Profit and Geography

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Abstract

Shareholders, executive boards and other decision makers of the firm decide upon strategies of where to produce and where to sell. During some periods it has been popular to produce goods near the market where they are sold. In some periods it has been popular to produce in for example low cost countries on the other side of the earth and export from there. Transporting goods between continents is costly for firms. It is difficult to see all transportation costs, because they appear randomly at different locations within and around the firm. Therefore I develop a theory of visibility of transportation costs. If transportation costs are visible, the importer, the exporter and their customers and suppliers are sharing the welfare loss from trade cost. But I find that if a transportation costs is invisible, it will solely be borne by the equity holders of the firm, while its customers will not pay anything for the invisible trade cost. I estimate the effect of intercontinental trade on operating margins for 26 good transporting firms of mostly Swedish origin over the period 1970 to 2008. I find some evidence that there is some invisibility in transport costs and that, by keeping production and sales margins constant, one percentage unit increase intercontinental trade cause a decrease operating margin by 0.21 percentage units.

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II DISPOSITION

The thesis is divided into three main parts; executive summary, detailed part, appendix. The executive summary exists in order for the public, to be able to grasp the most important parts of this difficult thesis. The detailed part contains the full thesis, including everything within the executive summary. The appendix contains econometric techniques, robustness tests, data tables and diagrams, which is not central to the thesis, but is there to give credibility to the empirical measurements.

1 INTRODUCTION

Globalization is not something new. Goods have been proved to move between continents as early as eleven thousand years ago. The most famous early intercontinental trade routes are the Silk Roads, which in the around three thousand years ago was a trade route for silk and other goods between China, India, Middle East, Africa and Europe. In the mid 18th century, China represented ten to fifteen percent of Swedish trade. Even if trade was less than today in absolute terms, it can be compared with the relative figures of 1992 when China represented 0.6 percent of Swedish trade or 2007 when China represented 3.5 percent of Swedish Imports.

Swedish firms have also been globalized for over a century. An example is Ericsson who had its first FDI in 1897 when the factory in St:Petersburg opened. At year 1897 Ericsson had sixteen percent of its sales outside Europe. Ericsson had local production sites all over the world, much due to reduced labor and transportation costs, but also due to business politics. In fact, Ericsson had only two factories in Sweden before 1946, both located in Stockholm. Ericsson opened eleven factories located in the Swedish countryside during 1946 to 1960.

I find that intercontinental trade is much more developed nowadays than a century ago. It is common knowledge that China is the factory of the world and that Europe and USA are the major consumers of the world. However, only a small part of the goods an individual person buys, comes from another continent. I find that in 2007, only 3.5 percent of Swedish imports are from China, 3.6 percent of Swedish exports are towards Africa and that 18 percent of Swedish imports are from Sweden's neighbor Germany. This is a common pattern around the world according to the research on gravity models, the further away two countries are, the less they trade. Some large good producing firms have however moved production to low cost countries like China.

Moving goods from one location to another takes time. Customers want their goods sooner than later and they are willing to pay for a reduction in time. Hummels find that the per day value of transportation time is 0.8 percent of the initial cost of the good. Moving goods from Far East to Europe takes 6 weeks and it would then equal a tariff of 33.6 percent.

The cost of direct labor for a good produced in Europe is around 21 percent. Moving the production from Europe to Asia would imply lower wages, increased transportation costs, constant machine cost, constant material costs and constant administration costs. This raises a few questions. How can firms replace labor costs with transportation costs? Are they irrational?

In this thesis I try to find out how the firm is affected by intercontinental trade. I analyze previous research and develop theories of visible and invisible costs. I also develop theories of cognitive mechanics of visibility of trade costs. I also test empirically for existence of invisible trade costs and at what extent invisible

intercontinental trade costs affect the profit of the firm. I also analyze the welfare effects on the stakeholders in society, due to the event of trade between continents.

2 Theoretical and Empirical Foundations

In this thesis I combine several research areas and some other evident facts I find, which will be the foundations of understanding how intercontinental trade affects the profit of the firm.

2.1 Foundation I – Time as a Trade Barrier

One of the foundations of my thesis is time as a trade barrier. Hummels proved that each day saved in shipping time is worth 0.8 percent ad-valorem for the manufactured goods.

The per day cost of the good, is a function of two factors; the per day interest rate, the depreciation rate for the good. Depreciation rate for the good is differing among types of good. Some depreciation is predictable as for example spoilage of cut flowers. Some depreciation is probabilistic. Depreciation of the probabilistic type is; damage, absence of key components, mismatch between supply and demand.

The longer the transportation time is, the higher the cumulative probability of damage. The higher the cumulative probability of damage, the higher the expected cost.

Some key components cannot be substituted by other goods at a certain time. Such goods have no indifference curve specified. If a key component is not available at a time the consumer is in immediate need of the key component, the consumer suffers from lower profits. An example is a car manufacturer with thousands of components per car. If one component is missing, the car cannot be manufactured. The longer the time of shipment is, the earlier the goods need to be shipped in order to be available in time, since intercontinental shipments can take months. Such strategy clearly violates the "just-in-time" strategy, since the JIT-strategy has an ambition holding only a few hours of component inventory.

2.2 Foundation II –Gravity Models

According to Anderson, gravity models had at 1979 been the most successful empirical trade evidence since 25 years back. Gravity models find evidence for, among other things, that the further away two countries are from each other, the less they trade in physical goods. This empirical finding has been the similar up to today, even though theoretical models have developed.

Portes uses gravity models for empirically analyzing trade of equity and find that gravity models apply just as well on equity as on physical goods. Equity is not of physical nature and is not transported. Portes finds that the most natural explanation for that, the further away countries are from each other the less they trade in equity, is informational frictions that are positively correlated with distance.

Some banks only lend to customers whose habitat is visible from the bank office of the decision making originator. Such strategy is called the church tower principle, which is a criterion meaning that the originating officer can only lend to a client if he can see the office or home of the client from the top of the church tower. If the originating officer cannot see the habitat of the client, he and the client are likely to not have enough contact to each other.

Brainard find that firms' overseas production increases the higher the transport costs are and the lower the plant scale economies are.

Research using gravity models is mostly using aggregated data from different governmental data sources. The main focus on gravity models is to find quantity outcomes from rationally selecting firms' sensitivity to different variables like distance between two countries. From the quantity of trade, the gravity models makes an effort to estimate transportation costs since costs and quantities are assumed to be linear.

However, in order to make a comprehensive economic analysis, I need to analyze many different functions other than cost functions. A comprehensive analysis needs cost functions, revenue functions, quantity functions which results in profit functions, which the rational firm makes decision from. A quantity measure, incorrectly named to a cost measure, is not a sufficiently rigorous analysis.

Most research of gravity models also use aggregated data, and surprisingly few pieces of research about FDI and transportation use micro firm data. From firm data, like annual reports, profits, revenues, costs and quantities can easily be extracted.

2.3 Foundation III – Cost Break Down

In order to understand the size of transportation-costs contra savings in off-shoring to low-cost countries, I need to make a cost break down of typical articles produced in Europe that often are off-shored to low cost countries.

The major incitement of off-shoring is said to be direct labor cost reduction. I find that the direct labor of a good produced in Europe to be 21 percent of the total production cost.

Transporting goods does however cost also. I estimate using Hummels measure that the time value of shipping from China to Europe is around 33.6 percent ad valorem if shipped with ocean vessel. Adding to this is the cost of the shipment itself, which might be quite low.

2.4 Foundation IV – Economies of Scale

Economies of scale can increase profits. If firms export their products to other continents, the firms' volumes go up and then the firms' fixed costs are spread out over a higher volume which reduces its average cost and increase the profit of the firm. An example of firm fixed costs is research and development costs which can

have use of economies of scale. Production is less likely to use economies of scale, because the flexibility of machinery and personnel can often be used for producing other goods. However, machinery and personnel which can only be used for producing specific good can be considered as a fixed cost and should be kept as low as possible.

When a firm cannot reduce its fixed costs, economies of scale can be achieved by plant specialization and international trade. For example the U.S.-Canada Auto pact of 1965 where Canadian plants produced too many models and by trade liberalization firms could produce a higher quantity of fewer models.

Economies of scale are thereby an incentive for the firm to trade, given that there are firm fixed costs. I should also consider if and how the share of firm fixed costs to total cost changes over time, because the share of international trade to production changes over time.

2.5 Foundation V – Sunk Entry and Exit Costs

When a firm enters a market, the firm bears a fixed entry cost. When a firm exits a market it bears a fixed exit cost. Decision to take these costs both appear before trade with the new market and are, once the event of investment in the new market, sunk costs, because the money invested can only be used for that specific investment in the new market and the firm can never get the money back from that investment.

A problem occurs when the expected future stream of operating margin does not cover the sunk cost of entering the new market. Even though, after the entry, the entry project suffers from a negative gross profit (including the fixed sunk cost), the firm will continue to export because the mark-up profit (excluding the sunk cost) is positive.

There is empirical evidence that sunk costs are relevant for staying within the market after entry. A firm which suffers from decreased profits from exporting, increases the probability of exporting during the current year by 30 percentage units if it participated in exporting the last year.

2.6 Foundation VI – Iceberg Transport Costs

Martinez developed a model of transportation costs caused by depreciation of the value of the good (like a melting iceberg). The cost is visible by both the importer and the exporter and thereby the price of the good is reduced and thereby a larger quantity is demanded.

2.7 Foundation VII – Specialization in Knowledge About Intercontinental Trade of Goods

I believe that production costs are in general constant over the world, except for direct labor costs which is a relatively small part of production cost. I believe that all marginal costs included in trade, which I call transportation costs in this thesis,

might be relatively high compared to the differences in marginal costs between continents and that transportation has a negative effect on profit.

There are a few problems with my statement:

- Firms do trade over continents
- It is assumed by me to be unprofitable to trade over continents
- Firms must be constrained in some way to act in a way which is unprofitable for the firm.

I find three types of constraints which could allow the firm to act in an unprofitable way:

- Cognitive constraints (irrationality), which restricts visibility of profits
- Capacity constraints (rational second best strategy), occurs when there is not enough production capacity near the location of sales
- Fixed costs constraints (rational second best strategy), occurs when a firm needs high fixed costs in order to keep up with competitors

My favorite explanation for why firms act in a way that may result in decreased profits is cognitive constraints.

No one knows everything. No matter how intelligent individuals are, they only have a limited information processing capacity. Since knowledge is limited, individuals within organizations tend to specialize in certain areas. Even individual organizations themselves have limited knowledge and thereby tend to specialize in different areas. If for example an apple manufacturer would know everything there is to produce and sell apples, he would do everything himself since he would get all the profits up-streams in the value chain. Such an apple manufacturer would have to know; apple manufacturing, accounting, law, biology, chemistry, transportation with trucks, manufacturing of trucks. The list of accumulated knowledge in producing an apple is endless and impossible for a single human being to manage, due to the knowledge constraints of human beings.

It is more effective for individuals and organizations to specialize in certain areas. Inside an organization, individuals also specialize, so that they together can cover the knowledge set of the organization. Since knowledge is limited for a single human being, he tends to specialize and trade his knowledge for other peoples' knowledge. If the individual specialize, he can use the group's variety of knowledge.

There are two constraints hindering specialization to be triggered. First, specialization will only occur if there is an incentive of specializing in a certain area. The individual will specialize in the area which gives him the highest profit. The profit is given by the marginal revenue of specializing in a certain area, marginal cost of specializing in a that same certain area and the quantity of knowledge achieved from specializing in that same certain area. Second, specialization occurs through a

trial-and-error process. When an individual sees an error, he changes his strategy and tries again. If he sees an error the next time he changes his strategy again and tries once more. The individual will continue like that until no more errors can be seen.

If it is too costly, relative to quantity and revenue of knowledge, to specialize, or if the individual does not see the error, the individual will not trigger specialization. I argue that costs of transportation are occurring randomly at very different places within the organization. I consider a cost which is not expected in advance by the individual to be an error. If the cost is occurring at a department within the organization which is far away from the department of the individual, the individual will not see the cost. If that individual is the decision maker regarding the sourcing location, there may be no trial-and-error process triggered to improve specialization of transportation costs. Alternatively, the individual decision maker sees some of the errors, but due to its randomness and cost of learning from the errors, he may actively choose not to specialize in transportation costs.

2.8 Foundation VIII –The World Factory

The title "The world factory" was first awarded to the United Kingdom during the industrial revolution. Later, the United States industrialization took off in the 1870 and surpassed the United Kingdom and thereby took over the title "The world Factory". After the World War II, USA made up almost half the world GDP. During the 1970s, Japan and Germany had a strong manufacturing performance and won the title of "world manufacturing centers".

Zhang explains that China's export symbolize the emergence of China as the world factory. Zhang explains that the world sees China as the world factory and therefore he analyze if China is the world factory and if it is possible that China can be the world factory in the future. Zhang conclude that China is not the world factory and that both Germany and USA both have a larger share of world exports than China.

2.9 Foundation IX – Welfare Effects of Spatial Trade

In this part I sometimes use the notation price for a cost. Seeing the costs of trade as trade barriers, I can analyze how the firm's adjacent environment is affected by trade.

Some importer countries create import trade barriers, like for example tariffs. The trade barriers make it more costly for a purchaser of the good to import goods than without the trade barrier. Since the price is higher with the trade barrier, a lower quantity is demanded by the purchasers within the domestic market. There are other types of non-tariff trade barriers, like for example governmental regulations. The purpose of a governmental trade barrier is to reduce quantity in order to protect a certain industry within the domestic market. However mostly, the rest of the society in the domestic market (like for example other industries and consumers), has to

suffer from a decreased welfare due to the tariff, increased prices, reduced quantities.

The welfare effects of different types of visible trade barriers, as tariffs, can be analyzed with neo-classical theory using domestic, foreign and world supply and demand diagrams. The reduction in quantities induces a consumer loss (importing firms), producer gain (domestic competition) and a government revenue gain (only for tariffs). Adding these three costs and gains together, the society in total usually makes a welfare loss.

The firm supplies the market with a quantity and price of goods which makes the marginal revenue of the firm equal to the marginal cost of the firm. Such quantity and price is called the optimum quantity and optimum price, because the quantity and price maximizes profits. Markusen developed a model which suggest that if there are imports to a market, there may in addition to marginal cost of production, be marginal cost of transports which decrease the optimum quantity, increase the optimum price and decrease the profits. The rational firm which see the marginal transportation cost will decrease quantity and suffer from decreased maximum mark-up profits. The firm also has firm fixed cost and plant fixed costs. Depending on at which location most of the consumers are, the firm selects between three strategies of production; production at home country, production at foreign country, production at both countries. The strategy of production in home country is most profitable if most of the customers are at the home market, due to marginal transportation costs. The strategy of production in foreign country is most profitable if most of the customers are at the foreign market, due to marginal transportation costs. Production at both countries has higher plant fixed costs and does not have any marginal transportation cost and is thereby most profitable if there is roughly a similar amount of customers in both countries.

3 My Extensions to Theoretical Foundations

I distinguish between visible and invisible costs of trade and thereby visible trade barriers and invisible trade costs. A common definition of invisible tariffs and invisible trade barriers is nontariff trade barriers, such as standards and regulations etc. I argue that such nontariff barriers are actually visible for the agent because they need to be visible in order to reduce quantity traded and without reduced quantity traded they would not be trade barriers and therefore it would be incorrect to define them as invisible. A better definition of such trade barrier would be trade barriers in disguise, since the purpose of the regulation is to decrease import quantities which they also do because they are visible.

I define an invisible trade cost as a trade cost which is not visible to an individual due to cognitive constraints of the group of individuals.

Costs of trade which is visible for the individual are visible trade barriers and cost of trade that is invisible for the individual are just invisible trade cost. What is visible

and what is invisible depends on the cognitive mechanic setting of the individual and of the importing organization and its environment (consultants, media etc). The price set by the carrier is most likely to be a visible trade barrier. The interest rate on goods stored during transport is also likely to be a visible trade barrier. The different types of stochastic depreciations which can occur on a good are mostly invisible for the agent.

In a world where some part of the costs of transport is hidden, I argue that the domestic and foreign countries can be assumed to still clear the price and quantities according to the neoclassical visible trade barrier equilibrium. The welfare is affected as in the neoclassical case, but an additional welfare cost of the hidden trade barrier is paid by the domestic firm. The foreign firm set the same optimum price and optimum quantity and therefore is not affected by invisible trade costs. The equilibrium is simply set by what is visible.

I believe that the size of this hidden trade costs is quite large compared to the visible trade costs. According to Hummels, every day a good is transported, an ad valorem cost of 0.8 percent per day is inflicted on the good. I find that the lower the visibility, the higher the transportation cost is allowed by the optimal import quantity constraint. I also find that given any positive transportation cost, the lower the visibility, the lower the profits are for a given import strategy. Lastly I find that the lower the transportation cost, the higher the actual mark-up profit.

4 Analysis of Theoretical and Empirical Foundations

In this part I combine and analyze the theoretical and empirical foundations.

Hummels find that for every day a physical good is transported, the buyer of the good is willing to pay a mark-up cost of 0.8 percent of the cost of the good. I argue that this is a mark-up which the buyer rationally selects as best or second best alternative. Shipping by ocean from China to Europe, means a 42 day transport which equals a 33.6 percent mark-up cost.

