipping firm: ability to charge consumers a price that exceeds the shipping firms' marginal cost and monopsony power with producers which results in price and exported quantity less than it would be in a competitive market. In any case, market power enables firms to adopt pricing strategies such as price discrimination aimed at capturing consumer surplus.

The general definition of market power is given by Pindyck and Rubinfeld (1997). They define market power as 'the ability – of either a seller or a buyer – to affect the price of a good'. However, they use the term 'monopoly power' in the sense of 'market power on the part of sellers, whether substantial or not' (Pindyck and Rubinfeld 1997: footnote p.334). In further discussion I will employ the term 'market power' in its general meaning.

Firm's market power is measured by Lerner index which is the percentage markup of price over marginal cost. In the equilibrium in a monopoly market, the Lerner index is inversely related to the market price elasticity of demand:

$$\frac{P - MC}{P} = -\frac{1}{e_D}$$

The *firm's elasticity of demand* is an ultimate determinant of monopoly power and depends on the following factors:

- The elasticity of market demand
- The number of firms in the industry
- The interaction among firms

The **elasticity of market demand** sets a lower boundary for the elasticity of demand of a single firm, thus limiting the potential for monopoly power. It shows shippers' sensitivity to freight rate changes. A less elastic demand curve perceived by firms signifies higher market concentration. Being one of three determinants of the firm's market power, elasticity of market demand influences the possibilities for higher markup for shipping firms.

An important driver of the price elasticity of demand is the threat of substitute products outside the industry. A firm might have monopoly, but its index of market power can still be low if the firm faces strong competition from substitute products (Besanco, Braeutigam 2005). The shippers' propensity to substitute is influenced, among other factors, by the type of the product and possibilities of substitution between different transport modes.

The number of firms depends on the general attractiveness of the shipping market and on existing barriers to entry. The most frequent barrier that deters entry of new competitors is economies of scale. This aspect will be discussed in the cost structure part.

The interaction among firms refers to the competitive intensity, i.e. whether incumbent firms cooperate or compete aggressively for the market share undercutting one another's prices. I will not perform the structural analysis of competition as it represents a strategic issue and will rather focus on market structure.

Market structure

Market power is strongly related to the market structure. If the existing market structures are ranged on a continuum from perfect competition to monopoly, market power is increasing as the market moves towards monopoly (Davies and Lam 2001). However, monopolies and oligopolies common in transport do not exclude the possibility of competition. Even when the number of operators is small, competition can come into play by threat of potential market entrants. This is the case for *contestable market* (Quinet 1993). Market contestability depends on several factors, namely client mobility, price flexibility and absence of entry and exit barriers.

Client mobility denotes how easily shippers can switch from one transport provider to another. Transportation as such may only be a part of the service provided. The additional logistics services such as handling and warehousing may put shippers in a dependent position substantially reducing their mobility.

Price is a strategic barrier that incumbent firms implement in order to deter entry of new competitors and preserve their market shares. Therefore, flexibility to change price in response to competitors' moves provides a better shield from potential market entries.

Absence of entry and exit barriers makes incumbent firms particularly vulnerable and reduces their ability to charge higher prices.

Chapter 7 addresses the effect of fragmentation on the determinants of firm's market power and the factors that might limit market power in order to understand the impact of fragmentation on the revenue side of shipping companies.

4.2 Costs

The analysis of the cost side of the equation will be based in the first place on the operator cost function defined in transport economics. The cost function permits to derive some important variables useful in the analysis of changes in transportation costs. The cost function is also closely connected to the market structure which is essential in the present analysis.

It was mentioned earlier that operator's profit will depend upon the possibility to charge higher prices and to press the costs. Consequently, pricing policy and cost savings are equally important for the operator's profit.

4.2.1 Cost structure and market structure

It is argued by Quinet and Vickerman (2004) that cost functions are not solely determined by prices of inputs and efficiency of the processes. They also depend on the market structure which in turn influences the market power of the firm and the size of the shipping margin. Market structure clearly affects the behaviour, pricing policy and as a result financial performance of shipping companies.

The studies of relationship between cost function and market structure (Quinet 1993) reveal that, in case of the sea transport market, liner shipping is characterized by monopoly and oligopoly, while the market for tramp services is closer to perfect competition.

4.2.2 General cost function

The cost function of a transport operator is the minimal cost which must be incurred to produce a given quantity *q*. The cost function of the transport operator can be expressed in different ways.

One alternative is to define transport costs as a function of quantity and price of input factors (Quinet and Vickerman 2004). If the operator can use production factors *x, y, z,* the prices of which are p_x, p_y, p_z, the cost function can be written:

$$\mathbf{C = C\ (q, p_x, p_y, p_z)}$$

and marginal cost is expressed as: $\partial C/\partial q$

Another alternative is to express cost as a function of parameters that capture complexity around providing a transport service. A common characteristic of transport operators is that they are multiproduct firms: they may carry both freight and passengers, provide a range of different services to different groups of customers using a number of common inputs. The cost function depends on a range of variables that include the total quantity transported, average weight, average length of haul and total length of the network (Quinet 1993). In a simplified form this gives a cost function:

$$\mathbf{C = f\ (R, Q)}$$

where C – total cost

R – the extensiveness of the network of the transport firm

Q – the total quantity transported expressed in ton-kilometres

Extensiveness of network refers to the geographical extension of transport network and comprises such parameters as the number of routes covered, the average length of haul and total length of the network. Both the transported quantity and the size of the transport network are positively correlated with total costs.

From this function we can define some key economic concepts that have a pronounced effect on the financial performance of any transport operator.

Economies of scale

Economies of scale are expressed as:

$$e_s = \frac{f(R,Q)}{Rf'_R + Qf'_Q} = \frac{1}{e_R + e_Q}$$

where $\boldsymbol{e_R}$ and $\boldsymbol{e_Q}$ are the cost elasticities with regard to the size of the network and the total volume transported respectively.

In terms of the cost function, the firm benefits from economies of scale when its marginal cost is lower than the average cost, and both average and marginal costs are declining. When the costs will rise less rapidly than traffic on a given route, the shipping firm can transport higher volumes at a lower average cost.

Stopford (1997) argues that there is substantial room for economies of scale. As demand for imports increases and more distant suppliers became available, the cost becomes offset to a large extent by the economies of scale obtainable from the use of large bulk carriers (Stopford 1997:126). Economies of scale for a particular ship are given by the relationship between cost and size. This relationship will be discussed later.

Economies of density

The expression for economies of density is:

$$e_D = \frac{f(R,Q)}{Q\,f'_Q} = \frac{1}{e_Q}$$

where e_Q is cost elasticity with respect to the quantity transported.

Economies of density are connected to the size and the structure of the network and are calculated holding the network (the number of nodes, length and arcs) constant.

Presence of the economies of density witnesses that, in any given network, the unit cost of transport will decrease as traffic density becomes heavier. Traffic density refers to the frequency of transport services. Frequent transport services on a given route attract a large number of shippers which, in turn, supports frequency provided.

Economies of density appear to be significant in freight transportation (Mori, Nishikimi 2002) and are particularly important in liner shipping due to the obligation to serve fixed routes which locks capacity at least in the short run.

Economies of scope

Economies of scope are defined as:

$$C(q_1,q_2,) < C(q_1,0) + C(0,q_2)$$

where q denotes the quantities of a number of different goods and **C** is the cost of producing these goods. This condition expresses that the cost of producing two (or more) different goods together is less than the costs of producing these goods separately. In terms of providing networks, serving a range of destinations by one operator is more economically efficient than by several operators as it will enable use of a larger fleet, better management of the fleet, higher rates of utilization as well as better prevention of accidents. The existence of economies of scope is determined solely by cost structure of particular operators and is specific to each separate case.

Economies of scope and economies of scale are often encountered in the presence of monopoly and are therefore important in the market analysis.

4.2.3 Shipping costs

It is further necessary to turn from the general cost function to the costs specific to the shipping firms.

Stopford (1997) splits the costs of running a ship into five main categories:

- Operating costs consist of the expenses incurred in the daily running of the ship. Subcategories of the operating costs are crew costs, stores, routine repair and maintenance, insurance and administration.
- Periodic maintenance costs
- Voyage costs are variable costs incurred in undertaking a particular voyage. The main items are fuel costs, port charges and canal dues.
- Capital costs depend on the way of financing the business.
- Cargo handling costs represent the expense of loading, unloading, and stowing cargo. They are particularly important in the liner trades.

Not all of the cost categories mentioned above are subject to the changes triggered by fragmentation, be it customer preferences or the nature of the product. Most of them remain unchanged regardless of shipowner's decision about the service quality dimensions such as speed, reliability and security. Exception is fuel costs under the voyage costs category that are extremely sensitive to the operating speed of the vessel. As the speed acquires a critical importance in the fragmented environment, fuel costs analysis is particularly relevant in the context of fragmentation. Fuel costs as an input variable in a trade-off between fuel savings and revenue loss will be discussed later.

As for the administrative costs, one may argue that demand for higher quality of service might result in higher administrative costs. However, the analysis of administrative costs is mostly relevant in the comparison between liner and tramp shipping as the administrative costs exhibit a big discrepancy across these two sectors.

The relationship between key parameters such as unit cost, size, and speed influence the total cost of running a ship and formulate some fundamental cost-related principles.