I find that direct labor cost in Europe is about 21 percent for a majority of industries. I also find that other costs are constant over the world, since raw-material, machinery and tools cost roughly the same over the world. Even though some of the direct machine production processes can be replaced by direct labor production processes, I find it likely that there is not enough difference in production margins between different continents to cover the marginal transport costs. Thereby a firm should suffer from decrease in profits due to any increased transports.

I also find that using modern activity based cost calculation (ABC), the good is not bearing any costs which it is not using. Any overcapacity is due to bad planning and the good should not be charged by overcapacity, because the department should bear it instead. Nowadays the border of the firm is somewhat vague and a firm can produce goods for different firms in the same machine. Thereby I find it very

difficult to justify that plant fixed costs really exists nowadays. Kaplan (1999) also argue that expenses are fixed only when managers fail to do anything to reduce them. This situation is interesting, because it means that the only fixed cost that exists within the firm is firm fixed cost. I believe that by being very restrictive in classifying a cost as plant fixed cost, the optimal strategy of producing in both countries might be more independent of market size and more profitable than the other two strategies.

Martens proves that there are incentives to specialize in specific subjects if the revenue from trade in the specific knowledge is larger than the cost of specializing. Specializing occurs in a trial-and-error process, when the individual tries by acting and learn from a visible error. I argue that unexpected costs of transportation appear randomly at different parts of the organization, far away from the decision maker of the sourcing location. Thereby it is a very low probability that the individual will ever see the unexpected cost as is error. I also argue that by the stochastic nature of transportation costs, even if the decision maker would see them, the decision maker might find it too costly to specialize in. Thereby I believe that decision makers regarding sourcing locations are not specialized in transportation costs. If no one specializes, group knowledge can be incorrect. An example of incorrect group knowledge is the incorrect world perception of China as the world factory and the incorrect perception of that it would be cheaper to produce in China and transport the goods to other continents.

At this point I define my alternative hypotheses

Hypothesis $HS1a_{alt}$: The individual decision makers are not specialized in transportation costs

Hypothesis $HS1b_{alt}$: The individual decision makers have not received by them perceived trustworthy group knowledge.

Hypothesis $HS2_{alt}$: The group which the decision maker is included in, does not have full knowledge of transportation costs

Hypothesis $HC1_{alt}$: The individual decision makers are not constrained by production capacity constraints in certain continents, forcing them to source from other continents.

Hypothesis $HT1_{alt}$: Increased intercontinental transportation decrease profits.

My research question is:

Question W1: Who gains and who loses from invisible transportation costs?

5 METHODOLOGY

I will in this part develop empirical methods for testing the five hypotheses.

5.1 HYPOTHESES HS1A, HS1B AND HS2

If all of the hypotheses $HS1a_{null}$, $HS1b_{null}$, $HS2_{null}$ and $HT1_{null}$ are significantly rejected, there are strong proofs suggesting that organizations are constrained by its cognitive system impeding them from seeing transportation costs and thereby act irrational and thereby trading un-optimal quantities of goods between continents, leading to an invisible decrease their profits.

5.2 HYPOTHESIS HC1

If the null production capacity constraint hypothesis $HC1_{null}$ is rejected for the alternative production capacity constraint hypothesis $HC1_{alt}$, there are strong proofs suggesting that firms are not forced to increase transports because of production capacity constraints.

5.3 THE SURVEY METHOD FOR TESTING HS1A, HS1B, HS2 AND HC1

Of ethical reasons, it is important to understand that I am not measuring the cognitive capacity of the individual or the cognitive capacity of the group (firm), but rather the property settings of the cognitive system of the group. In other words, I am not measuring cognitive capabilities of the individuals or the firm, but rather how the group organizes to use its knowledge in an optimum way and how it affects the group's knowledge regarding intercontinental transportation costs.

I will in order to test the hypotheses interview purchasers of an anonymous intercontinental firm. The purchasers purchase parts worldwide for assembling in Sweden to finished goods. To test the hypotheses $HS1a$ and $HS1b$, the interviewees need to have a relatively high probability of seeing transportation costs. A relatively high probability does not necessarily mean high probability. I will in the survey check if the interviewees are decision makers regarding the supplier and its sourcing location. If they are, then they have a relatively higher probability of seeing transportation costs, than a CEO or an equity investor. I will also test hypotheses $HS1a$ and $HS1b$ by dividing the interviewees into three different group with different advance information; no advance information (O-group), advance information which is negative to intercontinental trade (N-group), advance information which is positive to intercontinental trade (P-group). If the groups differ in their answers regarding questions regarding transportation costs, I can reject the null hypotheses of $HS1a$ and $HS1b$ in favor of their alternatives, which would suggest that individual decision makers are not specialized into transportation costs and that they have not received by them perceived group knowledge regarding transportation costs. This would suggest that there might not be sufficient knowledge within the group to make transportation costs visible.

I will also test the hypothesis 2, if the group has knowledge about transportation costs, with questions. If the group answers that transportation costs are relatively unimportantly low, they do not see transportation costs like me and Hummels and thereby I have some very weak proof of the group not seeing transportation costs. If I can also prove by hypothesis $HT1$, that increased transports decrease profits, there are some additional proof for deciding about $HS2$, that the group does not have full knowledge of transportation costs.

5.4 Hypothesis HT1

The most important hypothesis to test is $HT1$, if increase in transports decrease profit. If the tests of $HS1a$ and $HS1b$ suggests that there is invisibility in transportation costs, $HT1$ could be able to measure the effect of increased transports on profit. If there is no invisibility, there should be no invisibility causing un-optimal transportation causing negative effects on profit. However, there could be other reasons why increase transport decrease profits. For example the firm might be forced to transport due to production capacity constraints or other reasons. I will in the survey test the hypothesis $HC1$, if individuals transport goods across continents due to production capacity constraints. I will use observations of different firms over time.

5.5 The method for testing HT1

To be able to test the hypothesis $HT1$ I need observations of firms over time. Different firms invest differently in production and sales in different continents at different times. Since firms change its production and sales at different times, it is possible to compare these firms at the same time-unit, to see if firms that transport less do worse or better than firms that transport more.

5.6 Data

I will use a survey for testing $HS1a$, $HS1b$, $HS2$, $HC1$. The survey has a number of questions which decision makers regarding international transports will answer. The questions are divided into; determination of who is the decision maker, specialization of transportation costs, accuracy of group knowledge regarding transportation costs, actual problems with transports. In order to test specialization the interviewees will be divided into three groups with different advance information; no advance information (O-group), advance information which is negative to intercontinental trade (N-group), advance information which is positive to intercontinental trade (P-group).

I will use annual report data in order to test hypothesis $HT1$. The annual report data has for every firm and for every time period, information about operating margin, sales per continent and employees per continent. From the continental share of world employees variable, I will create a continental share of world production variable. Since I have continental share of world sales and continental share of world

employees, I know how much is exported from every continent and can create a world transports variable.

I use annual reports of 26 good providing firms between 1970 and 2008. Most of the firms are Swedish or at some extent Finnish. From the annual reports I use data from the consolidated group's; operating income, total sales, sales per continent, employees per continent.

It is important that every variable in each observation represents the same firm and therefore I use printed annual reports instead of digital versions which often have been altered. Observations that are missing some variable are quite easy to estimate. Missing variable data are relatively few.

Some firms do not have annual reports of some periods available for the public and then I can find the annual reports at Bolagsverket (Swedish Companies Registration Office).

Since some firms do not have annual reports for certain years, I need to make different estimation periods in order to make the panel data balanced. I use five panels with different estimation periods; 1970-2008, 1970-1998, 1984-2005, 1993-2008, 1996-2008.

6 Analysis of Empirical Results

6.1–Analysis of Empirical Results from Specialization tests

There are six main purposes of the interview; (a) measuring individual specialization regarding intercontinental trade versus reliance of group knowledge regarding intercontinental trade, (b) identifying the decision makers of sourcing location, (c) measuring capacity constraints of production, (d) measuring the activity of trade between continents, (e) understanding actual problems caused by intercontinental trade, (f) measuring constraints of the cognitive system of the organization.

My investigation suggests that the purchasers are part of the decision making process regarding the choice of sourcing location. Since the purchasers are decision makers regarding sourcing location, I assume that their work task partly or fully covers trade and the cost which trade causes. Thereby the interviewees have relatively high visibility of transportation costs.

The anonymous firm does not trade much with other continents, which may be due to that the transportation costs may be visible for the interviewees.

None of the interviewees turn to production capacity in other continents due to production capacity constraints in the continent where the goods are sold.

I find that individuals rely on my advance information, as is group knowledge, and thereby they do not specialize in transportation and they have not received by them perceived trustworthy group knowledge about transportation costs. Individuals simply rely on others when estimating the effect of transportation costs on profit.

I also find that group knowledge is not accurate regarding the relative size of transportation cost to production cost.

Individuals find more problems sourcing from other continents, where the majority of problems are belated transports and the minority of problems is damaged goods.

6. 2 – Analysis of Empirical Results from Trade tests

I find some evidence for that the hypothesis that intercontinental transports decrease profits is true; there is a negative relationship between intercontinental transports and operating margin. For every percentage unit increase in intercontinental transports, the operating margin will decrease with 0.21 percentage units. If transports increase by 10 percentage units from 10 percent to 20 percent, there will be a decrease in operating margin by 2.1 percentage units, which is a quite high change in operating margin for competitive industries. Alternatively 1 percent increase in intercontinental transports will decrease profits by 1 percent.

Marginal revenues in different continents are controlled for by marginal profits with respect to revenue which is a world share of sales quantity variables. Marginal costs in different continents are controlled for by marginal profits with respect to costs which are the world share of production quantity variables.

However, other variables than invisibility could cause increased transports, which could bias the estimated parameter. High fixed costs like R&D may force the firm to increase its revenue by entering new continents. However, there is nothing hindering the firm from setting up a new plant in the new market and thereby remove some transportation. Also, one expensive high capacity machine can be replaced with two less expensive low capacity machines in each market, which would reduce trade. Also production capacity constraints within the continent where goods are sold could force the firm to increase transports from continents with production overcapacity. However, there are a vast number of good producing firms within a continent which could produce for nearly any firms and also the result from the survey say that decision makers do not trade between continents due to production capacity constraints.

I also analyze what can change over time and find that visibility of transportation costs is the same in the 1970s and the 2000s. Group knowledge can due to herd mentality change over time, if for example media signals a certain continent as the most effective continent to produce in. I find that direct transportation costs, which I assume to be visible transportation costs, can change over time and due to changes in oil prices etc. I did not include direct transportation costs in my thesis and it may thereby be a weak point of my findings which could bias the estimated parameter. I also find that technology and changes in demand for technology change over time, but I control for such changes in the continental marginal cost and continental marginal revenue variables. I find that competition can change over time. For example competition on the supply side can change if for example firms from other

continents increase its technological level and enter developed continents, like for example the numerous Asian car brands which has entered Europe and North America. I find that competition on the demand side is constant in developed countries, but not in continents where demand for technology is changing due to economic advancement. Firms can enter or exit new continents due to changes in technology, demand for technology and changes in direct transportation costs over time. However, again there is nothing hindering the firms from setting up plants in the new markets in order to reduce marginal transportation costs.

I also find that a firm may first choose to invest in a continent and after investing in the new continent it cannot regret the investment because it has sunk costs which may never be recovered. Sunk costs can be a reason why a firm continues on a market even though it was never profitable if looking at the total cost. Therefore, a transportation cost which may be invisible today but not necessarily invisible tomorrow can leave a strategy trace by the firm's continuance to transport tomorrow.

To sum up what can cause transportation of non-optimal quantity of goods I find that:

- Invisibility in transportation costs caused by
  - Cost of specializing in transportation costs (constant over time).
  - 'Guess work' and herd mentality group knowledge about transportation costs and production strategies (changes over time).
- Visible direct transportation costs (changes over time)

I have earlier concluded that individual decision makers are not specialized in transportation costs and that they have not received by them perceived trustworthy group knowledge and that individual decision makers do not trade over continents due to production capacity constraints.

I now conclude that intercontinental transports decrease profits, since visibility of transportation costs are low, which makes the decision makers to trade un-optimal quantities of goods. Now I also conclude that group knowledge regarding transportation costs is not accurate.

7 Conclusions and Further Research

My evidences all point in the same direction, which suggests that there may be invisible costs causing profit-un-optimal quantity of trade. The equity holders of an importing firm bear alone all invisible trade costs, which is proved by my theory and my empirical testing. The customers of a firm do not pay for invisible trade costs, since such trade costs does not change quantities or prices. If a cost is visible by both the importing and exporting firms the cost is shared between the firms, their customers and suppliers, which previous research proved.

If a cost is invisible both before and after the trade, the decision maker will never be influenced by the cost. If a cost is invisible before the trade but visible after the trade, the decision maker may still after the trade decide to continue with the same strategy as decided upon before the trade, even if the decision maker would have took another strategy if the cost was visible before the trade. An example is if the future cash flows of a so called sunk fixed investment cost would not cover that sunk cost.

A cost which is invisible for one individual within a firm is not necessarily invisible for another individual within the same firm. Direct costs, like container shipping invoices from suppliers, have a higher probability being visible than more stochastic costs which can occur anytime anywhere within the firm. For example corrosion damage due to ocean shipping on two out of thirty components to be assembled on trucks in a truck factory. The visibility of transportation cost drivers and the cost relative to the revenue of specializing in estimating the cost of transportation are determining if an individual is triggered to specialize in estimating transportation marginal costs. If the cost drivers are invisible for the individual he will not specialize in estimating transportation costs. I conclude that it is extremely difficult to see transportation costs drivers and to estimate transportation cost, due to the random location and temporal nature of transportation cost drivers. My theory and empirical evidences support my conclusion. Inaccurate group knowledge about transportation cost may change over time, due to herd mentality etc.

I find that firms do not transport between continents due to production capacity constraints within the continent where the good is sold.

Margins can differ per continent and time. I control for marginal effect of quantity sold per continent on profit and marginal effect of quantity produced per continent on profit. Margins can change over time, due to technological improvement in production (supply side) and change in technological demand (demand side). I find that change in demand or supply is not really an incentive to trade, so my measurement will not be biased from changes in demand or supply.

Direct transportation costs can change over time, but I do not control for them in my thesis, which may be a weak point in my thesis. There may be some bias in my estimated parameter.

Other subjects which can affect profits are differences in importers and exporters time zones and differences in importers and exporters cultures. Such subjects are constant over time and controlled for in the marginal effect on quantity sold and produced per continent variables. Also the distance between continents may cause information frictions which make it costly to trade. However, I see such information frictions just as a visible or invisible trade cost.

I also noted that it may be fixed sunk costs that I measured in my model instead of transportation costs, however I have more support of that it is invisibility than fixed sunk costs in my estimated parameter.

I also note that many successful firms produce within or near the same continent where the goods are sold, like for example H&M, Zara, Sandvik, Nokia, Toyota, Scania, and Volvo. Examples of not so successful firms who do not produce near the same continent where the goods are sold are; Ericsson, Brio, Saab Automobile.

Most empirical economic geography research is regarding quantities, which is not sufficient for a rigorous economic analysis which needs to contain profits, costs, revenue and quantities. I analyze profits, costs, revenue and quantities and thereby I contribute with a more rigorous theoretical and empirical model. However, I need to be careful not to say that I am the first person writing a thesis in this way, since there is usually someone who has done something similar.

I now put down my foot and say that firms may suffer from invisibility of trade costs and that it is the equity holders who pay for the costs, since the operational profits are reduced and the profit to equity holders are a residual of operations and cash flows to creditors. I do not have any recommendation in how to increase visibility, since it may be too costly to increase visibility in transport costs. The only recommendation I can give, is to transform plant level fixed cost to marginal cost of production and set up one plant in each continent, like the successful firms have done.

I recommend some subjects to be further researched. Changes in direct trade costs may be incentive to increase or decrease trade.

It would also be interesting to include firms with other head-quarters than firms with European head-quarters, because there may be an effect of distance from head-quarters which could be controlled for.

If it would be possible, it would be interesting to separate the effect on profit of invisibility from visibility.

It would be interesting to develop a model for long run and short run equilibrium on profit and quantities. Perhaps the quantities will go down in the long run which would make the customers pay more in the long run.

It would be interesting to not only measure the intercontinental transports effect on mean profit, but also intercontinental transports effect on standard deviation of profit. I suppose that increase in transports increases standard deviation of profit.

It would be interesting to develop a model of marginal loss in revenue due to transports. Perhaps the demand shifts if goods are late or old.

DETAIL D.1 – INTRODUCTION

Globalization is not something new. Goods have been proved to move between continents as early as eleven thousand years ago (Kislev 2006). The most famous early intercontinental trade routes are the Silk Roads, which in the around three thousand years ago was a trade route for silk and other goods between China, India, Middle East, Africa and Europe (Elisseeff, p. 2). Much later in Sweden, in the year 1732, a vessel from the Swedish East Indian trade company for the first time left the harbor in Gothenburg to trade canons for silk in eastern Asia (Olán 1923, p. 29, Johansson 1992, p. 3). In the mid 18th century, China represented ten to fifteen percent of Swedish trade. Even if trade was less than today in absolute terms, it can be compared with the relative figures of 1992 when China represented 0.6 percent of Swedish trade (Johansson 1992, p. 1) or 2007 when China represented 3.5 percent of Swedish Imports (SCB 2010).

Swedish firms have also been globalized for over a century. An example is Ericsson who had its first FDI in 1897 when the factory in St:Petersburg opened (Lundström 2006, p. 40). At year 1897 Ericsson had sixteen percent of its sales outside Europe, twenty one years after the firm was founded (Meurling 2006, p. 39). Ericsson had local production sites all over the world, much due to reduced labor and transportation costs, but also due to business politics (Meurling 2006, p. 39). In fact, Ericsson had only two factories in Sweden before 1946, both located in Stockholm. Ericsson opened eleven factories located in the Swedish countryside during 1946 to 1960. Ericsson sold off some foreign factories and focused on production in Sweden, until the 1990s. Markusen also find that foreign direct investments grow rapidly in the late 1980's (Markusen 1995b, p. 171).

I find that intercontinental trade is much more developed nowadays than a century ago. It is much easier and less expensive to transport nowadays, due to different transportation technology and political openness to trade. It is common knowledge that China is the factory of the world and that Europe and USA are the major consumers of the world (Zhang 2004, p. 264). However, only a small part of the goods an individual person buys, comes from another continent. I find that in 2007, only 3.5 percent of Swedish imports are from China, 3.6 percent of Swedish exports are towards Africa and that 18 percent of Swedish imports are from Sweden's neighbor Germany (SCB 2010). This is a common pattern around the world according to the research on gravity models (Anderson 1979, p. 106). Some large good producing firms have however moved production to low cost countries like China.

For some reasons we do not trade that much with other continents as have been signaled to us by media. There is reason to believe that intercontinental trade is more costly than to trade with our neighboring countries or to trade within our own town. Trade occurs in space from one location to another. Moving goods from one location to another takes time. Customers want their goods sooner than later and

they are willing to pay for a reduction in time. Hummels find that the per day value of transportation time is 0.8 percent of the initial cost of the good (Hummels 2001, p. 26, Hummels 2007, p. 9). Moving goods from Far East to Europe takes 6 weeks and it would then equal a tariff of 33.6 percent.

The cost of direct labor for a good produced in Europe is around 21 percent (*Table B.1.a and Figure B.1.b*). Moving the production from Europe to Asia would imply lower wages, increased transportation costs, constant machine cost, constant material costs and constant administration costs. This raises a few questions. How can firms replace labor costs with transportation costs? Are they irrational?

In this thesis I try to find out how the firm is affected by intercontinental trade. I analyze previous research and develop theories of visible and invisible costs. I also develop theories of cognitive mechanics of visibility of trade costs. I also test empirically for existence of invisible trade costs and at what extent invisible intercontinental trade costs affect the profit of the firm. I also analyze the welfare effects on the stakeholders in society, due to the event of trade between continents.

Detail D.2 – Theoretical and Empirical Foundations

In this thesis I combine several research areas and some other evident facts I find, which will be the foundations of understanding how intercontinental trade affects the profit of the firm.

D.2.1 Foundation I – Time as a Trade Barrier

One of the foundations of my thesis is time as a trade barrier. Hummels proved that each day saved in shipping time is worth 0.8 percent ad-valorem for the manufactured goods (Hummels 2001, p. 26, Hummels 2007, p. 9). Hummels analyze two transport modes; air shipping and ocean shipping. Air shipping is faster than ocean shipping and air shipping is also more expensive than ocean shipping. Due to the relative cost in air shipping to ocean shipping an air shipping premium is defined in the article. By analyzing the firm's choice of transportation modes, Hummels estimate the cost of time to be 0.8 percent ad-valorem for the good. Because of the size of the ad-valorem number, trade has an economic meaning for the profit of the firm.

The per day cost of the good, is a function of two factors; the per day interest rate, the depreciation rate for the good. Depreciation rate for the good is differing among types of good. Some depreciation is predictable as for example spoilage of cut flowers. Some depreciation is probabilistic. Depreciation of the probabilistic type is; damage, absence of key components, mismatch between supply and demand. For example H&M has mini-seasons of clothes of 5-7 weeks (Pettersson 2001, p. 198). Therefore H&M prefer to source some of their goods from Turkey which takes 3 days to store with truck, instead of from East Asia which takes them 3 weeks (Pettersson 2001, p. 202). I find that in H&M stores in Stockholm, on average 41

percent is sourced from EU, 28 percent from near EU (for example India) and 31 percent from East Asia (*Table B.1.l i-ii*).

The longer the transportation time is, the higher the cumulative probability of damage. The higher the cumulative probability of damage, the higher the expected cost.

Some key components cannot be substituted by other goods at a certain time. Such goods have no indifference curve specified. If a key component is not available at a time the consumer is in immediate need of the key component, the consumer suffers from lower profits. An example is a car manufacturer with thousands of components per car. If one component is missing, the car cannot be manufactured. The longer the time of shipment is, the earlier the goods need to be shipped in order to be available in time, since intercontinental shipments can take months. Such strategy clearly violates the "just-in-time" strategy, since the JIT-strategy has an ambition holding only a few hours of component inventory (Hummels 2004, p. 12).

In my thesis, Hummels estimate of time cost is now given to be true. The cost of shipping, which is often defined as the price set by the carrier and customs tariffs etc, is in general deterministic and visible for the consumer. The cost of time more complicated since it is both deterministic and stochastic. I believe that both the deterministic part and the stochastic part of the cost of time, is difficult to estimate for an individual human being.

D.2.2 Foundation II – Gravity Models

According to Anderson (1979, p. 106), gravity models had been the most successful empirical trade evidence since 25 years back. Gravity models find evidence for, among other things, that the further away two countries are from each other, the less they trade in physical goods. This empirical finding has been the similar up to today, even though theoretical models have developed. For example Baier and Bergstrand (2009) used the gravity model to estimate the effect of changes in trade barriers and proved that if a country joins a free trade agreement with a trade union, its trade with the trade union doubles in the long run.

Portes (2004) uses gravity models for empirically analyzing trade of equity and find that gravity models apply just as well on equity as on physical goods. Equity is not of physical nature and is not transported. Portes finds that the most natural explanation for that, the further away countries are from each other the less they trade in equity, is informational frictions that are positively correlated with distance. The data is however from 1989-1996, which I believe is from a period when it was difficult and expensive to trade equity with distant parts of the world. Nowadays anyone can buy equity funds containing equity from anywhere in the world, which I believe was not as developed then as now.

Herrmann and Mihaljek (2011) use up-to-date data from 1993-2008 of debt lending, which come to similar result as Portes et al. Information frictions reduce lending to

far away borrowers. Some banks only lend to customers whose habitat is visible from the bank office of the decision making originator (Handelsbanken annual report 2002). Such strategy is called the church tower principle, which is a criterion meaning that the originating officer can only lend to a client if he can see the office or home of the client from the top of the church tower. If the originating officer cannot see the habitat of the client, he and the client are likely to not have enough contact to each other.

Egger et al (2001) analyze how distance is a proxy for both trade cost and fixed cost of setting up a plant. Egger et al find that distance affects fixed costs of setting up an extra plant more than transportation costs from exports. The authors rely on that firms are rational and that the outcome of how firms act is a proxy for costs in trade and FDI. However Egger et al do not analyze costs, revenues, quantities, profits and strategy selection as a function of profit together.

Brainard (1997) find that firms' overseas production increases the higher the transport costs are and the lower the plant scale economies are. The data Brainard use is aggregated macro data from one single year, 1989. Brainard use econometrical techniques to extract some variables from other visible ones.

Research using gravity models is mostly using aggregated data from different governmental data sources. From the aggregated data, missing variables are extracted using different advanced econometrical techniques. The main focus of gravity models is to find quantity outcomes from rationally selecting firms' sensitivity to different variables like distance between two countries. From the quantity of trade, the gravity models makes an effort to estimate transportation costs since costs and quantities are assumed to be linear. So in short, gravity models estimates quantities actively selected by assumed rational firms and the models equalize the quantities with transportation costs.

However, in order to make a comprehensive economic analysis, I need to analyze many different functions other than cost functions. A comprehensive analysis needs cost functions, revenue functions, quantity functions which results in profit functions, which the rational firm makes decision from. A quantity measure, incorrectly named to a cost measure, is not a sufficiently rigorous analysis.

Most research of gravity models also use aggregated data, and surprisingly few pieces of research about FDI and transportation use micro firm data. From firm data, like annual reports, profits, revenues, costs and quantities can easily be extracted.

D.2.3 Foundation III – Cost Break Down

In order to understand the size of transportation-costs contra savings in off-shoring to low-cost countries, I need to make a cost break down of typical articles produced in Europe that often are off-shored to low cost countries.

The major incitement of off-shoring is said to be direct labor cost reduction. I find that the direct labor of a good produced in Europe to be 21 percent of the total production cost (*Table B.1.a and B.1.b*). My measure is for typical components manufacturing like; steel machinery, sheet-metal work, plastic forging. This measure might not completely represent all type of goods produced in Europe, since the industry I measured is using their machines very effectively in 3-shifts and thereby having a lower direct machine cost. But it would most probably be rare to find a good with more than 40 percent or even 35 percent direct labor in modern European production facilities.

Transporting goods does however cost also. I estimate using Hummels measure that time value of shipping from China to Europe is around 33.6 percent ad valorem if shipped with ocean vessel. Adding to this is the cost of the shipment itself, which might be quite low.

I find that moving the production from Europe to Asia would imply lower wages, increased transportation costs, constant machine cost, constant material costs and constant administration costs (Anonymous Cost-Engineer 2010, B.2).

D.2.4 Foundation IV – Economies of Scale

Assume that a firm which produces good X has firm fixed effects, F, Marginal costs, MC_X, and produce the good at a quantity Q_X. The total cost of producing good X is then defined as (Markusen 1995a, p. 178)

$$TC_X = F + MC_X \times Q_X$$

The average cost is defined as

$$AC_X = \frac{F}{Q_X} + MC_X$$

For any quantity, Q_X, the average cost, AC_X, is larger than the marginal cost, MC_X, because of the fixed costs, F.

$$AC_X > MC_X$$

This means that if there are fixed costs, there cannot be a competitive equilibrium, $p = MC_X$, because at a competitive equilibrium, the firm would lose money because

$$AC_X > p$$

If price would increase to $AC_X = p$, the firm would produce an infinite amount of goods because $p > MC_X$ (Markusen 1995a, p. 179).

However, if the firm would monopolize the industry we have a standard monopoly outcome $MR_X = MC_X$, with a profit $\pi_X = (p - AC_X)Q_X$ (Markusen 1995a, p. 179) and a monopoly equilibrium would then allow for firm fixed costs. If a firm increase

its output, Q_X, its average fixed costs, $\frac{F}{Q_X}$, would decrease and as a result its average cost, AC_X, would decrease and its profit, π_X, would increase.

If the fixed costs, F, are very high, the firm might be forced to increase output by exporting to new markets in order to have a positive profit, $\pi_X > 0$, at all. Firms can do so by specialization of its plants (Markusen 1995a, p. 188) and reduce firm fixed costs. Little theoretical work has according to Markusen been done in this field, but some empirical work has emphasized plant specialization as an important source from gains from trade, like for example the U.S.-Canada Auto pact of 1965 where Canadian plants produced too many models and by trade liberalization firms could produce a higher quantity of fewer models.

Economies of scale are thereby an incentive for the firm to trade, given that there are firm fixed costs. I should also consider if and how the share of firm fixed costs to total cost changes over time, because the share of international trade to production changes over time.

D.2.5 Foundation V – Sunk Entry and Exit Costs

When a firm enters a market, the firm bears a fixed entry cost. When a firm exits a market it bears a fixed exit cost. These costs both appear ex-ante trade with the new market and are, once the event of investment in the new market, sunk costs, because the money invested can only be used for that specific investment in the new market and the firm can never get the money back from that investment (Roberts 1997, p. 547).

A problem occurs when the expected future stream of operating margin may not cover the sunk cost of entering the new market (Roberts 1997, p. 560). Even though, ex-post the entry, the mark-up profit (excluding the sunk cost) is positive, the entry project suffers from a negative gross profit (including the fixed sunk cost).

Roberts find that sunk costs are relevant for staying within the market after entry (Roberts 1997, p. 560). Participation within the market in the previous year increases the probability of exporting during the current year by 63 percentage units (Roberts 1997, p. 559). If a firm which is in general a profitable firm (plant effect α=1) and suffers from decreased profits from exporting (25th percentile of βZ_{it}), there is a 29.7 percentage unit higher probability that the firm continue to export this period if it exported last period than if it did not export last period. The reason to sustain a unprofitable export, is due to sunk costs.

D.2.6 Foundation VI – Iceberg Transport Costs

Martinez et al (2006) developed a model of transportation costs caused by depreciation of the value of the good (like a melting iceberg). The cost is visible by both the importer and the exporter and thereby the price of the good is reduced and thereby a larger quantity is demanded.

Martinez develop theoretical monopolistic and an oligopolistic model which is considering quantities, prices, costs and profits, but he does not test them empirically.

D.2.7 Foundation VII – Specialization in Knowledge About Intercontinental Trade of Goods

The goal of this thesis is to investigate if and how trade of goods over continents affects the profit of the firm. I believe that production costs are in general constant over the world, excluding direct labor costs which also are a relatively small part of the production cost. My idea is that the costs from transports might be relatively high and that if the transportation costs are higher than the difference between the marginal costs of the two different production sites, the profit might be affected in a negative way. There are a few problems with my statement:

- Firms do trade over continents
- It is assumed to be unprofitable for firms to trade over continents
- Firms must be constrained in some way in order to act in a way which is unprofitable

I find three types of constraints allowing the firms to act in an unprofitable way:

- Cognitive constraints (irrationality), which restricts the visibility of profits
- Capacity constraints (rational second best strategy), occurs when there is not enough production capacity near the location of sales
- Fixed cost constraints (rational second best strategy), occurs when a firm needs high fixed costs in order to keep up with competitors

My favorite explanation for why firms act in a way that may result in negative profits is cognitive constraints.

Martens summarize theories about cognitive mechanics of trade in his book. One of the cornerstones of cognitive economy is bounded rationality. Martens (2004, p. 49) summarize Simon (1952) who argues that individuals, no matter how intelligent they are, only have a limited information processing capacity. Therefore individuals can only grasp a small fraction of the total information or knowledge available in the world. Such argument violates the rational choice theory which is one of the cornerstones of neo-classical economics. Simon argues that people rarely behave as rational calculators searching for the most optimal solution for a problem.

Martens summarize Conlisk (1996) who argues that individuals follow behavioral rules and get sufficient ex-post results from such strategy. Martens (2004, p. 49) argue that the theories of bounded rationality, asymmetric information and distributed knowledge are based on the idea that agents in an economy hold different information sets and that none of them are perfectly informed. Martens (2004, p. 49) argue that agents are specialized into different sub sets of information

which gives them comparative advantage which enables them to gainfully trade such informational advantages, which are distributed within goods and services.

Martens (2004, p. 61) makes qualitative explanations of the properties of knowledge, but he also takes a rigorous approach to knowledge, when he explains how knowledge functions inside the human brain and the society. He starts with neuronal network models of cognition using graph theory concepts. Martens claims that the neural network in the human brain can be translated to graph theory, because neural networks are based on neural nodes and neural links between the neural nodes. Using graph theory, Martens define the total knowledge as a knowledge graph, K, which represents the total knowledge in the brain.

Such knowledge graph has sub graphs, V, and every sub graph has its own knowledge subject and is disconnected from other sub graphs. One knowledge subject can be for example car mechanics and another knowledge subject can be language. Every sub graph can also be further separated into different sub graphs. For example language can be fragmented into sub graphs with different languages and those can be further fragmented into sub graphs of grammar and vocabulary. Martens clams that the number of sub graphs, V, is a measure of variety in K, since every sub graph contains its own subject.

However, the more connected the links between neural nodes are, the more accurate the knowledge is.