One of such principles is the relationship between cost and size which is often referred to as *economies of scale.* This relationship can be illustrated by means of the annual cost per dwt[1] of a ship. The annual cost is calculated as the sum of operating, voyage, cargo handling and capital costs incurred in a year divided by the deadweight of the ship:

---

1 Deadweight tonnage

$$C_t = \frac{OC_t + PM_t + VC_t + CHC_t + K_t}{DWT}$$

C_t – cost per dwt per annum

OC_t – operating cost per annum

PM_t – periodic maintenance provision per annum

VC_t – voyage costs per annum

CHC_t – cargo handling cost per annum

K_t – capital cost per annum

DWT – ship deadweight

t – year

As the costs in the numerator do not increase in proportion to the deadweight of the vessel, this equation suggests that using a bigger ship reduces the unit freight cost. An example shows that for dry bulk carriers the annual running cost per deadweight for a ship of 170.000 dwt is about one third that of a 30.000 dwt vessel (Stopford 1997: 158). It implies that the owner of a large ship has a substantial cost advantage provided the availability of the cargo volume and port facilities. However, deployment of bigger ship has its downside in the form of loss of flexibility. The size of the vessel limits the number of ports that can be entered and consequently makes it more difficult to obtain backhaul cargo to reduce ballast time.

As it follows from the annual cost equation, the economies of scale are inherent in the cost structure of the vessel and are achieved through a reduction of a unit cost. The realization of economies of scale will depend on external factors. E.g. transport demand and traffic intensity determine whether deployment of bigger ships on a given route is profitable.

Another important cost-related principle is known as a *trade-off between fuel savings and revenue loss* and concerns the shipowner’s decision about the optimal speed of the vessel. For any ship with given hull design and hull smoothness, fuel consumption will depend on its operating speed. Operating speed of the vessel is positively correlated with water resistance resulting in lower fuel consumption when the ship is slow steaming. Fuel is the single most important item in voyage costs. As an example, fuel costs account for 47 per cent of the total for a ten-year-old Capesize bulk carrier under a Liberian flag at 1993 prices (Stopford 1997:160). It is worth mentioning that the fuel cost fraction of total costs of running a ship varies considerably with bunker prices. However, this number suggests that fuel savings might be substantial. Being unable to control bunker prices, the shipowner can still control the level of fuel consumption and consequently fuel costs by adjusting the operating speed within the margins provided by ship design.

The mean operating speed influences not only fuel costs, but also the amount of cargo that can be delivered during a fixed period and hence the revenue earned. This relationship confronts shipowners with a trade-off between fuel savings and revenue loss.

It is obvious that freight rates and fuel prices determine the outcome of this trade-off. In a high freight market it pays to steam at full speed, whereas at low freight rates a reduced speed may be more economic because the fuel cost savings may more than compensate the loss of revenue. The relationship between speed and freight rates is expressed in the following equation that defines the optimum speed of the vessel (Stopford 1997: 140):

$$s = \sqrt{\frac{R}{3pkd}}$$

s – optimum speed in miles per day
R – voyage freight rate
p – price of fuel
k – the ship's fuel constant
d – distance

In addition to the price of fuel and freight rates, the efficiency of the ship and distance influence the optimum speed. The possibility to adjust the operating speed adds flexibility to shipping firms allowing for a better match between demand and supply for shipping services in the short run.

The trade-off between fuel savings and revenue loss is of particular interest in the context of emphasis on timeliness and speed as it explains how the revenue and costs of the shipping firm are governed by customer's service quality requirements.

One should also keep in mind that old and new vessels have different cost structures. Therefore, the fraction of different cost categories varies according to the age of the ship. The decision about new versus old tonnage is important since the costs of running a ship shape the short run supply curve.

4.2.4 Shipping costs in liner shipping

Fink et al. (2001) develop a model of liner transport prices for U.S. imports. I will use this model in order to see how fragmentation might change the cost of liner shipping assuming that the model is not limited to U.S. imports only but is valid for trade routes worldwide. The model relates a price of shipping a product to the marginal cost of service and a markup term. $\mathbf{P_{ijk}}$ is the dollar price of shipping a unit of weight of product ***k*** from foreign port ***i*** located in country ***I*** to U.S. port ***j*** located in district ***J***. ***Φ*** is a markup term and ***MC*** is the marginal cost of service.

$$P_{ijk} = \Phi(I,J,k)\ MC(i,j,k)$$

Markup term and marginal cost term are further decomposed into a number of variables. For simplicity I will omit the equations and present the variables in the form of a table. Two first columns of Table 8 list the variables for the marginal cost and the markup term respectively, while their estimated consequence for the overall transport costs is presented in the last column. The consequences are based on the findings by Fink et al. (2001).

The **marginal cost** is said to depend on:

- the differences across customs districts in port services and other auxiliary services
- differences in the physical properties of shipped goods such as weight and size
- the share of goods shipped in containers
- shipping distance
- economies of scale represented by the total value of imports carried by liners
- policy indicators such as cargo reservation policy, existence of barriers to the foreign supply of cargo handling services, and restrictiveness of the port service regime (i.e. the extent to which port services are mandatory).

The **markup term** is a function of the elasticity of demand perceived by liner companies serving the routes between country *I* and U.S. district *J* for product *k*. The markup is influenced by product characteristics and by policy indicators; cargo reservation policies, price-fixing agreements and cooperative agreements.

Not all variables are relevant for the topic of this paper which excludes differences in port services and policy indicators. I will describe relevant variables to show to what degree they account for changes in transport cost. The relevant variables are marked blue in table 8.

Marginal cost *(mc)*	**Markup term *(φ)***	**Estimated consequence for the transport cost**
Differences in port and auxiliary services		
Product specific effect (physical properties)	Product specific effect (transport demand elasticity)	
Containerization		Reduces liner prices
Distance		Transport cost increases with distance but less than proportionally
Economies of scale		There are economies of scale for traffic originating from the same port. Small countries are relatively disadvantaged.
Policy indicators[1]		
Cargo reservation policies[1a]	Cargo reservation policies[1a]	Have no longer an important influence on liner trade
Barriers to the foreign supply of CH services	Price-fixing agreements (conferences)[1b]	
Mandatory port services (the restrictiveness of port service regime)	Cooperative agreements[1c]	

Table 8. Liner costs
Source: The table is based on Fink et al. (2001)

Determinants of liner shipping costs

The **product-specific effect** is included both in the marginal cost equation and in the markup equation but refers to different product characteristics. Physical properties such as weight and size influence the marginal cost, while the markup term depends on transport demand elasticity of a particular product. Transport demand elasticity is derived from the final demand for product in the country of destination. Fink et al. (2001) use product-specific

[1] *Comments on policy indicators:*
1. Policy indicators:
a) Restrictive policies are expected to lead to cost inefficiencies.
b) Limit directly the extent of competition from foreign liners and thus may push up markups.
c) Both price-fixing agreements and cooperative agreements are collusive agreements that are likely to push up markups of liner companies.
Price-fixing agreements are more powerful and have a greater impact on transport prices than cooperative agreements.

effects related to both physical properties of the good and its transport demand elasticity in order to see whether the commodity will be shipped by air or, in case of ocean shipping, by tramp or liner. The results show that valuable and light products are likely to be sent by air while tramp services are primarily used for heavy commodities with low unit values. In a similar study, Clark et al. (2003) use value-to-weight ratio as a proxy for the insurance component of liner transport cost. They find out that there are large differences in insurance costs per kilogram across countries even for products in the same category. However, one tendency is common for all products; the more expensive the product per unit of weight, the higher the insurance and hence the overall transport cost.

Containerization is estimated to be negatively correlated with transport costs. The explanation is that containerization reduces services cost, such as cargo handling, and therefore total maritime charges. The study reveals that transporting goods in containers will reduce transport costs by around 4 percent (Clark et al. 2003).

Distance has a significant positive effect on transport costs. A doubling in distance roughly generates an 18 percent increase in transport costs (Clark et al. 2003). This distance elasticity close to 0,2 is consistent with the interval 0,2-0,3 estimated by Fink et al. (2001). However, the effect of shipping distance on shipping cost becomes less pronounced on longer distances.

The variable capturing **economies of scale** is the level of trade that goes through a particular maritime route. Economies of scale can be found at the vessel level and at the seaport level. In general, most of the economies of scale are at the vessel level but they are related to the total volume of trade between two regions. Maritime routes with low trade volumes are covered by small vessels and vice versa (Clark et al. 2003). The analysis shows that the increase of traffic originating from the same port leads to lower marginal cost of shipment. This may come from the fact that higher transported volumes allow deployment of bigger vessels, or might induce competition between liner companies covering the route.

The variables presented above are analysed in Chapter 7 with the view to determine how they change in response to changes in the world economy.

5. Transport demand

Transport economics literature provides an overview of the main determinants of demand for transport which are general for all transport sectors including shipping. The demand for transport depends on:

- The price of the service
- The price of substitute and complementary goods
- The income of potential buyers
- Quality
- Consumer tastes

These variables are concerned with passenger transport but, intuitively, can also be applied to the transport of goods. Transport is a service purchased by shippers and its demand obeys the same rules as the demand for other goods and services.

In addition to the variables mentioned above, come the requirements that are said to influence demand for sea transport services. These requirements are set by customers and are identified by Stopford (1997) as price, speed, reliability, and security. Last three requirements are related to 'the quality of service' which emphasizes customer's perception of shipping as a service.

Transport can be viewed as an input factor into the firm's production process since the firms use transport as a link between production segments and a link further to consumer markets. Therefore, demand for transport can be explained by means of theory of factor markets. From microeconomic theory, 'factor demands are *derived demands* – they depend on, and are derived from, the firm's level of output and the costs of inputs' (Pindyck and Rubinfeld 1997). The cost of inputs corresponds to "the price of service" above, while the firm's output depends on the consumer demand of the end product and will be discussed in the section devoted to the income of potential buyers.

5.1 Price

Price of service, i.e. freight rate, affects shipper's demand for transport in two ways. First, it represents a pure monetary cost that the shipper faces in connection with transportation of the good. Freight rate is a key variable in the shipper's demand function as the shipper measures the output obtained from use of the input factor against its price. Second, price alters the delivered price of the goods transported and their relative prices.