The two main dimensions of knowledge; accuracy and variability, can according to Martens help us understand specialization. The volume of knowledge is a product of accuracy, A, and variety, V.

$$v(K) = AV$$

For an individual, the volume of knowledge can be assumed to be given by the amount of neural cells. The individual must optimize its knowledge by changing his knowledge set, KS, which is the mix of accuracy and variety. If the individual increase its variety by removing neural links, the individual also reduces its accuracy vice versa. The individual aims to maximize his resource, R, by minimizing his uncertainty, UC. UC is negatively correlated with both accuracy and variety and thereby with both R and K. The agent's objective function takes the form $R^{-1} = UC = f(V^{-1}; A^{-1})$. Resources are assumed to be subject to decreasing returns

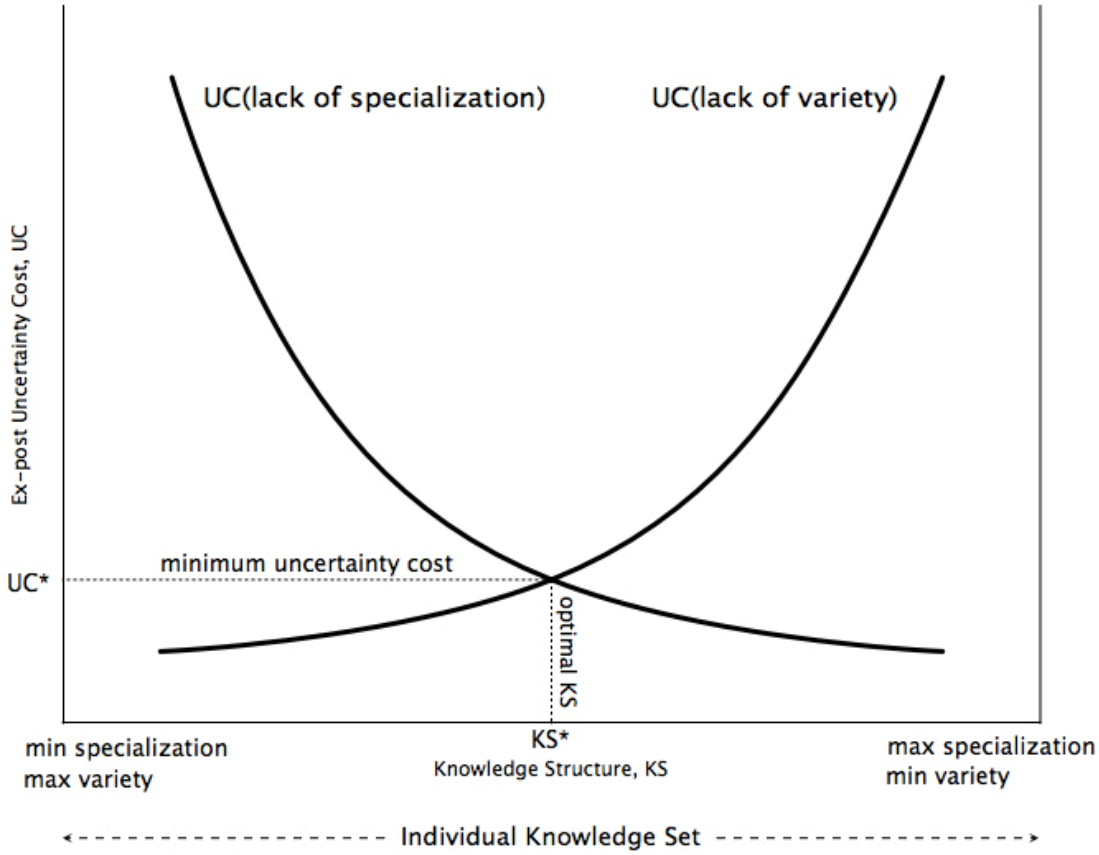
$$\frac{\partial R}{\partial A} > 0$$

and

$$\frac{\partial^2 \partial R}{\partial^2 A} < 0$$

which allows us to define a unique equilibrium locus between accuracy and knowledge. In the diagram below UC is minimized with respect to accuracy and variety, subject to the capacity constraint $VA \leq \max v(K)$.

Figure D.2.7.a Accuracy versus Variety in knowledge

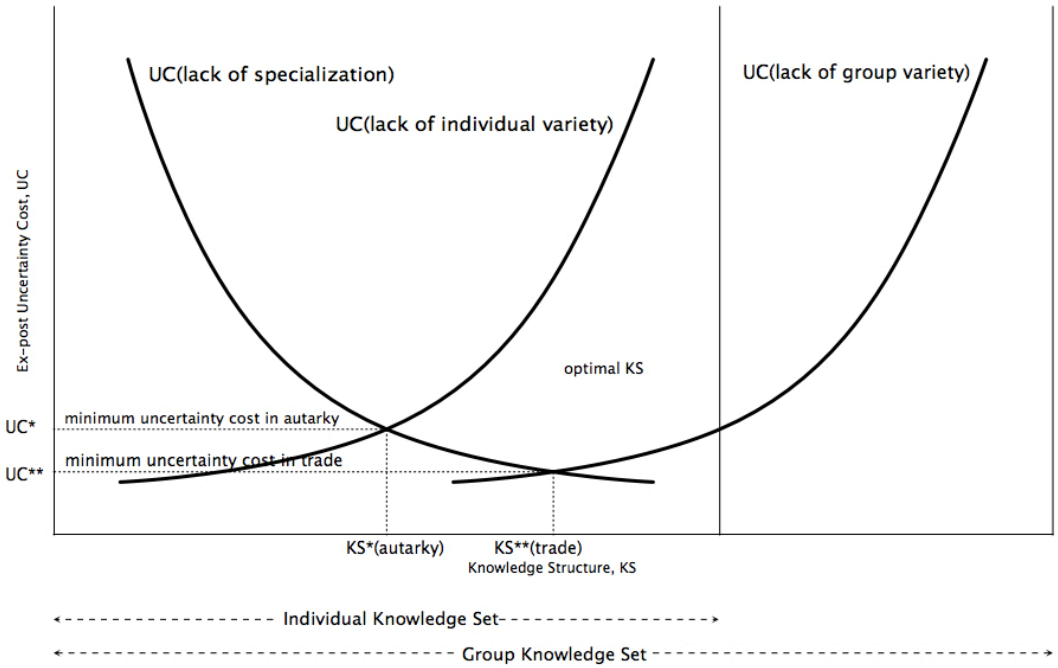


Source: Martens (2004), p.65

In order to achieve equilibrium composition of accuracy and variety, the individual needs to go through a trial-and-error process (Martens p. 65). The trial-and-error process is an important part for my analysis of theory in this thesis.

This model described is a model of an individual agent living in a cognitive autarky. In a world of cognitive autarky, there are no other individuals to receive knowledge from, by for example asking colleagues for help.In a world of cognitive trade, different individuals would be specialized in certain areas because specific knowledge can be sold to individuals who do not have that specific knowledge (Martens 2004, p. 95). Accorging to Boyd & Richerson (Martens 2004, p. 92) individuals do not learn when costs of learning are too high and Martens add to their theory that quantity or income effect is also important to consider (2004, p. 93). Martens analyzes incentives to trade learn and to trade find that the learner must be able keep his knowledge for himself and be able to charge the imitator for using the knowledge (Martens, p. 95). The diagram below explains an individual who is able to trade knowledge with a group.

Figure D.2.7.b From cognitive autarky to trade: the advantages of specialization and exchange of knowledge



Source: Martens (2004), p.109

As can be seen by the diagram, the individual specialize more since he can use the group's variety in knowledge. An individual can ask his colleagues for knowledge and the individual will also supply knowledge to the group. Thereby there are incentives for the individual to specialize in a certain area. In order for an individual to be able to charge the groups other individuals, the knowledge must have a value for the other individuals of the group. If the whole group would receive a specific knowledge, Martens argue that the same specific knowledge would have no value. However, specific knowledge is very difficult to transfer from one individual to another since different individuals knowledge graphs are not isomorphic (there is no one-to-one correspondence between two individuals' neural nodes) (2004, p. 105). Specific knowledge can have a value if the individual carrying it supplies it in a truncated format, so that the individuals in the group only have a simplified version of the knowledge (2004, p. 109), or that individuals in a group have limited knowledge capacity and thereby needs to make choices of which knowledge they want to learn (Martens 2004, p. 107).

There are two constraints hindering specialization to be triggered. First, specialization will only occur if there is an incentive of specializing in a certain area. The individual will specialize in the area which gives him the highest profit. The profit is given by the marginal revenue of specializing in a certain area, marginal cost of specializing in a that same certain area and the quantity of knowledge achieved from specializing in that same certain area. Second, specialization occurs through a trial-and-error process. When an individual sees an error, he changes his strategy

and tries again. If he sees an error the next time he changes his strategy again and tries once more. The individual will continue like that until no more errors can be seen.

If it is too costly, relative to quantity and revenue of knowledge, to specialize, or if the individual does not see the error, the individual will not trigger specialization. I consider a cost driver which is not expected in advance by the individual to be an error. If the cost driver is occurring at a location which is far away from the individual, the individual will not see the cost and there may be no trial-and-error process triggered to improve specialization in the cost. Alternatively, the individual decision maker sees some of the errors, but due to its randomness and cost of learning from the errors, he may actively choose not to specialize in costs. The visibility of errors and the relationship between the revenue and cost of specializing is important for the analysis of theory in my thesis.

D.2.8 Foundation VIII –The World Factory

The title "The world factory" was first awarded to the United Kingdom during the industrial revolution. Later, the United States industrialization took off in the 1870 and surpassed the United Kingdom and thereby took over the title "The world Factory". After the World War II, USA made up almost half the world GDP. During the 1970s, Japan and Germany had a strong manufacturing performance and won the title of "world manufacturing centers" (Zhang 2004, p. 258). Zhang explains that the world's most populous country is emerging as the world factory through turning into an exporting machine and that a visit to a department store will reveal that many of today's consumer goods are produced in China (Zhang 2004, p. 1). Zhang also explains that China's export symbolize the emergence of China as the world factory (Zhang 2004, p. 2). Zhang explains that the world sees China as the world factory and therefore he analyze if China is the world factory and if it is possible that China can be the world factory in the future. Zhang conclude that China is not the world factory (Zhang 2004, p. 264) and that both Germany (10 percent of the world exports) and USA (9 percent of the world exports) both have a larger share of world exports than China (6.5 percent of the world exports) (Zhang 2004, p. 258). China also only have 13 percent of US GDP (Zhang 2004, p. 259). Zhang find that China has a vast pool of unskilled labor, skilled technicians and natural resources (Zhang 2004, p. 266-267), but only time will tell if China will be the world factory (Zhang 2004, p. 267).

I find that Swedish imports from China is around 3.6 percent of all imports, to be compared to Swedish exports to Africa which is 3.5 percent of all exports. I also find that Sweden trade mainly with geographically adjacent Nordic countries and Germany. Countries from other continents are only of marginal importance.

D.2.9 Foundation IX – Welfare Effects of Spatial Trade

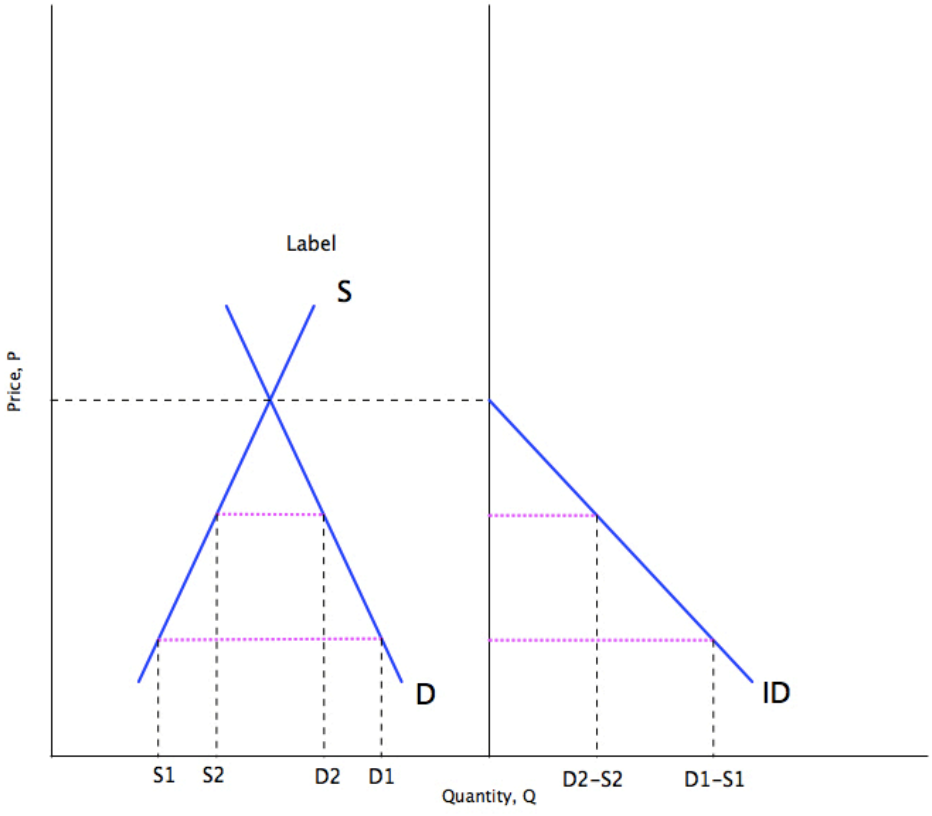
In order to understand who lose and who wins from transportation costs, I need to analyze international trade theory on microeconomics level.

First I summarize theory about effects of trade on price and quantity in the importing country's market, exporting country's market and the world. According to the neoclassical trade theory people act rationally and have perfect knowledge about all parameters and all variables that set the prices and the quantities.

In an autarky, price and quantity for a good is set, at the intersection between the demand function and the supply function, where the quantity demanded equals quantity supplied and the demand price equals the supply price. The quantity and the prices are the autarky equilibrium quantity and the autarky equilibrium price of supply and demand. The demand function is usually downward sloping according to the law of demand. The supply function is usually upward sloping according to the law of supply.

As the price decreases below the autarky equilibrium price, quantity demanded exceeds quantity supplied, since more consumers are willing to buy more for a lower price and less suppliers are willing to supply for that lower price. If goods could be imported there would be a demand for such quantity of domestic demand exceeding domestic supply. For every price lower than the autarky equilibrium price such import demand quantity can be derived. The import demand is a function of the autarky supply and demand functions which is derived in the diagram below.

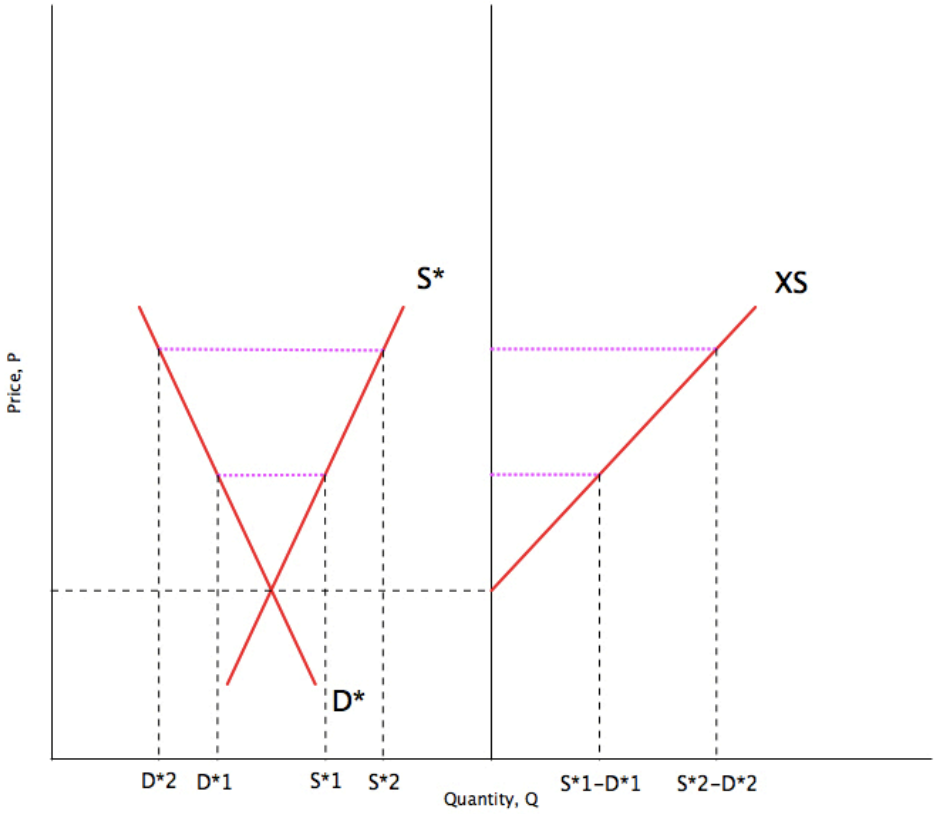
Figure D.2.9.a Home's Import Demand Curve



Source: Krugman (2003), p.188

Likewise, for every price higher than the autarky equilibrium price and export supply function can be derived. The export supply is a function of the autarky supply and demand functions which is derived in the diagram below.

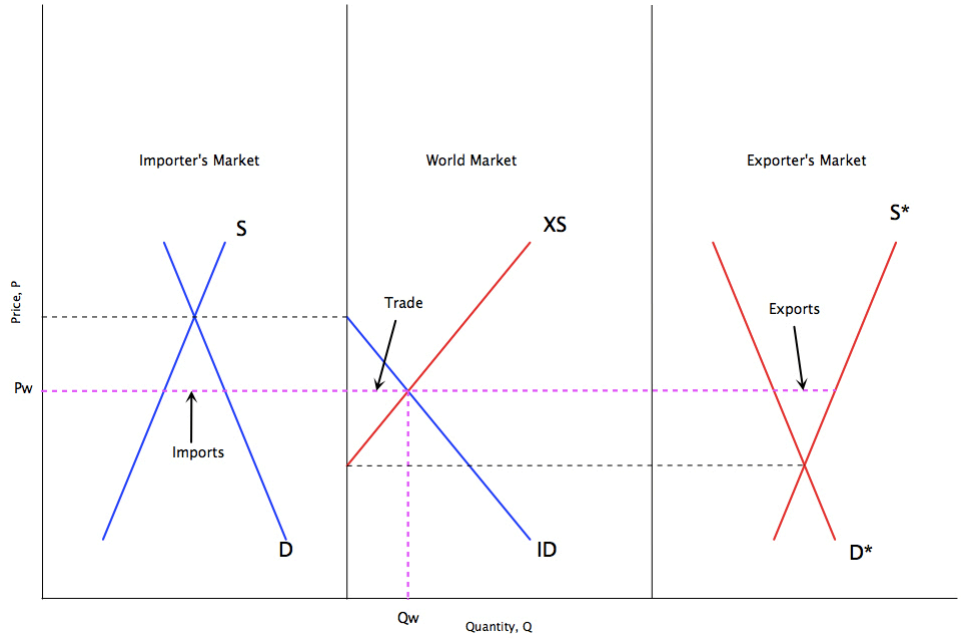
Figure D.2.9.b Foreign's Export Supply Curve



Source: Krugman (2003), p.188

Two countries which differ in their respective autarky equilibrium prices and quantities can trade with each others. In the diagram below, the exporter country has a lower price than the importer country. The exporter country has an export supply function defined and the importer country has an import demand function defined. Where the export supply function and the import demand function intersect, the equilibrium free trade price P_w and quantity Q_w is defined in the diagram below. In the diagram can also be seen that the import quantity equals world trade quantity Q_w and export quantity, as the world exists of two countries.

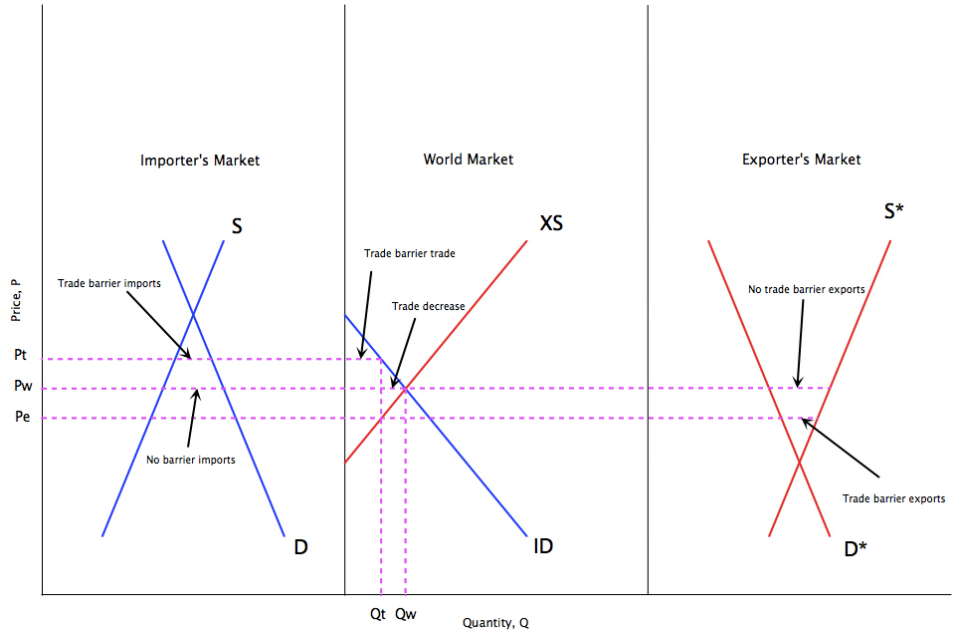
Figure D.2.9.c World Equilibrium



Source: Krugman (2003), p.189

Some importer countries create import trade barriers, like for example tariffs. Such trade barriers make it more costly for the consumers to import goods. Since price is higher for the consumer to buy imported goods with a trade barrier, a lower quantity is demanded according to the autarky demand function and thereby the import demand function. Since less quantity is demanded by the importers and that the world exists of two countries, the export supply quantity is also reduced and thereby the export supply price. The free trade quantity Q_w is in fact reduced until trade barrier quantity Q_t, where the difference between the import demand price and the export supply price equals the cost of the trade barrier, as can be seen in the diagram below. In other words the exporting firm in the exporters market and the importing consumer in the importing market are in fact sharing the cost of the trade barrier. Please note that the exporter's price will only change if the importer is a large open economy, because then the importer is a price setter. If for example a continent like EU imposes an import tariff, the exporter's price will change, but if the small country Gibraltar would impose an import tariff, the exporter would most likely not change its price. In the proceeding parts I am analyzing continents as large economies.

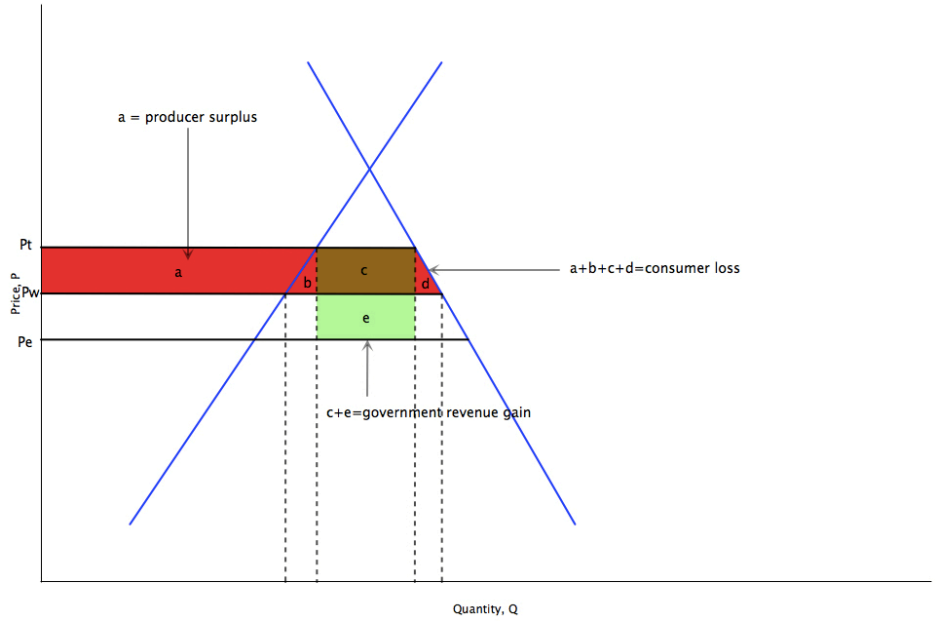
Figure D.2.9.d Effects of a Tariff



Source: Krugman (2003), p.190

Looking solely into the importers market, there are different welfare effects. There is a loss in consumer surplus, by the area a+b+c+d. There is a revenue gain for the importer markets government if that government uses a tariff as a trade barrier, by the area c+e. There is an increase in producer surplus, by the area a, since a less quantity is imported. Often such trade barriers are created by the government in order to protect a certain local industry, resulting in such producer surplus.

Figure D.2.9.e Costs and benefits of a Tariff for the importing country



Source: Krugman (2003), p.195

Foreign direct investments

Markusen analyzes profits of different types of foreign direct investments; exports, horizontal FDI, vertical FDI. In his model he assumes a monopoly market with linear functions of revenues and costs. I will also assume in my analysis that the market is a monopoly, even though all firms I analyze act in a market with monopolistic competition. An oligopoly market is much more difficult to analyze than a monopoly market and also I simplify my analysis by assuming linear functions, just like Markusen.

The mark-up profit function for a firm consists of revenue and cost. Revenue is a function of price which is a function of quantity Q.

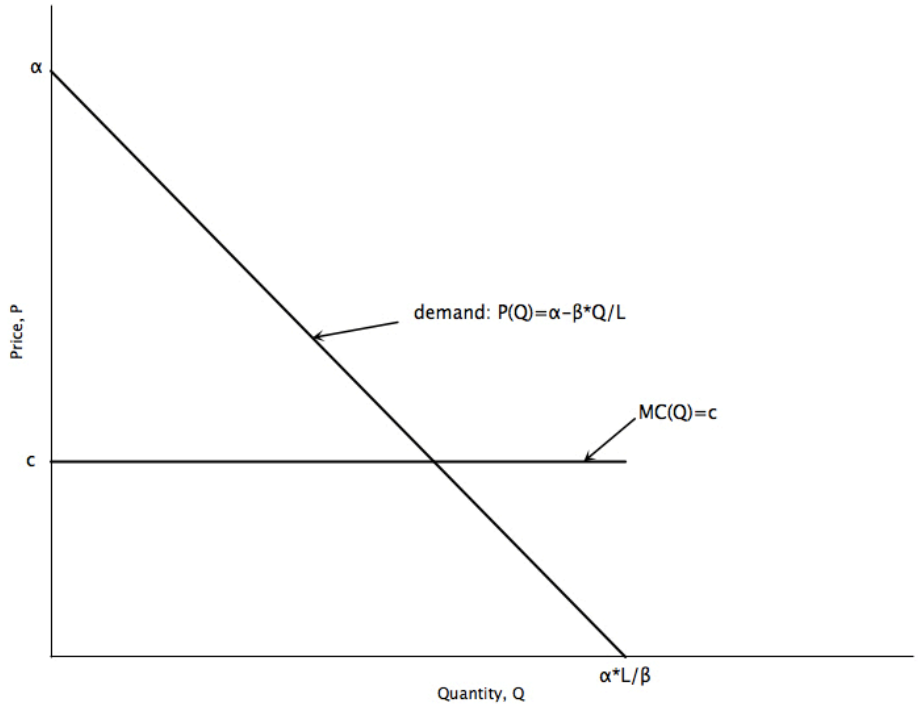
$$\pi_{monopoly\ mark-up} = \overbrace{\widehat{P(Q)Q}}^{Revenue} - \overbrace{\widetilde{cQ}}^{Cost}$$

The demand function is assumed to be a quasi-linear demand and derived from an assumed quasi-linear utility function (Markusen 2004, p. 22). The demand curve have an intercept parameter α, a slope parameter β, a labor parameter L and a quantity variable Q. The per capita quantities is represented by $\frac{Q}{L}$ (Markusen 2004, p. 23).

$$P(Q) = \alpha - \beta \frac{Q}{L}$$

Markusen simplify the model assuming constant marginal costs, c.

Figure D.2.9.f Constant Marginal Cost of Production and Market Demand



Source: Markusen (2004)

The firm tries to maximize the mark-up profit by adjusting quantities subject to demand

$$\max_{\{Q\}} \pi = \overbrace{P(Q)Q}^{Revenue} - \overbrace{cQ}^{Cost}$$

$$s.t.\, demand: P(Q) = \alpha - \beta \frac{Q}{L} \qquad (a)$$

The firm tries to maximize the profit by adjusting the quantities with first order condition of finding the maximum point of profit where its first derivative is zero (Markusen 2004, p. 23).

$$\frac{d\pi}{dQ} = 0$$

$$\frac{d\pi}{dQ} = \overbrace{\frac{dP}{dQ}Q + P}^{\substack{product\ and\\ chain\ rule\\ of\ P(Q)Q}} - c = 0$$

$$P - c = -\frac{dP}{dQ}Q \qquad (b)$$

The first derivative of the demand function *D.2.9.a* with respect to quantity is

$$\frac{dP}{dQ} = -\frac{\beta}{L} \qquad (c)$$

And replacing the derivative in *D.2.9.b* with *D.2.9.c* gives

$$P - c = \beta\frac{Q}{L}$$

Mark-up profit is maximized under *D.2.9.b* subject to the demand function *D.2.9.a* resulting in

$$\overbrace{\overbrace{\alpha - \beta\frac{Q}{L}}^{(a)\ P}}^{\frac{\pi}{Q}} - c = \overbrace{\beta\frac{Q}{L}}^{(b)\ P-c} \qquad (d)$$

Using the formula *D.2.9.d*, an equilibrium where marginal revenue equals marginal cost can be found, which is a relationship between the variables and the parameters where the mark-up profit of the firms is highest.

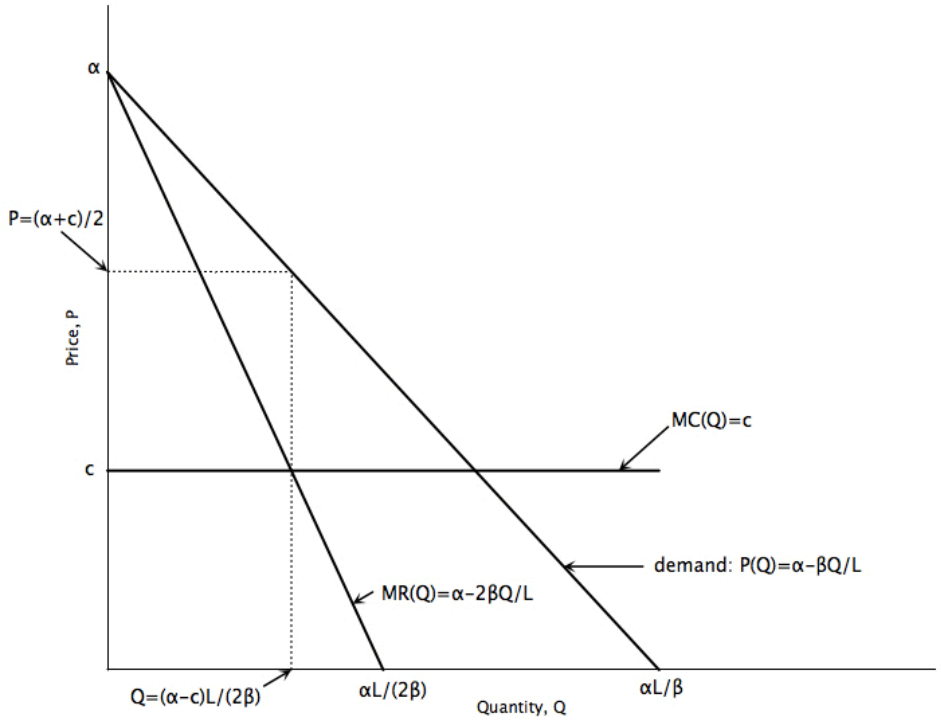
$$\overbrace{\alpha - 2\beta\frac{Q}{L}}^{MR} - = \overbrace{c}^{MC}$$

Solving for the optimal quantity and the optimal price gives (Markusen 2004, p. 23)

$$Q = \frac{\alpha - c}{2\beta}L$$

$$P = \frac{\alpha + c}{2}$$

Figure D.2.9.g Linear Monopoly Model – Constant Marginal Cost of Production, Marginal Revenue and Market Demand



Source: Markusen (2004)

Solving for the optimal mark-up profit

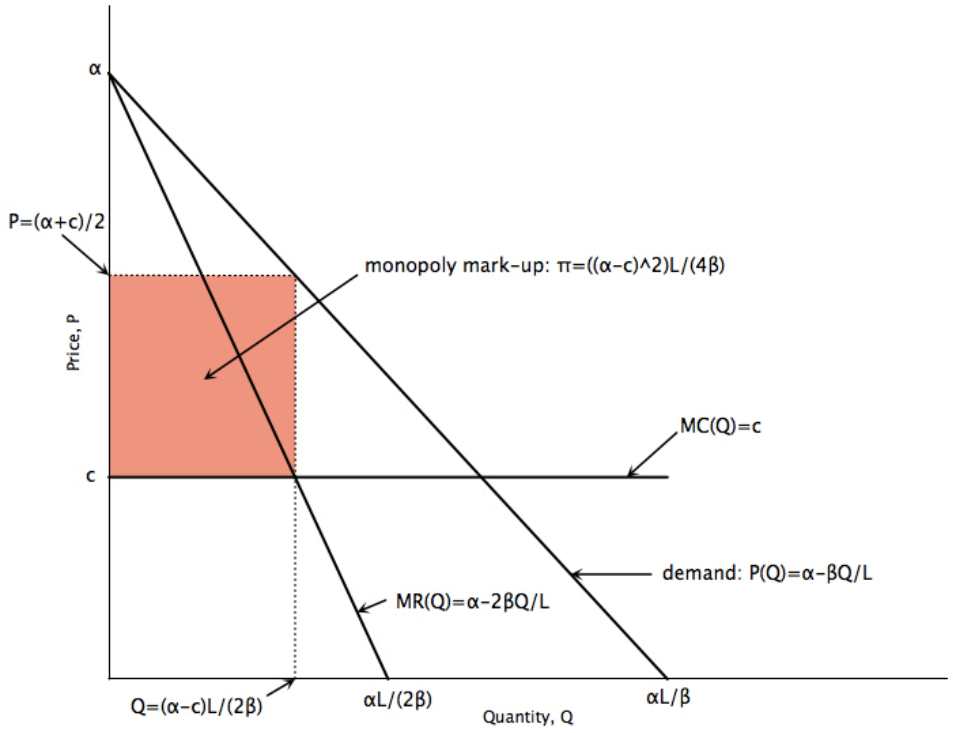
$$\pi_{monopoly\ mark-up} = (P - c)Q$$

$$= \left(\frac{\alpha + c}{2} - c\right)\frac{\alpha - c}{2\beta}L$$

$$= \left(\frac{\alpha - c}{2}\right)\frac{\alpha - c}{2\beta}L$$

$$\pi_{monopoly\ mark-up} = (\alpha - c)^2\frac{L}{4\beta}$$

Figure D.2.9.h Monopoly Mark-Up Profit



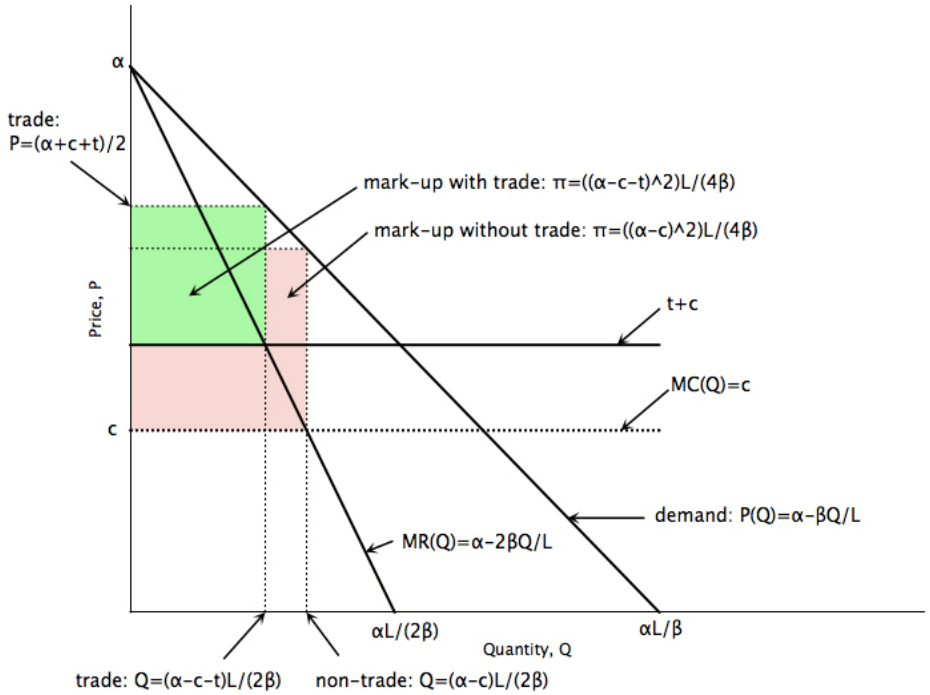
Source: Markusen (2004)

Adding firm fixed costs, F, and plant fixed costs, G, to the markup profit gives the monopoly profit for an autarky market (Markusen 2004, p. 24)

$$\pi_{monopoly} = \overbrace{(\alpha - c)^2 \frac{L}{4\beta}}^{\pi_{monopoly\ mark-up}} - F - G$$

By adding another country to the market in which the firm acts, an additional mark-up profit is affecting the monopoly profit. Depending on localization of production, the two countries' mark-ups can however be affected by transportation costs, t. Below is a diagram of mark-up sales profits in a market with local production (without transport costs) and mark-up sales profits in a market without local production (with transport costs).