Sensitivity of demand to price is captured by the *price elasticity of demand* (for the input factor), which is the percentage change in cost-minimizing quantity of input demanded resulting from a 1-percent change in its price (Besanko and Braeutigam 2005: 243). If quantity and price are denoted by Q and P, the price elasticity of demand is written algebraically as:

$$e_p = \frac{\Delta Q/Q}{\Delta P/P} = \left(\frac{P}{Q}\right)\left(\frac{\Delta Q}{\Delta P}\right)$$

Price elasticity will normally vary according to the sub-market, time horizon (short- versus long-term), the time period considered, and transport mode (Powell 2001).

It is difficult to measure the demand elasticity partly because the market for most transport services is an aggregate of a number of sub-markets, each with a different elasticity. Within each sub-market the demand elasticity may also vary depending upon the price charged; it may become higher after some critical price level, at which the cost becomes significant relative to the end product price.

The elasticity of demand is different for different transport modes. For a particular mode it will vary upon the extent of competition from other modes and the pricing structure adopted. It may also vary depending upon the time period considered as it takes time for users to adjust their trade or production patterns in response to a change in the cost of transport.

In addition to being a monetary expenditure, price affects the shipper's demand (and modal choice) indirectly by altering the delivered (CIF) price of the commodities and their relative prices. Value-to-weight ratio of a good is a useful estimate of the impact that transport costs will have on its delivered price and on the price compared to prices of other goods. An example can help understand the logic behind this statement[1]. Imagine a 10€ and 1000€ good (wristwatch in Hummels 2007) of similar weight and size to be shipped from A to B. A

[1] The purpose of the example is merely to illustrate the relationship between transport costs and commodity prices. The numbers are chosen randomly and do not reflect real prices.

1000€ good has a higher value-to-weight ratio in comparison to the 10€ good and typically requires services of higher quality, such as more rapid delivery, more insurance, and greater care in handling. Transportation of the 1000€ good will be more expensive but not 100 times more expensive than transportation of a 10€ good (5 times in this example). As a result, low value goods become relatively more expensive for the end user compared to high value goods.

Example 1

	Good 1 (low value)	Good 2 (high value)	Relative prices (good1/good2)
FOB	10	1000	10/1000 = 1%
+ Transport cost	1	5	
= CIF (delivered price)	11	1005	11/1005 =1,09%
Transport cost/CIF	9,1%	0,5%	

It is obvious that the transport cost's impact on the delivered price depends not only on the value-to-weight ratio but also on transport cost's share of the commodity price. Example 2 illustrates this relationship. Two goods of similar value-to-weight ratio require different quality of service. Transport cost amounts to 10% of the commodity price for good 1 and to 30% for good 2, which results in the higher delivered price for good 2 relative to good 1.

Example 2

	Good 1	Good 2	Relative price
FOB	100	100	100/100 = 1
+ Transport cost	10	30	
= CIF	110	130	110/130 =84,6%
Transport cost/CIF	9%	23,1%	

Relative (i.e. percentage) rise in the delivered price due to transport costs is lower for more valuable goods (with high value-to-weight ratio) than for less valuable goods (low value-to-weight ratio). Consequently, high value-to-weight goods are less penalized by transport costs.

These two examples lead to the following conclusions: (1) high value-to-weight goods are less penalized by transport costs and (2) low value goods will become relatively more expensive for the end user compared to high value goods as a result of transportation.

5.2 Price of substitute goods and complementary goods

5.2.1 Substitutes

The main alternatives to the maritime transport services are truck, rail and air dependent on the length of haul. Truck and rail constitute the main substitutes on short distances, while air transportation is the major competitor for long-distance shipments. However, even with identical service quality characteristics, different modes of transport are not perfect substitutes. As some modes might be inappropriate for particular goods, the possibility of substitution is determined by the type of cargo. When the cargo allows for different transport modes, degree of substitution is reflected in cross-price elasticity of demand defined as ‘the percentage change in the quantity demanded for a goods that results from a 1 percent increase in the price of another good’ (Pindyck and Rubinfeld 1997). Cross-price elasticities depend on supply in the different modes.

Modal choice: price/speed trade-off

As modal choice decisions constitute a centrepiece of demand structure and reflect the threat on the part of substitutes, it is necessary to look at the criteria that influence the shippers' selection of transport mode.

In this thesis only long-distance trade is considered. This limitation is justified by the fact that blocks of the fragmented production process are usually dispersed around the globe over more than one continent. Trade flows between such production blocks are classified as long-distance. This view is supported by Rodrigue (2007) saying that international division of production and trade liberalization permitted by globalization has resulted in additional demands for long-distance trade, which relies mainly on maritime transportation.

In long-distance trade with non-adjacent partners nearly all merchandise moves via ocean and air modes (Hummels 2001), therefore, the only source of competition for maritime transport is air transport. However, there is imperfect substitutability between air and ocean transport subject to the type of cargo. As air freight is not relevant for some cargoes, there is no threat of competition from air transport for goods that are never air-shipped. Therefore, such goods are excluded from the analysis. The type of cargo is also determinative for the choice between bulk and liner shipping. This issue will be discussed in section 6.1.3

If product characteristics allow for both air and ocean shipping, shippers choose between these transport modes. Seaborne transportation is associated with lengthy shipping times at low freight rates, while air transportation offers speed delivery but at much higher cost. Hummels (2001) argues that shippers compare greater time costs in case of the ocean shipping with premium charged for air freight, and select the lowest cost alternative. Thus, air shipping is chosen if the greater time costs of ocean shipping exceed the premium charged for air freight. This trade-off is referred to as *price/speed trade-off* and to large extent depends on shipper's time costs and time sensitivity.

5.2.2 Complements

The increasing transport distances that accompany economic globalization often require use of complex chains of modes of transport. When the average haul grows, transportation from the point of origin to the point of destination can no longer be performed in a single movement. Instead, the goods are shipped to an intermediate destination (a hub or a distribution center), and from there to yet another destination. This operation is known as *transshipment*. Transshipment might be confused with transloading, though they represent distinctly different concepts. *Transloading* is the process that takes place when one mode of transport cannot be employed for the entire trip, as it is the case for international shipments between inland points, when the cargo must be transferred from one mode of transportation to another. Transshipment and transloading are inevitable operations in complex transport networks where the links between the points of origin and destination are not direct routes but several routes, or legs, converging and diverging at intermediate point(s). Though a shipment might comprise a number of legs, it appears as a single movement in the eyes of the shipper. When buying a service package, the shipper often contacts a single operator (usually a freight forwarder) regardless of the number of operators involved.

The consequences of increasing transport distances are aggravated by more sophisticated shipper preferences. In the fragmented environment shippers often require a door-to-door delivery. A door-to-door delivery and combination of different modes of transport (intermodality) are the principal characteristics of modern transportation. Intermodal freight transport involves the transportation of freight in a container or vehicle, using multiple modes of transportation (rail, ship, and truck), without any handling of the freight itself when changing modes. The method reduces cargo handling, and so improves security, reduces damages and loss, and allows freight to be transported faster. Intermodality was defined in the research conducted by Ludvigsen (1999) as ‘a characteristic of a transport system that allows at least two different modes to be used in an integrated manner in a door-to-door transport chain’. The intermodal transit chains usually involve two to four operators who perform different functions under cargo movement and whose actions are operationally and managerially integrated (Ludvigsen 1999).

A door-to-door delivery often is not possible without loading, unloading, transshipping, and setting up of cargoes. These operations are expensive and time-consuming and frequently involve more than one operator. When the shipping firm takes responsibility for the ocean leg exclusively, there is a need for participation of freight forwarders that provide a service package comprising services additional to the ocean freight, such as warehousing, pick-up, delivery, insurance, customs clearance, road and rail transport, inland distribution, etc. Freight forwarders are responsible for the integration of managerial and operational activities throughout the supply chain in order to provide a seamless transfer of cargoes. This growing need for door-to-door delivery emphasizes the need for cooperation between transport service providers and for technical compatibility between transport modes. The performance of the shipping firm providing the ocean leg in such an environment is strongly related to the synchronization of all activities throughout the transport chain and performance of all operators involved.

For goods transport, there is a diversity of types of auxiliary firms, intermediaries who perform a range of functions. Intermediaries can be transport operators which undertake the operations in addition to transport services in order to provide an integrated service to clients. When transport needs are simple to satisfy, final consumers can easily deal directly with operators. It is when these needs become more complex that intermediaries come into play (Quinet and Vickerman 2004).

Intermediaries have major functions:

- To manage risk and uncertainty: provide a greater degree of certainty in the operator's revenue stream, e.g. by purchasing cargo space which they sell on to customers.
- To provide specialist knowledge of transport operations to shippers who have infrequent needs for transport.
- The organization of formalities for customs and other documentation in international transport.

- To coordinate activities through the knowledge of the market and assure a greater matching of demand and supply by achieving a more efficient grouping of demands with the availability of capacity (e.g. to assign clients to the most suitable operator).

Intermediaries can exert greater influence on operators through their greater purchasing power compared to single shippers.

Though the shipper often perceives transport connections as seamless and deals with just one actor within the transport chain, the transport system is more complicated. From the transport system perspective, the ocean leg can be considered as a ”core” service as it covers major part of the total distance between the point of origin and destination, and other services might be considered complementary to the ocean freight.

The main idea is that a seamless cargo transfer from the shipper's point of view is a complex process on the supply side. Shipper buys a package which in reality is a combination of different services. If the ocean freight is a core service, other services in the package are additional, or complementary. The total price of the package is then the sum of the prices for different services. The fact that the ocean leg accounts for a little more than a third of total door-to-door shipping charges emphasized the role of complementary services and their performance (Fink et al. 2001).