Figure D.2.9.i Monopoly mark-up profit with and without trade



Source: Markusen (2004)

Also depending on localization of production, the monopoly profit can be affected by additional plant fixed costs, G. The relative market size, γ also affects the profit and the localization decision (Markusen 2004, p. 34).

$$L_d = \gamma L$$

$$L_f = (1-\gamma)L$$

These are the three outcomes of monopoly profits according to Markusen (2004, p. 24, 34)

$$\pi_{monopoly}^{domestic\ production} = \overbrace{(\alpha - c_d)^2 \frac{\gamma L}{4\beta}}^{\pi_{monopoly\ mark-up}^{domestic\ sales}} + \overbrace{(\alpha - c_d - t)^2 \frac{(1-\gamma)L}{4\beta}}^{\pi_{monopoly\ mark-up}^{export\ to\ foreign}} - F - G$$

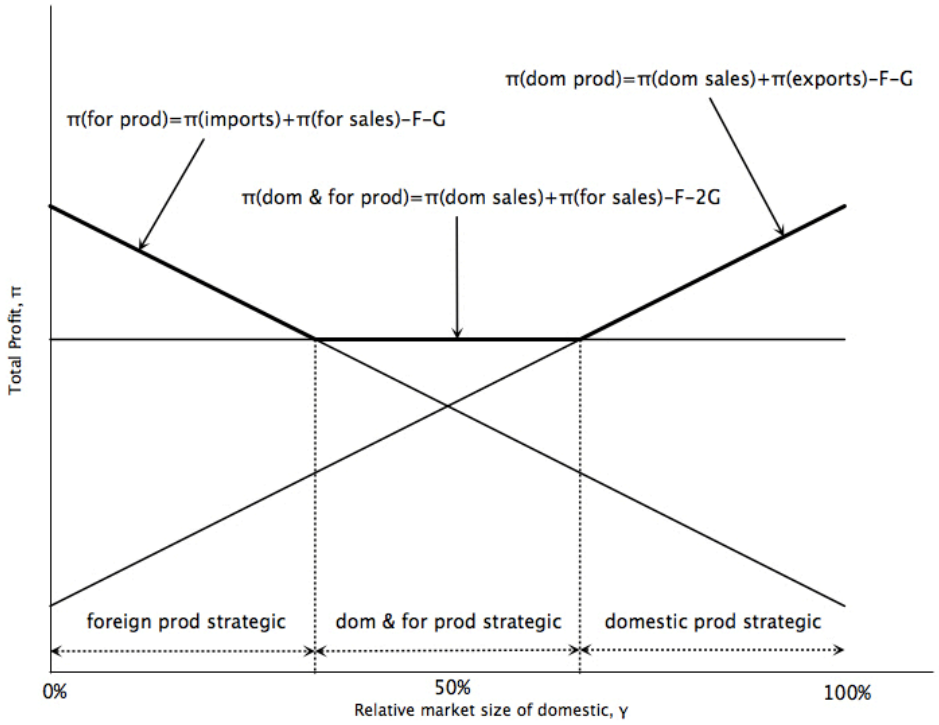
$$\pi_{monopoly}^{foreign\ production} = \overbrace{(\alpha - c_f - t)^2 \frac{\gamma L}{4\beta}}^{\pi_{monopoly\ mark-up}^{imports\ to\ domestic}} + \overbrace{(\alpha - c_f)^2 \frac{(1-\gamma)L}{4\beta}}^{\pi_{monopoly\ mark-up}^{foreign\ sales}} - F - G$$

$$\pi_{monopoly}^{dom\ \&\ for\ prod} = \overbrace{(\alpha - c_d)^2 \frac{\gamma L}{4\beta}}^{\pi_{monopoly\ mark-up}^{domestic\ sales}} + \overbrace{(\alpha - c_f)^2 \frac{(1-\gamma)L}{4\beta}}^{\pi_{monopoly\ mark-up}^{foreign\ sales}} - F - \overbrace{2G}^{additional\ plant}$$

The firm chooses the one of the three strategies which has the highest of the profits. The profits are dependent on the transportation costs, plant fixed costs, marginal costs by country (salaries and technology) and the relative market size.

The diagram below shows the three profit function and the thicker parts of the functions represents the most profitable strategy given γ.

Figure D.2.9.j Profit from the three production localization strategies given relative market size

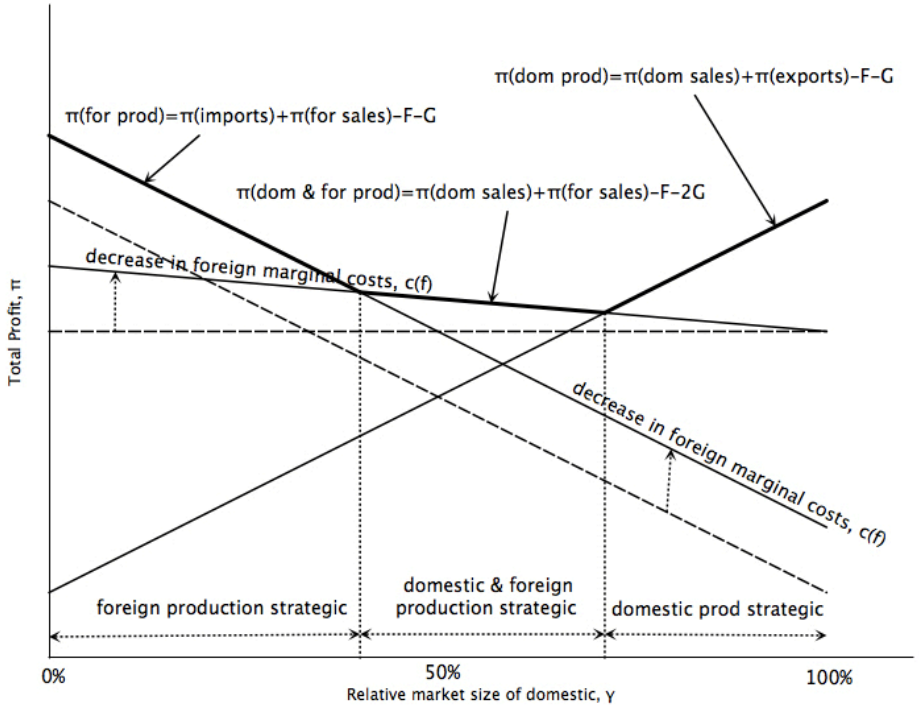


Source: Markusen (2004), p26

If the γ is less than, at the limit, where foreign production function intersects the domestic and foreign production function, meaning that the domestic market size is so much smaller relative to the foreign markets size, that it is more profitable to have a production plant solely in the foreign country.

Different countries can have different constant marginal costs, c_d and c_f, according to Markusen's model. For example low cost countries like China are believed to have lower marginal costs than for example Europe, due to lower salaries. The diagram below show how the profit function of foreign production is shifted up due to a decrease in constant marginal costs for the foreign country.

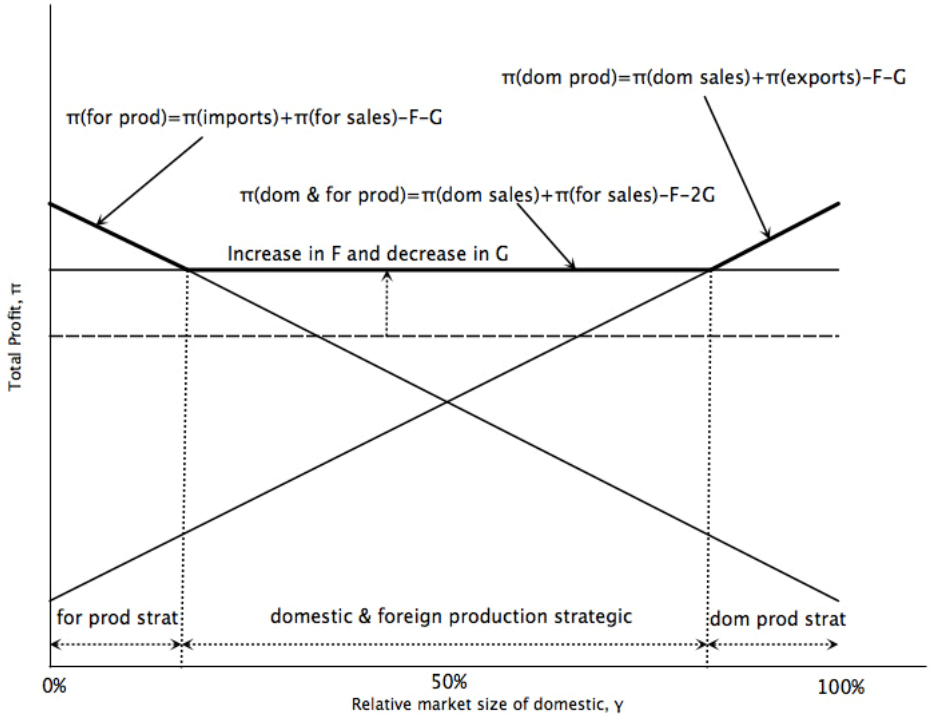
Figure D.2.9.k Effect of decrease in foreign marginal cost on profit



Source: Markusen (2004), p30

Increasing R&D costs, F at the same amount as decreasing manufacturing fixed costs, G, profit has solely an effect and a positive effect on the profit of the strategy of producing in both countries as can be seen in the diagram below.

Figure D.2.9.k Effect of increase in firm fixed costs and similar decrease in plant fixed costs on profit



Source: Markusen (2004), p29

I will extend this model with visible and invisible transportation costs.

Detail D.3 – My Extensions to Theoretical Foundations

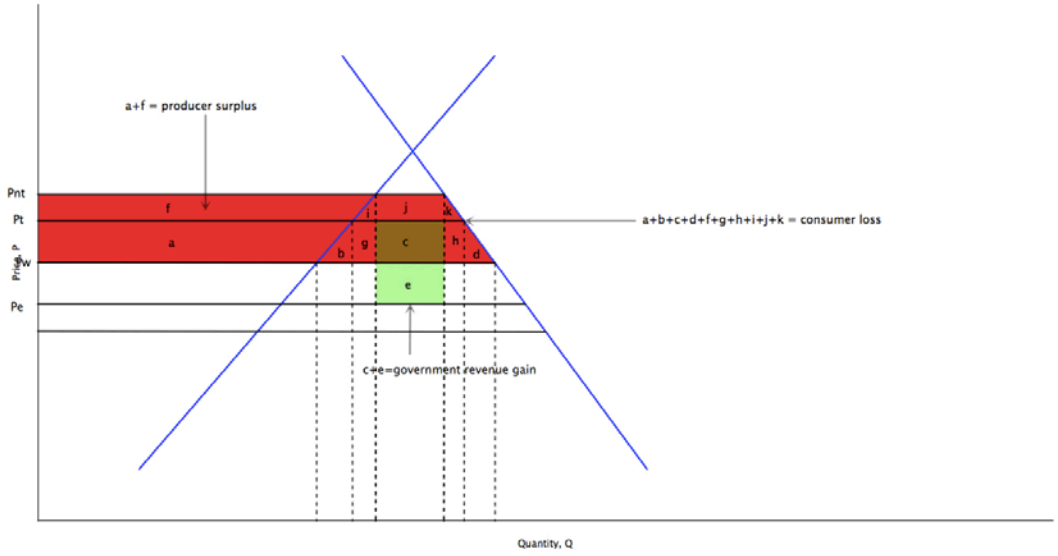
Neoclassical trade theory has very weak but necessary assumptions for validating itself. A very problematic assumption is that all variables, parameters and functions are visible for everyone acting in the market.

In this part I will extend neoclassical trade theory with cognitive mechanisms of trade, where I separate trade equilibrium in a setting of cognitive visibility from trade equilibrium in a setting of cognitive invisibility. I will develop a distinction between costs of trade that is visible and invisible for an individual actor in the market.

First I will, using neoclassical trade theory, separate visible governmental tariff trade barriers from other visible trade barriers. Non-tariff barriers (can for example be interest rate on goods in transport) inflicts an increased cost of the good, which adjusts the quantities just like a tariff trade barrier. The fact that quantities are adjusted downwards makes it a barrier. The diagram below shows two different types of visible trade barriers; governmental tariff (a+b+c+d+e+g+h) and non-tariff trade barrier (f+i+j+k). The non-tariff trade barrier is more expensive than the

governmental tariff trade barrier, since there is no government revenue from a non-tariff trade barrier.

Figure D.3.a Costs and benefits of a tariff and other visible trade barriers for the importing country

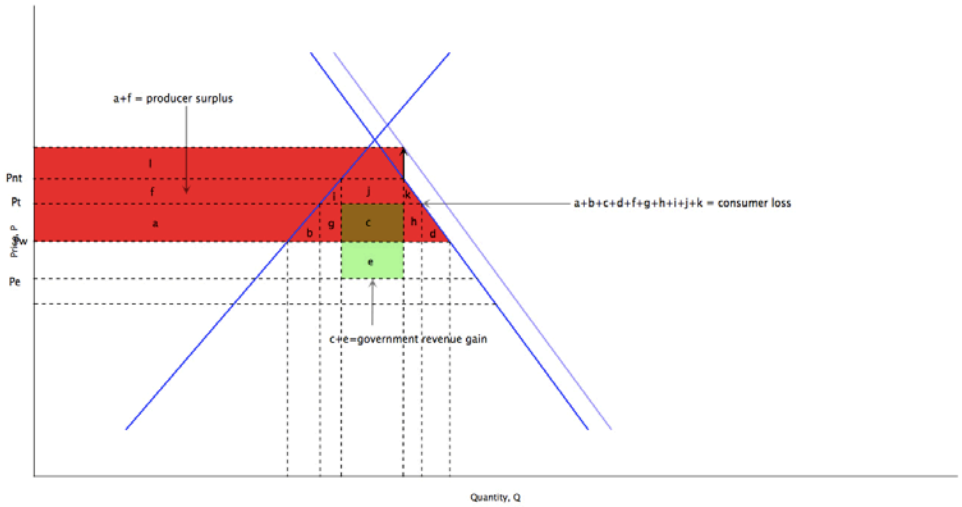


Now I will extend theory by separating visible and invisible costs of trade. It is important to notice that in order for the quantities to be adjusted, either the importer or the exporter need to see the barrier. If such cost of trade is invisible, quantities will never be adjusted and thereby the cost of trade will solely be an invisible trade cost and not a trade barrier. In the diagram below has an extra invisible demand function on top of the neoclassical visible demand function. The quantities are adjusted solely by visible trade barriers, but the individual acting on the market is unknowingly paying for more than it can see. Since the individual is paying for more a shadow demand function exists which is derived from the visible demand curve and shifted up by the per/unit invisible trade cost. The total invisible trade cost (l) is the invisible trade cost t_i times the visible quantity Q_v

$$t_i \times Q_v$$

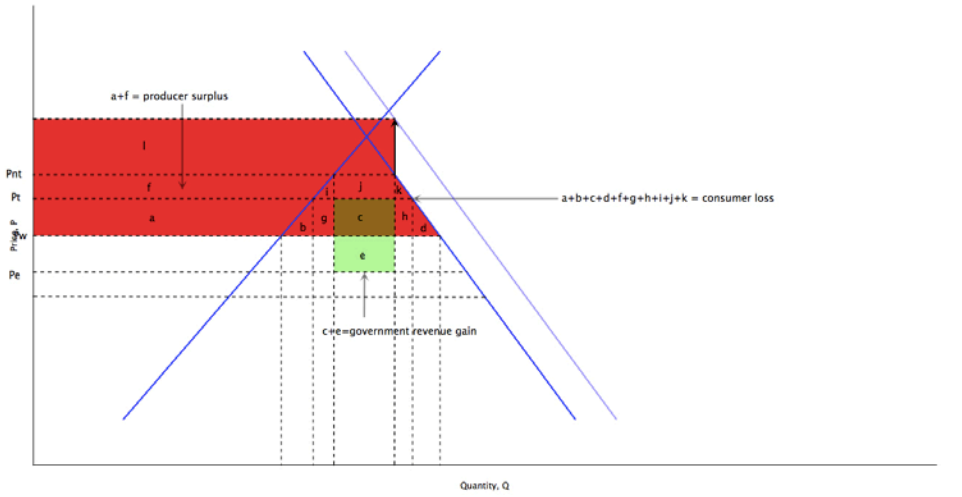
As can be seen in the figure *D.3.b* below, the price including all trade costs, visible and invisible, is not exceeding the autarky equilibrium price but it would be more profitable for the individual to see the trade cost and reduce quantity.