Intermodal transport constitutes a growing share of freight distribution across the globe. Transportation, in terms of modes and routing, is no longer of much concern for customers as long as shipments reach their destination within an expected cost and time range. Their concerns are mainly cost and level of service while for the intermodal providers routing, cost and service frequencies gain an ever greater importance.

5.3 Income of potential buyers

It was said in the introduction that demand for transport as an input factor depends on transport cost and the firm’s level of output. The cost of transport was discussed above, and this section concerns the firm’s level of output.

The demand for transport services is driven by the demand for the final product which, in turn, depends on a range of factors, one of which is the income of the end users. The income elasticity of demand for the end product is the percentage change in quantity demanded resulting from a 1 percent increase in income (Pindyck and Rubinfeld 1997):

$$e_I = \frac{\Delta Q/Q}{\Delta I/I} = \left(\frac{I}{Q}\right)/\left(\frac{\Delta Q}{\Delta I}\right)$$

There is indirect evidence of the rising consumer income in the literature. Hummels (2007: 20) touches upon the rising consumer income when explaining time sensitivity. Curzon Price (2001: 105) also mentions that customers become more demanding. These two comments can be regarded as the evidence of the rising consumer income, since higher income is usually reflected in more sophisticated consumer demands. How the demand for the good will respond to income changes depends on the type of good and consumers' preferences. The impact of consumers' income on the modal choice and requirements to transport system will be discussed in part 6.1.

5.4 Quality of service

As it was mentioned in the introduction to this chapter, Stopford (1997) defines requirements to transport system as price, speed, reliability and security. I regard speed, reliability and security as parameters of 'the quality of service'. Quinet (1993) argues that quality of service is an important field of competition among transport operators and is often expressed in frequency and timetables and the size of the network. I will present service quality parameters introduced by Stopford (1997) and Quinet (1993) and supply them by some additional definitions.

Though price is likely to be a significant criteria applying to transport as a good, transport decisions made by users depend rather on the combination of service quality and cost considerations. This relationship between cost and quality is articulated through the term *'generalized cost of travel'* (Powell 2001). For passenger transport the generalized cost of travel is defined as the sum of the fare and the disutility related to discomfort, time spent travelling, and other inconveniences associated with travelling. The cost of time spent travelling is based on the assumed value of time which depends on the income forgone and the activity for which this time could otherwise be used. The value of time is simply the amount people will pay to save time. In economic terms, the value of time equals the marginal rate of substitution between time and price.

5.4.1 Speed and time costs

Applied to freight movement, the logic of generalized cost of travel implies that along with monetary cost (freight rate) shippers face costs related to transit time. Hummels (2001) defines these costs as time costs.

Time costs consist of two elements: inventory-holding and depreciation costs. Inventory-holding costs include the costs of goods in transit (inventory in pipeline), as well as the need to hold larger buffer-stock inventories (inventory on-hand) at final destinations to accommodate variations in arrival time. Depreciation costs reflect the deterioration of the product's value over time and explain why a newly produced good might be preferred to an older one. In the production context depreciation may also reflect the immediate need for the good or component, and lost productivity from the component if it is not available. For example, the absence of a key component may idle an entire assembly plant, and an emergency shipment may be worth many times the nominal price of the component, while late arrivals are of considerably depreciated value.

Transit times also result in the time lags between production start and final sales. Because of the rapidly changing customer requirements the time lags translate into a mismatch between an 'ideal' product containing the ideal characteristic set and the product available in the market. The shorter the time between production ordering and final sales, the closer the produced good matches the ideal type.

Time costs are related to shipper’s **time sensitivity** which is the expression for the importance that transit time has for the shipper. High time sensitivity indicates that the shipper either incurs substantial time costs during transportation of the good or time costs incurred are relatively important. In any case, the shipper will opt for a faster transport mode in order to avoid time costs. Hummels (2001) argues that time costs are significant. For US trade in manufactured goods he estimates an average length ocean voyage of 20 days to be equivalent to a 16% tariff. This means that exporters in the largest manufacturing categories are willing to pay 0,8% of goods value for each day of the ocean voyage saved.

As both manufacturers and trade firms wish to reduce time costs, the fastest possible delivery is an obvious requirement to the transport system. There arises a conflict between shippers’ wish to speed up and the shipowners’ wish to save fuel costs by reducing the operating speed of the vessel (the loss of revenue/fuel savings trade-off).

Time sensitivity and **timeliness** are related terms yet concern different aspects of time. Timeliness which is a synonym for punctuality refers to the deliveries that occur exactly at the appointed time without deviations from a predetermined schedule. Anderson and Wincoop (2004) define service-link costs associated with timeliness as indirect costs due to inadequateness of delivery (Table 6).

5.4.2 Reliability and security

Reliability is a typical element of the quality of service. It refers to the ability of the shipping firm to consistently provide the quality of service compliant with promises/what has been agreed (Stopford 1997).

Security is related to the risk of loss and damage in transit (higher insurance) and arising inconveniences for the shipper and higher administrative expenses. Security minimizes the risk of loss or damage under transit.

Reliability and security are the invariable requirements, meaning that they are not affected by changes induced by fragmentation.

5.4.3 Networks

Freight distribution relies on networks established to support its flows and on nodes that are regulating the flows within networks (Rodrigue 2006). Geographical complexity of the supply chain is then expression for the level of spatial fragmentation of production. Networks are an inherent feature of transport markets. They arise because operators find advantages in exploiting simultaneously various geographical markets. Networks together with the price charged for journeys on that network constitute an important field of competition for transport operators (Powel 2001). The operators must determine the size of network they wish to serve before they can establish their timetables and set their prices (Quinet 1993). Network size affects the number and type of the links served and presents benefits to the user to the extent that it provides more destinations available without having to change operator, more consistent information, higher probability of compatible timetables and more possibilities of making changes to times. The strategy of transport operators in extending their networks or in increasing network compatibility is usually to provide for coordination of timetables. However, most benefits from better coordination fall on users and small operators, while the result for the large operator is ambiguous (Quinet and Vickerman 2004).

From the operator's viewpoint, the size of network determines the cost of service through its influence on economies of scale and scope and consequently on the price of service. From the user's point of view, the size of network is a parameter of service quality which mainly determines how convenient it is to use the services of the operator(s) providing this network.

5.4.4 Frequency

It was stated earlier that frequency is often included as a parameter of the service quality. For instance, Quinet (1993: 44) distinguishes frequency as one of the dimensions of the service quality when discussing competition among transport firms. In the research by Ludvigsen (1999) frequency is also mentioned as one of the service quality dimensions under the operational excellence category. It can be concluded that frequency is an inherent feature of the quality of service.

Hidden waiting time

In addition to the monetary cost of transport and time costs imposed by transit times, shippers face a cost associated with frequency of service called hidden waiting cost. This issue is addressed in the model of the demand for air transportation used by Norman and Strandenes (1994). It illustrates how frequency influences the transportation's value for the user by incorporating waiting cost imposed by time intervals between departures.

In the model, consumer demand for air transportation depends on both price and flight frequency. It is suggested that the timetable of a transport operator offers users $\boldsymbol{n}$ departures per day, with equal time intervals between departures, $\boldsymbol{l = T/n}$. The users are assumed to have certain preferences for the departure time, which are not necessarily perfectly matched by the timetable provided. Thus, the desired departure time, $\boldsymbol{z}$, might deviate from available departures (t_{i-l}, t_i , t_{i+l}, in Figure 9) causing some inconveniences to the users. The time that the users spend waiting due to discrepancies between the desired and the actual departures is called 'hidden' waiting time and is measured by the opportunity cost of time, $\boldsymbol{w{=}w|t\text{-}z|}$.

Also, the users derive value, $\boldsymbol{v}$, from consuming a transport service. Their gross value is decreased by the opportunity cost of the time, $\boldsymbol{w}$, and the ticket price, $\boldsymbol{p}$, leaving them with consumer surplus:

gross value ***v***

- opportunity cost of time ***w***

= net value

- ticket price ***p***

= consumer surplus

This calculation shows that the total cost for the users is given by the sum of the ticket price and the cost of 'hidden' waiting time that depends on the service frequency. Consequently, when choosing the time of departure, the users take into account both ticket price and the opportunity cost of time. This implies that the most suitable time of departure is the one minimizing the total cost.