Figure D.3.b Costs and benefits of a tariff, other visible trade barriers and invisible trade costs for the importing country



If increasing the invisible trade costs, so that the invisible demand curve shifts so much higher up that the cost of the good including all trade costs exceeds the autarky equilibrium price, it is not profitable to import the good, contradicting the believes of the individual importer.

Figure D.3.c Costs and benefits of a tariff, other visible trade barriers and large invisible trade costs for the importing country



I believe that invisible trade costs by far can exceed visible trade costs like tariffs and interest rates. According to Hummels, for every day a good is transported, an ad valorem cost by 0.8 percent is inflicted on the good (Hummels 2001, p. 26, Hummels 2007, p. 9). For a good to be transported by boat from China to Europe, means an ad valorem cost of 32 percent, which is higher than most tariffs. Many costs are difficult to see for an agent acting as an importer, due to the importing

agent's lack of specialization in the area of transports. An unexpected trade cost of can be inflicted anywhere in the organization, long time after the decision about importing is made, which makes it very difficult for the individual acting as an importer to foresee the forthcoming cost.

I would also like to discuss another type of constraint of the firm. Temporary capacity constraints in the local market can force the importing individual to import a higher quantity at a higher price (cost) than the neoclassical model would suggest. This can lead to a shadow demand function, just like the invisible demand function, with exactly the same outcomes as the invisible trade cost model. I therefore need to separate short-term capacity constraints from long-term cognitive constraints when I estimate these costs.

In this chapter I have contributed with some new terms. Visible trade barriers are trade barriers since they adjust the quantities downwards. Invisible trade costs are just costs and not trade barriers, since they do not adjust the quantities. What is visible for one individual does not need to be visible for another individual, since it is depending on every single individual's cognitive setting. The cognitive environment of an individual can influence the trade cost knowledge set of an individual. Something that, for a certain individual, is an invisible trade cost today can be a visible trade barrier tomorrow.

Foreign direct investments

I also extend Markusen's FDI monopoly model by separating trade costs, t, into visible trade costs, t_v, and invisible trade costs, t_i. The individual market agent does only act given what is visible for him, so that the agent tries to maximize mark-up profits given visible trade costs and excluding invisible trade costs. The profit visible for the individual is

$$\pi^{excluding\ t_i}_{monopoly\ mark-up} = \overbrace{P(Q)Q}^{Revenue} - \overbrace{cQ - t_vQ}^{Cost}$$

The actual mark-up profit is however

$$\pi^{including\ t_i}_{monopoly\ mark-up} = \overbrace{P(Q)Q}^{Revenue} - \overbrace{cQ - t_vQ - t_iQ}^{Cost}$$

Like Markusen's model, the individual tries to maximize the mark-up profit by adjusting quantities subject to the demand

$$\max_{\{Q\}} \pi^{excluding\ t_i} = \overbrace{P(Q)Q}^{Revenue} - \overbrace{cQ - t_vQ}^{Cost}$$

$$s.t.\, demand: P(Q) = \alpha - \beta\frac{Q}{L} \qquad (1)$$

Notice that the individual will not maximize the mark-up profit including the invisible trade costs. Since this profit maximization condition is the same as Markusen's model, the optimal quantity and the optimal price with the individual's cognitive setting are still

$$Q = \frac{\alpha - c - t_v}{2\beta} L$$

$$P = \frac{\alpha + c + t_v}{2}$$

Solving for the optimal mark-up profit, excluding invisible trade costs, t_i, is the mark-up profit which the agent believes will enjoyed by the firm.

$$\pi^{excluding\ t_i}_{monopoly\ mark-up} = (P - c - t_v)Q$$

$$= \left(\frac{\alpha + c + t_v}{2} - c - t_v\right)\frac{\alpha - c - t_v}{2\beta} L$$

$$= \frac{L}{2\beta}\left(\frac{(\alpha - c - t_v)}{2}\right)(\alpha - c - t_v)$$

$$\pi^{excluding\ t_i}_{monopoly\ mark-up} = (\alpha - c - t_v)^2 \frac{L}{4\beta} \qquad (5)$$

Solving for the actual mark-up profit, is however different from Markusen's model, since the actual mark-up profit model includes invisible trade cost, t_i.

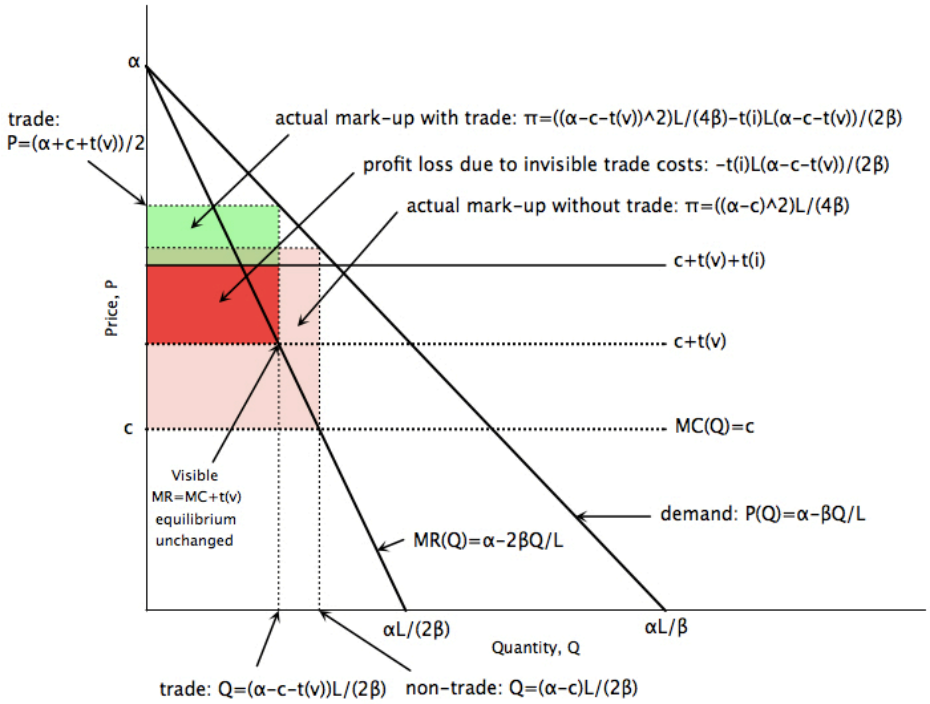
$$\pi^{including\ t_i}_{monopoly\ mark-up} = (P - c - t_v - t_i)Q$$

$$= \left(\overbrace{\frac{\alpha + c + t_v}{2}}^{P} - c - t_v - t_i\right)\overbrace{\left(\frac{\alpha - c - t_v}{2\beta} L\right)}^{Q}$$

$$= (\alpha - c - t_v)\left(\frac{(\alpha - c - t_v)}{2} - t_i\right)\frac{L}{2\beta} \qquad (5)$$

$$\pi^{including\ t_i}_{monopoly\ mark-up} = \overbrace{(\alpha - c - t_v)^2 \frac{L}{4\beta}}^{\substack{Profit\ visible\ for \\ market\ agent}} - \overbrace{t_i \frac{\alpha - c - t_v}{2\beta} L}^{\substack{Profit\ loss \\ due\ to \\ invisible\ trade\ costs}}$$

Figure D.3.d – Actual monopoly mark-up profit with and without trade and profit loss due to invisible trade costs



I argue that a cost that is not visible by the firm reduces profit more than if the same cost is visible. Keeping total trade costs constant, $\bar{t}$, I define the relative visibility of trade costs as

$$\bar{t} = t_v + t_i$$

$$t_v = \omega\bar{t}$$

$$t_i = (1-\omega)\bar{t} \qquad where\ \omega \equiv \{0, \ldots, 1\}$$

$$\pi^{including\ t_i}_{monopoly\ mark-up} = (\alpha - c - \omega\bar{t})^2 \frac{L}{4\beta} - (1-\omega)(\alpha - c - \omega\bar{t}) \frac{L\bar{t}}{2\beta} \qquad \text{(a)}$$

$$\frac{\partial\pi}{\partial\omega} = -\frac{\bar{t}^2(\omega-1)L}{2\beta} = \frac{\bar{t}^2(1-\omega)L}{2\beta} \qquad \text{(b)}$$

Since all variables $\bar{t}^2, L, \beta$ and ω are positive or zero, the first derivative is restricted to be $\frac{\partial\pi}{\partial\omega} \geq 0$. $\frac{\partial\pi}{\partial\omega} = 0$ only when there are no transportation costs or when all transportation costs are visible for the firm $\omega = 1$. Otherwise $\frac{\partial\pi}{\partial\omega} > 0$ which means that the firm must be able to increase profit by increasing visibility. The global

maximum of the profitability function is where $\frac{\partial \pi}{\partial \omega} = 0$, which is when the visibility is full $\omega = 1$ or when there are no transports $\bar{t} = 0$.

At some visibility, ω, the transport cost elasticity of profit is

$$\frac{\partial \pi}{\partial t} = -\frac{(t\omega^2 - 2t\omega - c + \alpha)L}{2\beta} < 0$$

At full invisibility, $\omega = 0$, and un-optimal quantity, the transport cost elasticity of profit is

$$\frac{\partial \pi}{\partial t} = \frac{(c - \alpha)L}{2\beta} \leq 0$$

Which is strictly negative or zero, since $\alpha > c$.

At full visibility, $\omega = 1$, and optimal quantity, the transportation elasticity of profit is

$$\frac{\partial \pi}{\partial t} = \frac{(t + c - \alpha)L}{2\beta} \leq 0$$

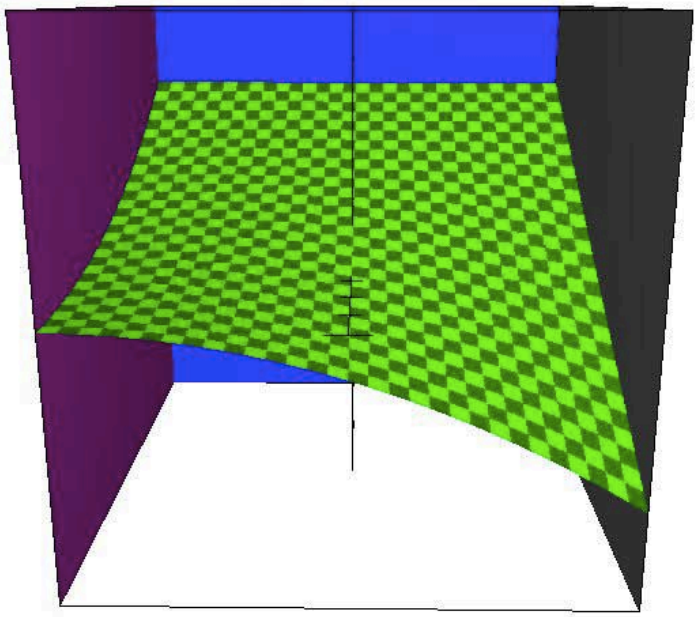
Which also is strictly negative or zero, since $\alpha > t + c$.

In the equation *D.3.a,* $\bar{t}, \omega$ and π are the coordinates of the Euclidian space, $\mathbb{R}^3$. The coordinates in the diagrams below are:

- $\bar{t}$ is the ordinate, decreasing in the depth
- ω is the abscissa, decreasing to the right
- π is the height, increasing in the height

The actual monopoly mark-up profit function π is represented by the green squared surface in the diagram below. The actual monopoly mark-up profit function is restricted in several ways. First, the transportation costs must be positive or zero $\bar{t} \geq 0$, which is represented by the blue plane in the back, $\bar{t} = 0$. Second, the visibility must be somewhere between perfect and nonexistent, $0 \leq \omega \leq 1$. Perfect visibility $\omega = 1$ is represented by the purple plane to the left. Nonexistent visibility $\omega = 0$ is represented by the grey plane to the right.

Figure D.3.e Actual mark-up profit, visibility and transport cost

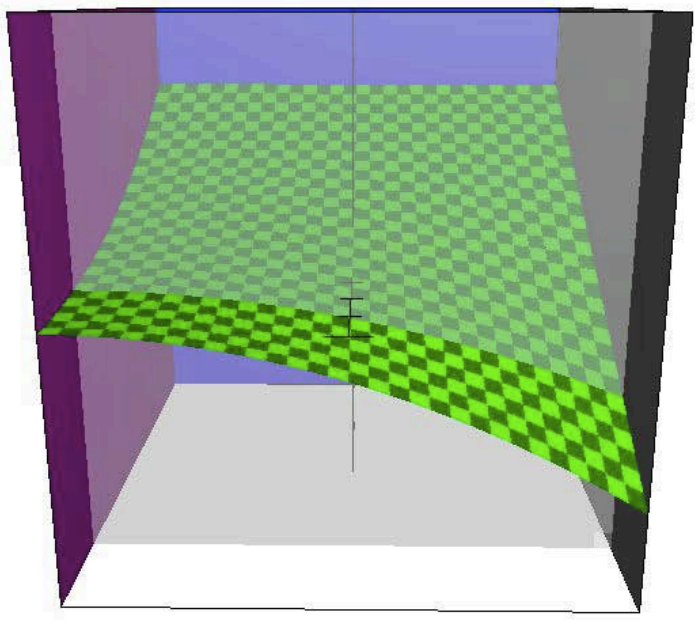


Note: Actual mark-up profit is the green surface. Full visibility is too the left. Full invisibility is too the right. No transportation costs is in the back and is increasing hitherwards

Transportation costs $\bar{t}$ are 0 in the blue plane in the back. Transportation costs are increasing the closer a transportation cost plane move to our viewpoint. The profit surface is decreasing at any intersection of the profit surface and transportation cost plane as the transportation cost plane moves closer to our viewpoint.

The transportation cost plane is the transparent plane in the diagram below. Notice that for any transportation cost $\bar{t}$, or position of the transportation cost plane, the lower the visibility ω, the lower the actual monopoly mark-up profit π. This effect might be surprising, since the cost and revenue functions are unchanged as well as their parameters. But the gain in profit due to increased visibility is simply due to a decreased quantity due to increased rationality. This is valid for any transportation cost $\bar{t} > 0$ but not for $\bar{t} = 0$, since there are no invisible transportation costs at $\bar{t} = 0$. At $\bar{t} = 0$, the monopoly mark-up profit π is homogenous for any visibility ω since $\bar{t} = t_v = t_i = 0$.

Figure D.3.f Actual mark-up profit, visibility and transport cost



Note: The transparent plane is a positive transportation cost. The same transportation cost gives different profits depending on how large share of the transportation cost is visible.

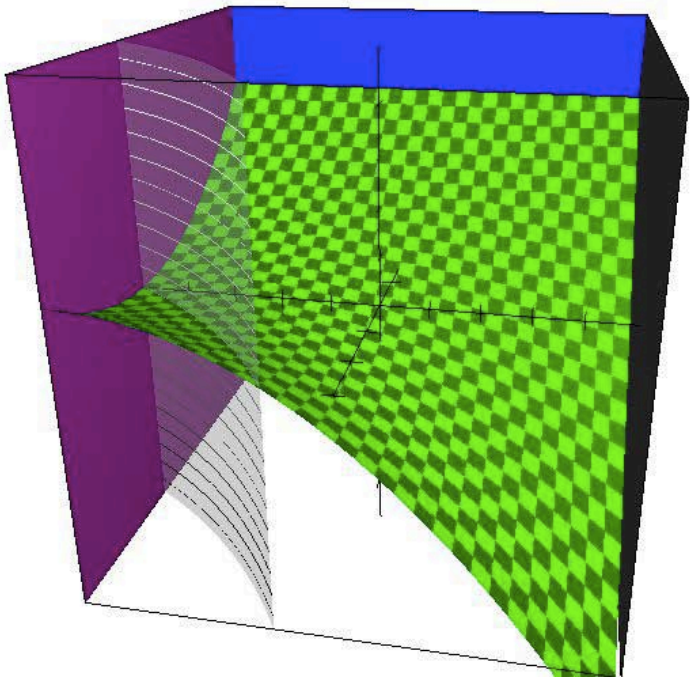
The last restriction is that the optimal import quantity chosen given some visibility must be zero or positive $Q = \frac{\alpha - c - t_v}{2\beta} L \geq 0$, since negative imports do not exist (negative imports and positive exports are not the same thing in this theoretical framework). In the diagram below the depth of the graph is increased in order to see how a higher transportation cost $\bar{t}$ is affected by the optimal quantity constraint. The optimal quantity restriction is represented by the transparent surface with lines where the optimal import quantity $Q = 0$.