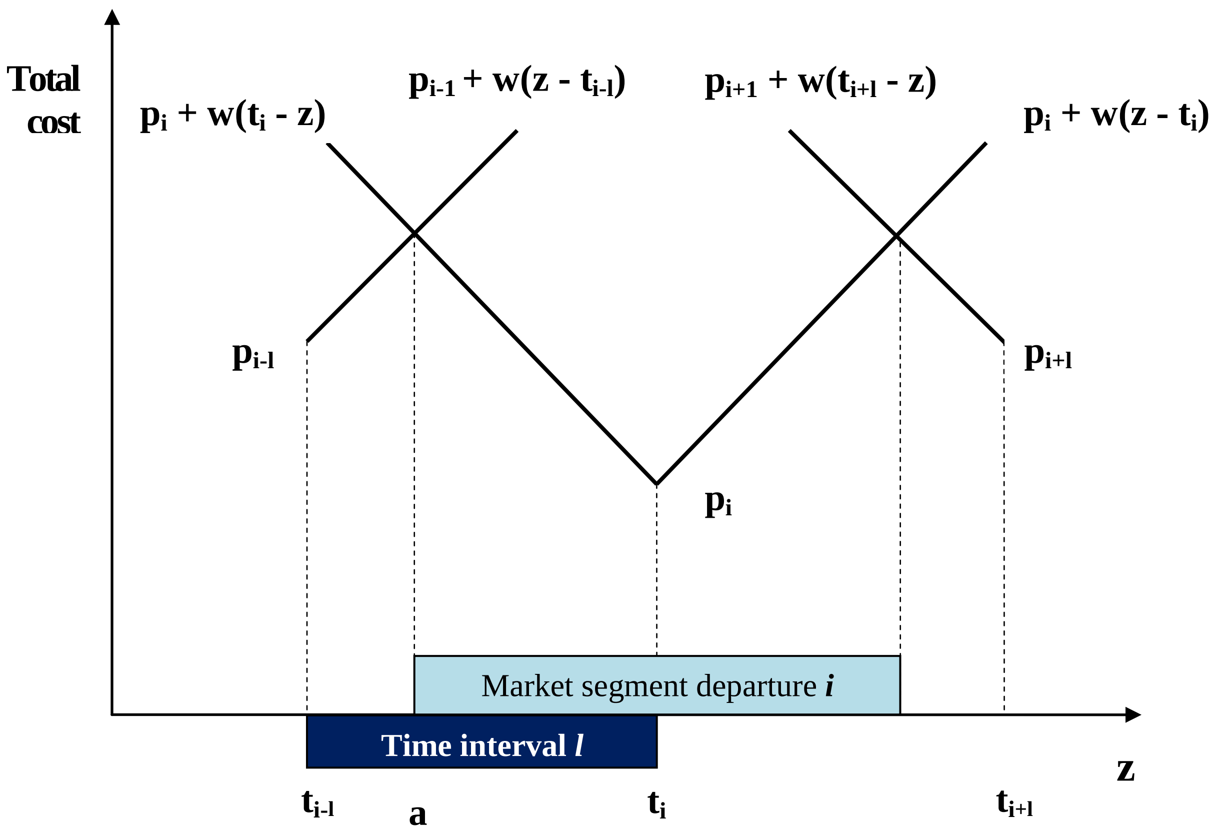

Figure 9. Hidden waiting time
Source: Norman and Strandenes (1994)

Operator provides departures t_{i-l}, t_i, and t_{i+l} with time interval l. The total cost for the user is given by the sum of the ticket price p_{i-l}, p_i, or p_{i+l} and the cost of 'hidden' waiting time z measured by opportunity cost of time.

This logic can be illustrated by means of Figure 9. Suppose that the desired time of departure, *z*, lies between t_{i-l} and t_i on z axis. When *z* is near t_{i-l}, the total cost is close to p_{i-l}. As *z* moves in the direction of t, the time difference between the desired and the actual departure rises resulting in higher opportunity cost and gradually augmenting total costs. This is showed by the upward sloping line $[p_{i-l}, p_{i-1} + w(z - t_{i-l})]$. Conversely, when *z* is far from t_i, the time difference between the desired and the actual departure is substantial imposing long waiting time with corresponding high opportunity cost for the user. As the gap between *z* and t_i is closing, the opportunity cost of time declines and the total cost approaches the ticket price p_i. The line $[p_i + w(t_i - z), p_i]$ is downward sloping. Generally, the better the desired time of departure matches the actual time of departure, the closer users' cost is to the ticket price, p_{i-l}, p_i , p_{i+l}, in Figure 9.

The users' choice of departures is obvious. All users with *z* belonging to the interval (t_{i-l}, t_i) are split into two groups; those who will prefer departure t_{i-l} and those who will prefer departure t_i. The division between them is marked by the intersection of two cost lines, point a. The users with *z*<a will choose departure t_{i-l}, and those with *z*>a will choose departure t_i.

Implications of the model for freight distribution

The model was used in connection with air passenger transport, but the concept of hidden waiting time can also be applied to the freight distribution. In the freight market, shipping firms operate a number of vessels of given size and provide a number of departures per unit of time on a given route. The cargo owners have their preferences regarding the ETS[1], and the time difference between the desired and available departures gives rise to hidden waiting time. The hidden waiting time brings the cargo owner extra costs (e.g. storage costs, discounts to the customer for untimely delivery) because the cargo cannot be shipped (and delivered) at the desired point of time. If the cargo is shipped earlier than needed, it necessitates the use of storage facilities at the point of destination and additional handling of cargo. The delay of cargo as a result of later shipment is also a disadvantage as it causes waiting time in the production system. In other words, shippers face the monetary costs in the form of the freight rate (ticket price in case of passenger market) and the opportunity cost of time.

The model assumes that the distribution of desired departure times is independent of the distribution of gross values across consumers and is uniform over the time interval (0,T) (Norman and Strandenes 1994). Uniform distribution of desired departure times implies that shippers will appreciate as frequent services as possible. More frequent departures reduce

1 Estimated time of sailing

discrepancies between desired and actual departure times and, consequently, the hidden waiting time. As a result, the value of transportation service for the user will augment.

Time concept in this paper

It is important to distinguish between the opportunity cost associated with hidden waiting time and time cost defined by Hummels (2001). The cost of hidden waiting time refers to waiting imposed by frequency of service and discrepancies between shippers' preferences and actual timetables, while time costs refer to time in transit, i.e. voyage length. Consequently, the shippers will set requirements to frequency and speed with a view to minimize costs. As hidden waiting time increases the total time that the cargo spends on the way from point of departure to the point of destination, it penalizes time sensitive products in the first place.

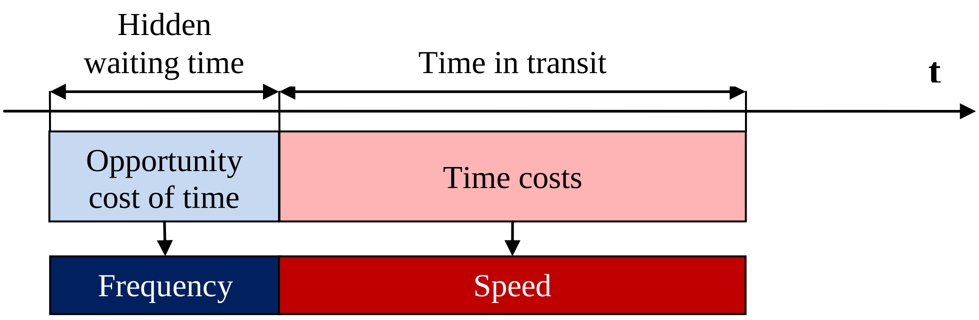

Figure 10. Time concept

Figure 10 illustrates distinction between two time concepts; hidden waiting time and time in transit. It is worth mentioning that hidden waiting time might occur before as well as after transit time. In Figure 10 it is placed in front of transit time meaning that the cargo has to wait at the place of departure. On the contrary, if the cargo is shipped and delivered earlier than desired, this will cause waiting (e.g. to be processed) at the point of destination, and hidden waiting time will be found after transit time.

Frequency of service matters for both the competition between transport operators as well as competition between transport modes. There is high probability that the shippers will switch to the operator providing better frequency of service. The same is true if an alternative transport mode offers a better frequency. In both cases other variables such as type of good, compatibility, customer loyalty and price come into play determining the final outcome.

5.4.5 Alternative definition of service quality

Service quality is an important parameter in transport decisions made by users. A detailed account of service quality was given in a research by Ludvigsen (1999). The research was aimed to identify the structure of supply and demand for single-mode and intermodal freight transfer in the Nordic countries (Norway, Sweden, Denmark and Finland), explore the content of market demand and assess the quality of performance of operators. As service quality constitutes the core of this investigation, its theoretical framework provides an extensive overview over main requirements set by shippers to the freight distribution providers.

An analytical model was developed in order to explain the relationship between quality of service and the shippers' route and modal choice decisions. The model is reproduced in Figure 11.

The model comprises three types of variables; antecedent, independent, and dependent. Shippers' demographics is the antecedent variable and consists of the revenue level, the type of cargo, types of unit load devices and types of shipment service required. The quality of service constitutes the independent variable which is an overall quality standard required by shippers. It was measured by twenty quality dimensions that are grouped into 6 categories. The quality dimensions are listed in Table 9. Although quality dimensions are identical for all Nordic countries, their grouping is slightly different depending on shippers' assessment and ranking of each dimension. Table 9 provides a synthesis of results for the four countries.

The antecedent variables are assumed to affect the shippers' ranking of service quality dimensions. It was hypothesized that the differences in shippers' preferences for service quality would affect their perception of the quality standards on the routes as well as their choices of routes and shipment modes.

One major finding from the study is that there is little difference between the service quality requirements that the Nordic shippers set to intermodal and single-mode transit. Another finding is that the cost of service does not function as a single decision-making criterion for operator and/or mode selection. Instead, modal choice decisions are affected by different sets of factors where price is just one criterion. Type of cargo is an important variable that affects the combination of quality elements. For instance, high-value cargo generates preferences for short transit time, high transloading efficiency, high quality of freight handling, and high accuracy and timeliness of pick-up and delivery. On the other hand, bulk materials require a high level of ULD's suitability for the transported commodity and large freight carrying capacity for large shipment sizes. Therefore low price of service will not compensate for poor service quality. Also, it was inferred that the role of cost level in quality assessments varies by shippers. The study also reveals a gap between the quality of service desired and the quality of service supplied, especially for intermodal solutions. Quality of intermodal routes was generally evaluated as inferior to single-mode routes.

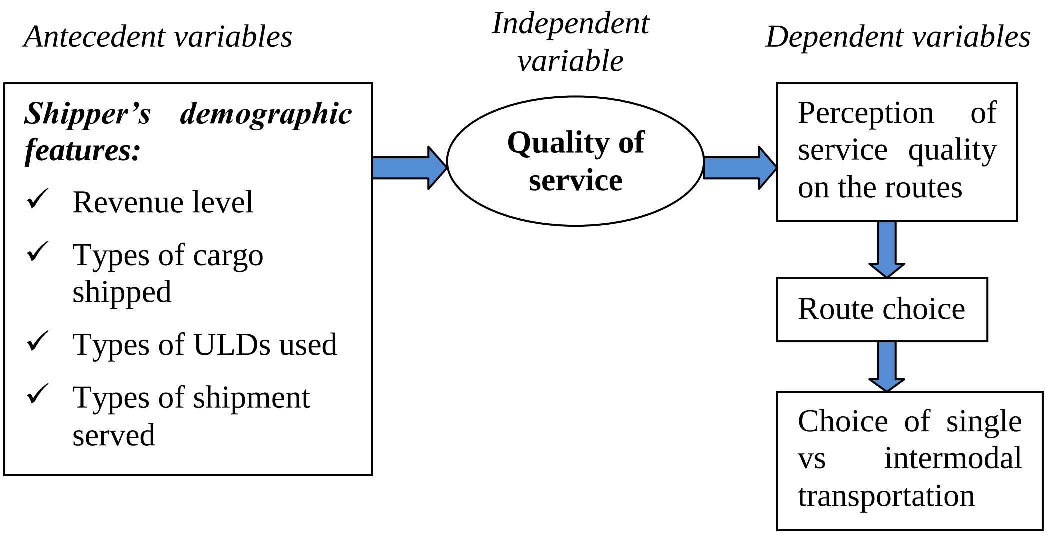

Figure 11. Variables affecting shipper's route and modal choice decisions
Source: Ludvigsen (1999)

The model presents the relationship between quality of service and shippers' route and modal choice. The quality of service, the independent variable, is measured by 20 dimensions. Shippers' demographic features affect the weightings that shippers attach to different quality components as well as perception of service quality on given routes. The perception of service quality is assumed to affect the shippers' route and modal choice. The major finding of research is that industrial shippers do not generally differentiate between the service quality required from intermodal and single-mode operators.

The recommendation for service providers was to guarantee the quality of service compliant with shippers' requirements at all times. For intermodal operators, the strategy to increase their market share vis-a-vis single mode competitors is to ensure the level of service quality that would be perceived as superior to the one offered by single mode operators. Enhancement of the quality emphasizes the need to develop an exhaustive understanding of major drivers of shippers' demand for various quality components. It was also recommended to vary the quality standards and the cost of services offered to different customer segments.

Detailed analysis of logistical parameters of cargo would allow developing customized quality packages and a better match between demand and supply.

Operational excellence	
	Efficiency of trans-loading stations Quality of freight handling Reliability of service Expediency of ordering and chartering Service availability at origin points Service availability at destination points Transit time Timeliness of pick-up and delivery Frequency of service Directness of service
Availability	
	Availability of unit load devices (ULD) Availability of tracing & tracking services
Technical efficiency	
	Suitability for commodity carried Suitability for shipment size
Cargo risk	
	Amount of loss and damage Processing of loss and damage
Information and value requirements	
	Information promptness After delivery service Cost
Timing	
	Equipment free time for loading/ unloading

Table 9. Service quality dimensions
Source: Based on Ludvigsen (1999)

5.5 Consumer tastes: transport and industry

Demand will also be affected by changes in users' preferences and tastes. For passenger transport it can be e.g. demand for non-smoking compartments. In freight distribution it is not the tastes but the needs of industrial firms stemming from the environment in which they operate. The environment sets requirements to the firms and shapes their demand on the transport industry.

Recent changes in the organization of manufacturing activities fundamentally change industry demands upon transport. Transportation is expected to provide fast deliveries on frequent and tight schedules over increasingly larger distribution networks. Fragmentation of modern manufacturing techniques combined with more liberal trade policies and establishment of a geographically large market require high quality of transport service because industry's ability to take advantage of location decisions allowing for cost minimization depends on the provision and efficiency of transport linkages. Therefore, the major requirements to the transport system are adherence to schedules and contribution through increased speed, particularly where high-value goods are concerned.

Part III: FRAGMENTATION AND SHIPPING. SYNTHESIS

6. Inference from fragmentation

This part represents a synthesis of fragmentation theory and transport economics. It attempts at explaining to what extent fragmentation and changes in the world trade account for changes in demand for transportation services and shape the operational environment that the transportation firms have to adapt to. I will synthesize fragmentation and transport economics by describing the consequences of fragmentation relevant for freight distribution and analyzing the effect of these consequences on revenue and cost components of shipping firms.

6.1 Inference from fragmentation

6.1.1 Larger networks and longer distances

The consequences of fragmentation such as surge of trade in parts and components, larger trade flows, availability of distant markets and involvement of gradually more actors into the vertical production sharing, influence transportation by making the networks larger and more complex. Trade distances within networks also get longer due to dispersion of production blocks over increasingly larger geographical areas.

Distance is positively correlated with trade costs (herein transportation costs) and is likely to be more important for parts and components that are more time sensitive than other products.

6.1.2 Timeliness and time sensitivity

Fragmentation contributes to the growing need for *timeliness* by making production blocks more interdependent. When the availability of parts from preceding blocks is critical for production to keep pace with the schedule, the need for timeliness grows.

The importance of timeliness is also enforced by existing industrial practices. Reduction of the stock level has for many years been one of the major concerns of the modern industry. Various methods (e.g. just-in-time) were developed to attain the goal. The result is smaller lot sizes, more frequent deliveries and absolute synchronization of purchasing, production and despatch activities. In such a tightly synchronized environment, the delay in delivery of one component may turn unfavourable and expensive since it can cause production stops. Undoubtedly, adoption of practices that rely on strict adherence to schedules makes timeliness extremely important.

In the past decades *time sensitivity* has increased, and fragmentation and rising consumer income are the explanatory factors behind this process. Fragmentation contributes to higher time sensitivity by magnifying time costs. When countries specialize in parts of production process, the number of stages increases and trade in intermediate goods occurs. Time costs (consisting of the inventory-holding and depreciation costs) are incurred from the first stage of production, and accumulate gradually until the final good is sold. When goods spend more time travelling between various locations, time costs accrue throughout the production chain. The cumulative time costs over the entire finished product will be much higher compared to the integrated production. As the composition of trade shifts from commodities to more complex manufactures, time sensitivity grows and the importance of time savings in transport rises with each stage. Increased total transit time resulting from a higher number of production stages leads to greater time lags between production start and final sales increasing the mismatch between the delivered product and the ideal one. At the same time, rising consumer income supports higher willingness to pay for precise product characteristics. That in turn puts pressure on manufacturers to produce to those specifications as rapid as possible and to respond to changing consumer preferences in a timely way. Combined together, consumers' willingness to pay as a result of rising consumer income and increased total transit time preventing manufacturers from delivering the exact demanded product, contribute to growing time sensitivity. The type of product influences time sensitivity to a great extent.

Time sensitivity expresses the importance that time costs have for the shipper and concerns both hidden waiting time and time in transit. The important variables are distance, speed and frequency of service. With growing time sensitivity the coefficient of distance in the total trade costs becomes larger as trade between remote countries tends to take a long time. This higher coefficient of distance is expected to be compensated by higher speed and/or more efficient cargo handling. Also, time sensitivity contributes to higher emphasis on the frequency of service. As hidden waiting time increases the total time that the cargo spends on the way from point of departure to the point of destination, it penalizes in the first place time sensitive products. This relationship becomes extremely important given the fact that goods with highest estimated time sensitivity have exhibited the most rapid growth in trade (Hummels 2007).

In summary, the transportation industry has to take into account and adjust to the following factors: higher proportion of parts and components in the world trade, larger networks, longer distances, high emphasis on timeliness and growing time sensitivity that create the need for fast and frequent transport.

6.1.3 Type of product

The type of product determines the importance of timeliness, time sensitivity and distance. Especially time sensitivity is extremely dependent on the type of product. For instance, time in transit does not matter much for bulk commodities and simple manufactures. Conversely, perishable goods and goods with uncertain or fluctuating demand suffer most from time costs (Hummels 2007: 19). Time sensitivity is product specific and has consequences for importance of distance, speed and frequency. Generally, the more time sensitive the product is, the more importance gains distance and the more value is attached to speed and frequency of service.

The effect of distance depends on technical characteristics of the product. If the product in question requires frequent changes in specifications or strict just-in-time delivery, proximity to the market is crucial, while for standardized parts proximity to the customer is of minor importance. Fragmented products are more exposed to timeliness and are more severely affected by service-link costs as constituent parts travel between production blocks before final assembly.

Concluding from the literature on international trade, fragmented and non-standard products exhibit the highest time sensitivity and elasticity of distance. Therefore, these products are the first to require fast transport and efficient cargo handling.

The effect of distance for a particular commodity depends on its elasticity of substitution. The commodity with high elasticity of substitution is more sensitive to price changes

(Kimura and Takahashi 2004). Since distance is frequently an estimate of trade costs, the coefficient of distance is likely to be larger for products with high elasticity of substitution.

The type of cargo is also determinative for the choice between bulk and liner shipping. In the model of liner shipping costs (Fink et al. 2001) the type of cargo is captured by product-specific effect related to both physical properties of the good and transport demand elasticity. The type of cargo is used to see whether the commodity will be shipped by air or, in case of ocean shipping, by tramp or liner. It was inferred that valuable and light products are usually sent by air while tramp services are primarily used for heavy commodities with low unit values.

Value-to-weight ratio

A value-to-weight ratio is the characteristic of the product that exerts influence on price sensitivity of the shipper, degree of substitution between different transport modes and consequently the level of competition.

The composition of trade, i.e. value-to-weight ratio of the transported goods, has changed in the past decades. World trade in high value-to-weight manufactures has grown much faster than trade in low value-to-weight primary products (Anderson and Wincoop 2004). Though the aggregate value-to-weight ratio of trade is increasing, it is falling for both air and ocean shipping. Hummels (2007) gives the following explanation for this paradox. If we arrange the goods along a continuum from heaviest to lightest, goods at the heaviest part of the continuum tend to be ocean shipped, and those at the lightest part tend to be air shipped. The border between air and ocean shipped goods is not fixed and depends on other factors such as product characteristics and freight rates. Due to falling relative price of air/ocean shipping, the goods at the margin shift from ocean to air shipping. Relative to the set of air shipped goods, these marginal goods are heavy, and the average weight of air shipped goods rises. But relative to the set of ocean shipped goods, these marginal goods are light, and by losing them the average weight of ocean shipped goods rises as well.

It was discussed earlier that high value-to-weight manufactures are less penalized by transport costs as the effect of the freight rate on the delivered price is smaller, and that low value goods will become relatively more expensive for the end user compared to high value goods as a result of transportation. These conclusions have the following effects. When the effect on the delivered price is smaller, as for the high value-to-weight goods, the shipper is much more likely to use the faster yet more expensive shipping option. Therefore, shippers of high-value goods are more willing to pay premium for speed delivery than shippers of low-value goods. If transportation is a small fraction of the delivered price, the explicit costs of transportation are overruled by implicit costs such as timeliness or reliability. Transportation costs constitute a smaller fraction of the delivered price of a high-value good compared to a low-value good, meaning that shippers of high-value goods pay more attention to the quality dimension of transport service.

6.1.4 Summary

Table 10 is a schematic representation of the above reasoning showing causal relationship between different factors and the resulting requirements that shippers set to transportation systems.

Cause	**Consequence**	**Resulting requirements**
Fragmentation	Interdependence of production blocks	○ The need for timeliness
	Longer distances translate into higher time costs	○ Increased time sensitivity and consequently ○ demand for speed and frequency of service
Rising consumer income	Willingness to pay for exact product attributes	
Type of product	High value-to-weight ratio ○ Lower effect on the delivered price	○ Preference to the faster transport mode ○ Service quality is more important than price ○ Lower price sensitivity
	Parts & components vs non-fragmented goods	○ The need for timeliness ○ Increased time sensitivity and consequently demand for speed and frequency of service

Table 10. Requirements to transport systems

As a result of fragmentation shippers become less price sensitive, more time sensitive and put more emphasis on service quality, namely timeliness, frequency and speed.

This defines a set of requirements to the shipping firms. They are expected to provide fast and punctual deliveries on frequent schedules over large distribution networks. Also, shipping firms have to handle a higher quantity of goods.

These requirements can be interpreted as follows:

○ The fact that shippers become less price sensitive indicates less elastic market demand curve. Lower price sensitivity also plays a role for the outcome of price/speed trade-off as shippers can accept higher freight rates.

○ Time sensitivity increases shipper’s propensity to substitute to the modes of transport that offer an advantage with respect to frequency of service and speed.

○ Speed is a decision variable in both the price/speed trade-off that faces shippers in their modal choice and trade-off between fuel savings and revenue loss that faces shippers in their choice of optimal operating speed. Therefore consumers’ demand for speed matters for the outcome of these two decisions.

○ Frequency has effect on economies of scale and economies of density, and also matters for price/speed trade-off.

The conclusions provide a basis for the analysis of the variables and factors introduced earlier in connection with demand and supply of the transportation services. The subsequent chapter presents the analysis divided into revenue and cost parts following the structure of theoretical part.

7. Effect on shipping companies

7.1 Revenue

The theoretical framework for the analysis of the revenue of the shipping firm is based on the model by Francois and Wooton (2001) supplemented by theory in part 4.1.2 and suggests the discussion of trade liberalization and market power of the shipping firm.

7.1.1 Inference from trade liberalization

From the earlier discussion, liberalization of trade influences the size of the shipping margin, the importance of transport costs in the world trade and the level of competition in the maritime industry. It was also stated that in addition to tariff rates, it is important to take into account other barriers such as non-tariff as they may intensify or extenuate the effects of falling tariffs.

A number of authors refer to trade liberalization and deregulation that currently characterize development of the world economy. For example, Curzon Price (2001) mentions deregulation ranging from classical trade-barrier reduction in the WTO, to the unilateral abolition of exchange controls on capital movements without giving quantitative estimates. The conclusion is concomitant with the one of Francois and Wooton (2001), about dramatic reductions in average tariffs as a result of successive rounds of trade liberalization and further reduction of trade barriers due to regional arrangements such as the EU and NAFTA.

Clark et al. (2003) mention policy shift in most countries from import substitution policies in the 1960-70s aimed to protect own industry to a more outward-oriented strategy by 1990s. They say that recent liberalizations have reduced tariff and, in some cases, non-tariff barriers. For instance, Asia reduced its average tariff rate from 30% at the beginning of the 1980s to 14% by the end of the 1990s, and Latin America reduced its average tariff rate from 31% to 11%. In this period the figures for Central America and the Caribbean were 21% and 9%, while African countries reduced their average tariff rate from 30% to 20%. The average tariff rates are calculated as simple averages of their unweighted tariff across countries. For the weighted tariffs, the resulting average rate will be smaller (Clark et al. 2003). According to Hummels (2007: 6) worldwide average import tariffs dropped from 8,6% to 3,2% between 1960 and 1995.

In other words, there is evidence of falling tariff rates and the liberalization of the world trade. On condition that the market structure allows shipping firms to capture benefits from trade liberalization, the expected result will be growth in the shipping margin according to the framework by Francois and Wooton (2001) (Figure 6 and Figure 8).

Besides, reduction of tariffs amplifies the importance of transport costs in the world trade (Clark et al. 2003 and Hummels 2007: 6). As tariffs become a minor barrier to trade, the fraction of transportation and other cost elements will increase. Obviously, shippers will be more attentive to the costs that heavily influence the total costs. This means that shippers become more sensitive to the freight rate fluctuations.

The influence of trade liberalization on the level of competition through the market for services (Jones and Kierzkowski 2001) will be covered in the next part devoted to the level of competition in the maritime industry.

The conclusion is that trade liberalization is expected to increase the shipping margin (depending on the market structure) and shipper price sensitivity as a result of more attention paid to transportation costs. Trade liberalization also leads to higher competition and an increase in scale of activity in service industries.

7.1.2 Market power

Demand elasticity

Elasticity of market demand reflects shippers' sensitivity to changes in freight rates. Some important conclusions can be made on the basis of the previous discussion. On the one hand, growing value-to-weight ratio of goods reduces the effect of transportation cost on the delivered price. The result is that the shippers tend to be less sensitive to price changes and can accept higher freight rates. On the other hand, trade liberalization manifesting in lower tariff rates raises shippers' awareness of the transportation costs and makes them more price sensitive. The modal choice decision is also of prime importance as the threat from substitutes results in more elastic demand. The sum of effects will determine the overall effect on market elasticity of demand.

Threat from substitutes: modal choice, price/speed trade-off

In this thesis only air transport as a substitute for ocean transport is considered. The choice between air and ocean freight will depend on product characteristics, availability of complementary services (service package) and price/speed trade-off.

It was stated above that goods that are never air-shipped are irrelevant for the analysis. For goods that can be shipped by air and by ocean, shippers face price/speed trade-off with the outcome depending on price sensitivity and time sensitivity (or alternatively, by freight rates, speed and service frequency).Taken into account shippers' falling price sensitivity, freight rates are assumed to play a lesser role than before. On the contrary, frequency of service and speed become important parameters of competition.

Frequency helps operator attract more customers by satisfying their need for frequent departures. The disadvantage of such strategy is higher cost for the operator. By providing more frequent departures, the operator will achieve the economies of density, but will sacrifice the economies of scale. An anticipated consequence of the need for faster transportation is that shippers are likely to switch to air transportation. Their propensity to substitute increases further if air transport offers more frequent departures than the ocean transportation. These advantages in the form of time cost savings are compared to the premium charged for air freight. However, complementary services and development of long-term relationships between transport providers and users to high extent reduces the latter's propensity to substitute.

The conclusion is that shippers are more inclined to switch to air transport with propensity to substitute restricted by the existence of complementary services and tendency for closer and more long-term oriented relationships between shippers and transport providers.

Number of firms

Trade liberalization manifests itself not only in tariff rate reduction but also in loosening of governmental regulation of service activities domestically and liberalization of barriers to service trade internationally. By making services obtainable in a global market, liberalization encourages an increase in scale of activity and degree of market competition in the service industries. The result is the growing number of firms competing about market share and stronger competition. Such higher degree of market competition in the service industries necessitates reduction of service-link costs in order to stay competitive in the market.

Consequently, liberalization of trade contributes to higher shipping margin through tariff rate reduction, but also exerts a negative influence by increasing the level of competition on the market for services.

Market structure

Study undertaken by Quinet (1993) confirms that liner shipping is characterized by monopoly and oligopoly, while the market for tramp services is closer to perfect competition. Firm's market power stemming from market structure might be adjusted by market contestability. The question is how the requirements set by fragmentation change market contestability and market power of the shipping firms.

Market contestability

On the one hand, in anticipation of market development, shipowners can easily switch vessels from one market to another in order to capture the highest revenue. On the other hand, fragmentation is said to make shippers' requirements and needs more unique. This means that fulfilment of those needs relies on good understanding and insight into clients' environment which is usually achieved through long-term cooperation. This idea suggests that the relationships between shippers and shipowners tend to be closer and more long-term oriented (Janelle and Beuthe 1997). Market demand characterized by unique customer requirements coupled with long-term oriented cooperation make hit-and-run entries difficult. Besides, unique customer requirements may lead to building specialized vessels designed to carry a particular type of cargo. This fact reduces possibilities of capacity transfer between markets even further. As a result, fragmentation fortifies entry/exit barriers in the shipping market.

Long-term cooperation between shippers and shipowners substantially reduces client mobility. The effect on price as a strategic instrument cannot be revealed as the framework presented in this thesis does not touch upon strategic issues.

Based on the above reasoning, it can be concluded that higher entry/exit barriers and reduced client mobility make the shipping market less contestable and thus strengthen market power of incumbent firms.

7.2 Costs

7.2.1 Bulk shipping

It was said earlier that the shipping firms are expected to provide fast and punctual deliveries on frequent schedules over large distribution networks as well as to handle a higher volume of goods. In this part I will analyse how these changes influence parameters in the cost function of the shipping firms. Theoretical part suggests analyzing the impact on the elements in the cost function (extensiveness of network and transported quantity), economies of scale, economies of density and the trade-off between fuel savings and revenue loss.

Cost function

Extensiveness of network refers to the geographical extension and the total length of transport network. Greater number of destinations and longer distances suggest enlargement of networks in terms of length of haul and geographical scope. As a result, the operator's costs will augment. Despite the negative effect on costs, transport operators are forced to maintain large networks in order to provide the expected quality of service.

Total transported quantity is another parameter in the cost function and is positively correlated with total costs. It means that larger trade flows generated by fragmentation will cause additional expenses to transport operators and their total costs will increase. On the other hand, large trade flows allow the shipping firms to fully exploit the economies of scale and give room for economies of density.

Economies of scale

The shipping firms can significantly cut their unit costs through deployment of bigger vessels which is encouraged by the need to transport higher quantities of goods. However, big ships are not economically efficient when the industry requires frequent deliveries of small cargoes with strict adherence to schedule. In this way fragmentation hinders the realization of scale economies. Thus, higher quantities to be transported and demand for frequency have opposite effects on the economies of scale.

Economies of density

Although fragmentation produces small economies of scale, it is conductive to large economies of density. Since fragmentation is likely to be found in the manufacturing industry, the economies of density characterize transportation of the manufactured products.

Mori, Nishikimi (2002) support this view by saying that economies of density is most pronounced nowadays in transportation of manufactured goods which uses a wide variety of fine components obtained from intermediate good suppliers at various locations. Also, higher transported quantity and frequency of service support the economies of density.

Trade-off between fuel savings and revenue loss

In their decision about the optimal operating speed of the vessel, shipping firms compare fuel savings with revenue loss. The decision depends primarily on fuel prices and freight rates. However, other factors such as quality of service cannot be ignored when optimizing the speed. When speed gains strategic importance by becoming a parameter of service quality, shipping firms are encouraged to speed up and sacrifice fuel savings to the quality of service demanded by shippers. Nevertheless, higher fuel costs might be compensated by higher freight rates, which is possible by virtue of shippers' lower price sensitivity and willingness to pay for the quality of service. The possibility to charge higher freight rates concerns first of all shipment of more valuable goods. Table 11 provides a brief summary of the analysis.

Consequences	Revenue	Costs
Trade liberalization	Higher shipping margin Higher price sensitivity Higher level of competition	
Larger networks	Positive effect as network is an element of service quality	Augment costs
Higher quantity		Augments costs Positive for economies of scale Positive for economies of density
Higher value-to-weight	Lower price sensitivity	
Income of shippers	Higher willingness to pay	
Quality of service:		
Speed	Competition from air transport	Trade-off between fuel savings and revenue loss
Frequency		Negative for economies of scale Positive for economies of density

Table 11. Impact of fragmentation on revenue and costs of shipping companies

7.2.2 Liner shipping

Product specific effect

The type of good influences both marginal cost and markup term through their physical properties and transport demand elasticity, which is a function of the final demand for the good in the country of destination. The final demand is individual for each commodity. As this paper does not regard any commodity in particular, the product specific effect on the markup term cannot be assessed. As for the physical attributes and marginal cost, the shift in the world trade towards more valuable products is likely to generate higher demand for air transport. Increasing value-to-weight ratio indicates higher proportion of insurance costs in the total transport costs.

Containerization

An overview of the modern mass transportation does not reveal any significant improvements for modal speeds (Rodrigue 1999), yet transport systems cope with growing volume of freight. The explanation is enhanced efficiency and cost effectiveness which are supported by containerization. Containerization has numerous implications for operational efficiency, service quality, port time, approach to pricing, concentration in the liner market, and liner costs (Stopford 1997). I will discuss the consequences relevant only for liner shipping costs because in the framework by Fink et al. (2001) containerization is a component of marginal cost of liner shipping.

Container is a load unit that has the advantage of being used by several transport modes such as maritime, railway and road. When several modes are all able to handle containers, compatibility between modes rises and consequently the flexibility of freight transport. This growing relationship between freight transportation modes gives liner companies the opportunity to offer a ‘door-to-door’ service. In a ‘door-to-door’ service the respective modes are used in the most productive manner, which enhances the economic performance of the transportation system (Rodrigue 2007). Containerization confers also significant time and cost savings by reducing transshipment costs, cargo handling costs and delays. This also contributes to increased flexibility of freight transport (Rodrigue 2007).

As one of the consequences of containerization, Janelle and Beuthe (1997) point out that transportation of containers rather than vehicles and trailers simplifies the clearance problem.

A favourable consequence of containerization for liner shipment costs is the combination of lower volume flows with enhanced economies of scale. Containerization permits lower volume flows and simultaneously offers economies of scale achieved by consolidation of numerous shipments in batch flow units (Hesse, Rodrigue 2004).

The conclusion is that containers and intermodal transportation improve efficiency of global distribution and confer substantial time and cost savings. This leads to a growing share of general cargo being containerized on a global scale (Rodrigue 2007).

The liner shipping cost model used by Fink et al. (2001) introduced in part 4.2.4 reveals a negative correlation between containerization and marginal cost of shipping. Given higher efficiency of freight distribution permitted by containers, time and cost savings, and a growing share of containerized cargo, marginal cost of liner shipping will decline.

Distance

Since there is positive correlation between transport distance and marginal cost of shipping, increasing average transport distance indicates that the marginal cost of shipping will grow. However, this negative effect diminishes as the average transport distance grows longer.

Economies of scale

The dramatic increase of the total volume of trade does not necessarily mean higher transported volume on one particular maritime route. If the number of routes increases, the marginal increase in volume might be equally distributed among the routes without changes of the volume transported on a single route. However, assuming that the level of trade that goes through a particular maritime route increases as a result of the increase in the total volume of trade, there are economies of scale at the seaport level and at the vessel level. The result is lower transportation cost.

The above discussion is summarized in Table 12.

Relevant variables	**Marginal cost**	**Markup term**
Product specific effect (physical properties and transport demand elasticity)	Higher proportion of insurance costs in total transport cost	Individual for each product
Containerization	Reduces	X
Distance	Increases	X
Economies of scale	Reduces	X

Table 12. Impact of fragmentation on components of liner shipping costs

7.3 Conclusion

Fragmentation which is an important characteristic of modern economy exerts significant influence on the shipping industry by changing its operational environment as well as preferences and requirements of shippers. Clearly, fragmentation has consequences for both revenue and costs of the shipping firm though its effect is not simple. The analysis of the revenue side was based on shipping margin framework supplemented with some additional parameters, while the cost side was approached through the study of operator's cost function and relationships between important variables.

It was inferred that as a result of fragmentation, shippers become less price sensitive, more time sensitive and put more emphasis on service quality, namely timeliness, frequency and speed. Consequently, shipping firms are expected to provide fast and punctual deliveries on frequent schedules over large distribution networks and handle larger volume of goods.

As for the revenue expressed by shipping margin, it is expected to grow by virtue of reduced trade barriers. Another dimension important for shipping margin, namely concentration in the industry, experiences conflicting effects from different forces. Liberalization of service trade augments the number of firms, while such changes as unique customer needs and development of long-term relationships with transport providers reduce market contestability and improve competitive advantage of shipping firms by making clients more dependent on specially tailored transport solutions.

The possibility to charge higher price for transportation is strengthened by lower price sensitivity stemming from higher value-to-weight ratio of goods and higher willingness to pay for exact product characteristics as a result of higher income of the users of final goods. Trade liberalization works in the opposite direction by increasing the proportion of transportation costs in the total costs and thus making shippers more price sensitive.

The need for speed deliveries is obviously adverse as it sets shipping in an unfavourable position vis-a-vis air transportation. However, shipper's propensity to substitute to air transportation is restricted by complementary services and tendency for closer and more long-term oriented relationships between shippers and transport providers. Also, the demand for speed necessitates higher freight rates in order to offset higher fuel costs resulting from higher operating speed of the vessel.

Necessity to operate large networks and higher volume of transported goods augment transport costs. As for economies of scale and economies of scope, they benefit from increased trade flows and suffer from demand for frequency of service.

The analysis of **liner shipping** was based on the model for liner transport prices. Although the analysis excludes policy issues that play a significant role in liner shipping, it is still possible to indicate the impact of fragmentation on liner transport prices.

Increasing value-to-weight ratio signals higher probability of using air transportation and simultaneously higher proportion of insurance costs in the total transport costs. Containerization and transport distance have contradictory effects on the marginal cost of shipping. Containerization promotes higher transport efficiency coupled with time and cost savings as well as permits for economies of scale. The sum of these consequences is lower marginal cost of liner shipping. However, marginal cost will rise with rising average transport distance. Higher traded volume is expected to reduce transportation cost allowing for economies of scale at the seaport and at the vessel level.

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