The actual monopoly mark-up profit function is thereby constrained by:

- Transportation costs must be positive or zero, $\bar{t} \geq 0$
- Visibility must be somewhere between perfect and nonexistent, $0 \leq \omega \leq 1$
- Optimal import quantity chosen must be positive or zero, $Q = \frac{\alpha - c - t_v}{2\beta} L \geq 0$

Notice how when there is full visibility, $\omega = 1$, less transportations costs, $\bar{t}$, are allowed than when $\omega < 1$. The lower the visibility ω, the higher the transportation cost, $\bar{t}$, is allowed by the optimal import quantity constraint.

Figure D.3.g Actual mark-up profit, visibility, transport cost and the zero import constraint



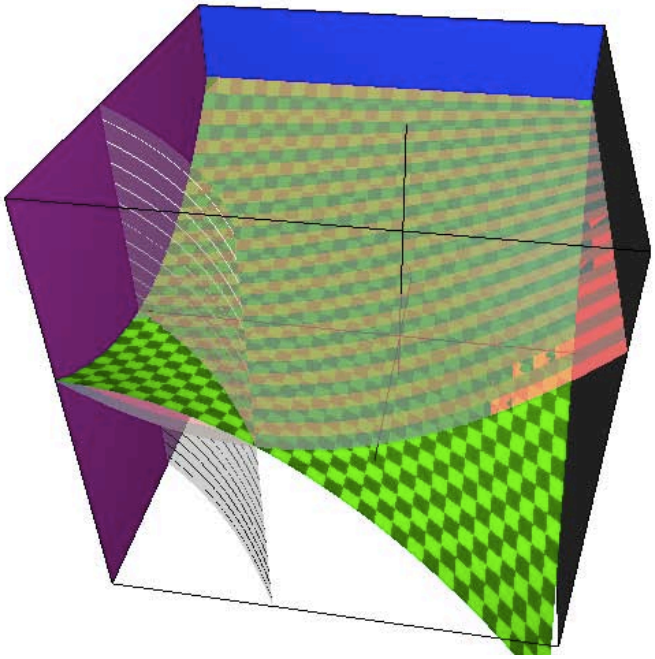
Note: As marginal transportation costs increase, there will be a locus where the visible transportation costs are equal to the marginal revenue and imports are zero. The transparent plane is the locus where imports are zero and actual profit is not defined hitherwards of the zero import locus surface.

The most important findings are:

- Given any positive transportation cost, the lower the visibility, the lower the actual profits are for a given import strategy, as can be seen in the diagram and by the formal analysis in equation *D.3.b.*
- The lower the transportation cost, the higher the actual profit.
- The lower the visibility, the higher transportation costs are allowed by the optimal quantity constraint.

The figure below (*Figure D.3.h*) shows the actual mark-up profit (green surface) and the visible mark-up profit (red surface). The visible mark-up profit is always higher than the actual mark-up profit, unless there is full visibility or if visible transportation costs cause zero imports or if transportation costs are zero. Visible mark-up profit is not defined hitherwards of the zero import locus surface.

Figure D.3.h Actual mark-up profit, visible mark-up profit, visibility, transport cost and the zero import constraint



Note: The visible mark-up profit is the red surface. It is always higher than the actual mark-up profit, unless there is full visibility or if visible transportation costs cause zero imports or if transportation costs are zero. Visible mark-up profit is not defined hitherwards of the zero import locus surface.

Increasing visibility is associated with difficulties, since the human being has specialization constraints. If increasing visibility of trade costs could be achieved, it would be done by making the invisible trade costs visible, which would result in a smaller optimal quantity

$$Q = \frac{\alpha - c - \omega\bar{t} - \overbrace{\Delta\omega\bar{t}}^{former\ t_i}}{2\beta} L$$

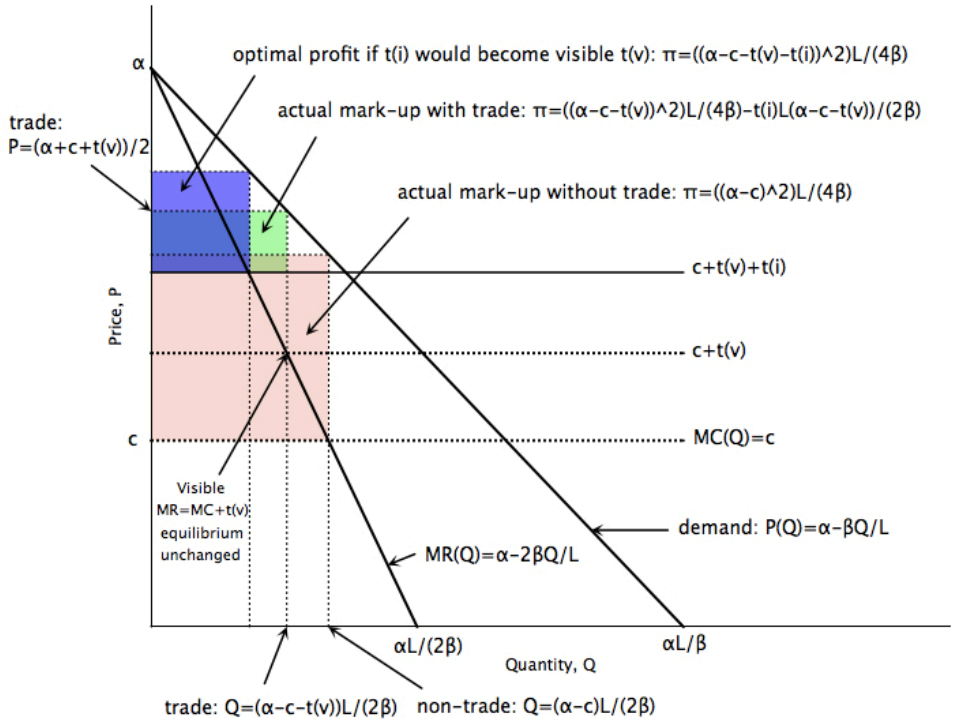
The fact that the quantity is reduced by the trade cost makes the trade cost a trade barrier. The invisible trade cost is thereby transformed into a visible trade barrier.

Monopoly markup would be

$$\pi^{t_i\ becomes\ visible\ \omega\bar{t}}_{monopoly\ mark-up} = \overbrace{(\alpha - c - \omega\bar{t} - \Delta\omega\bar{t})^2 \frac{L}{4\beta}}^{Profit\ visible\ for\ market\ agent}$$

Which I proved to be higher than the actual mark-up containing invisible profit as can be seen in the diagram below

Figure D.3.i Actual monopoly mark-up profit with and without trade and optimal monopoly mark-up profit if all trade costs were visible



However, I believe that such optimal profit given trade and all costs of trade is difficult to achieve because of limitation of specialization due to cognitive constraints of the organization regarding trade. Costs of trade are spread out all over the organization and can only be seen in the income statement. Such costs of trade that is seen in the income statement cannot be identified as trade. It is very unlikely that a decision-making agent at some part of the organization has a full view over and calculation capacity of all costs of trade.

Adding firm fixed costs, F, and plant fixed costs, G, to the markup profit gives the monopoly profit for an importing market

$$\pi_{monopoly\ mark-up}^{including\ t_i} = \overbrace{(\alpha - c - \omega\bar{t})^2 \frac{L}{4\beta}}^{\substack{Profit\ visible\ for \\ market\ agent}} - \overbrace{(1-\omega)\bar{t}\frac{\alpha - c - \omega\bar{t}}{2\beta}L}^{\substack{Profit\ loss \\ due\ to \\ invisible\ trade\ costs}} - F - G$$

These are the three outcomes of actual monopoly profits according to me

$$\pi_{monopoly}^{domestic\ production} = \overbrace{(\alpha - c_d)^2 \frac{\gamma L}{4\beta}}^{\pi_{monopoly\ mark-up}^{domestic\ sales}} +$$

$$+\overbrace{(\alpha - c_d - \omega\bar{t})^2 \frac{(1-\gamma)L}{4\beta} - (1-\omega)\bar{t}(\alpha - c_d - \omega\bar{t})\frac{(1-\gamma)L}{2\beta}}^{\pi^{export\ to\ foreign}_{monopoly\ mark-up}} - F - G$$

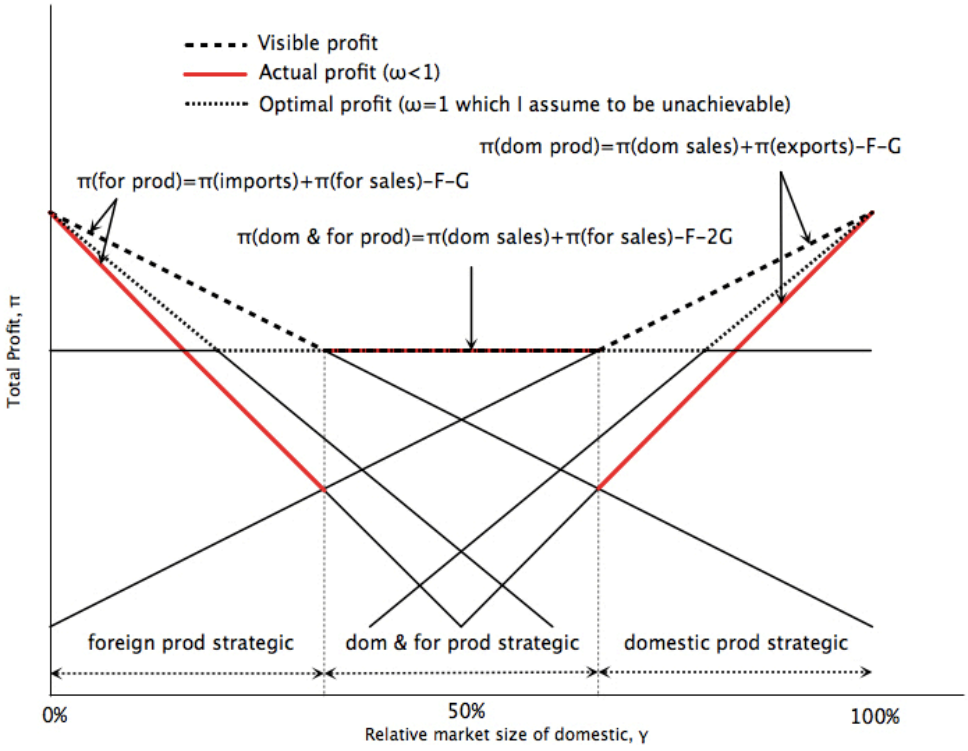
$$\pi^{foreign\ production}_{monopoly} =$$

$$= \overbrace{\left(\alpha - c_f - \omega\bar{t}\right)^2 \frac{\gamma L}{4\beta} - (1-\omega)\bar{t}\left(\alpha - c_f - \omega\bar{t}\right)\frac{\gamma L}{2\beta}}^{\pi^{imports\ to\ domestic}_{monopoly\ mark-up}} + \overbrace{\left(\alpha - c_f\right)^2 \frac{(1-\gamma)L}{4\beta}}^{\pi^{foreign\ sales}_{monopoly\ mark-up}} - F - G$$

$$\pi^{dom\ \&\ for\ prod}_{monopoly} = \overbrace{(\alpha - c_d)^2 \frac{\gamma L}{4\beta}}^{\pi^{domestic\ sales}_{monopoly\ mark-up}} + \overbrace{\left(\alpha - c_f\right)^2 \frac{(1-\gamma)L}{4\beta}}^{\pi^{foreign\ sales}_{monopoly\ mark-up}} - F - \overbrace{2G}^{additional\ plant}$$

The agent does not choose the highest of these actual monopoly profits, but he chooses the profits with only visible trade costs which Markusen's explained. The diagram below show the visible profits which the agent optimize from, the actual profits which includes invisible trade costs and optimal profits which includes invisible trade costs which are transformed to visible trade costs.

Figure D.3.j Visible, actual and optimal mark-up profits from the three production localization strategies given relative market size



According to figure *D.3.j*, the strategy with production in both countries is actually more profitable than production in only one country than is visible. The firm chooses strategy from the three visible profit functions resulting in the actual profit functions, instead of choosing strategy from the actual profit function which is difficult to see. Since the firm chooses strategy from the incorrect visible profit function instead of the actual profit function, the firm acts irrationally. The more visible transportation costs become, the closer the visible profit functions and the actual profit functions becomes the optimal profit functions. At the extreme, when all transportation costs are visible, then the visible profit functions, the actual profit functions and the optimal profit functions conform. Therefore my hypothesis is that there is a negative linear relationship between a firm's transports and the profit of that firm.

Since I do not have data of visibility, ω, but I know that any invisibility $(1-\omega) > 0$ cause profits to decrease. If there is such invisibility $(1-\omega) > 0$, quantity will strictly increase due to invisibility, $(1-\omega)$, because

$$\frac{\partial Q}{\partial(1-\omega)} = \frac{tL}{2\beta} \geq 0$$

If there is such invisibility $(1-\omega) > 0$, I should then be able to measure any effect on profit by measuring the transport quantity elasticity of profit, which should be strictly negative

$$\frac{\partial \pi}{\partial Q} \leq 0$$

There may also be other reasons to increase trade than invisibility. One example is production capacity constraints within the continent where the good is sold which could increase the marginal cost, c. Other reasons are change in visible trade costs, ωt. The amount of possible consumers, L, could increase or any other demand parameter α or β could change.

Detail D.4 – Analysis of Theoretical and Empirical Foundations

In this part I will combine and analyze the theoretical and empirical foundations.

I start with time as a trade barrier. Hummels find that for every day a physical good is transported, the buyer of the good is willing to pay a mark-up cost of 0.8 percent of the cost of the good (Hummels 2001, p. 26, Hummels 2007, p. 9). I argue that this is a mark-up which the buyer rationally selects as a best or second best ex-post alternative. The mark-up is calculated from the value of the good and the mode of transport (air or ocean) the buyer actively selects. For example, if a good is transported from a low cost country like China to a high cost country like Sweden, the transportation by ocean carrier takes 6 weeks which equals 42 days. By instead choosing air shipment, the buyer is willing to pay a mark-up which equals the value

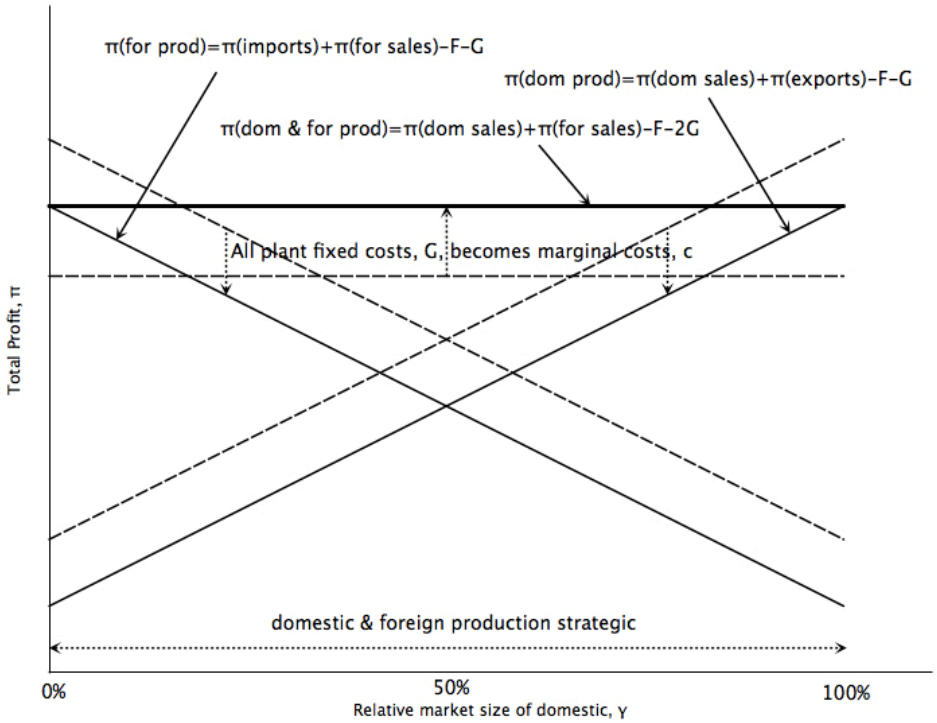
of a 42 day transport, which equals a 33.6 percent mark-up cost of the good purchased.

I continue with the cost break down of typical machining goods produced in Europe and I find that the direct labor is representing only about 21 percent of the value of the good. Even though some of the direct machine production processes can be replaced by direct labor production processes, I find it likely that there is not enough difference in production margins between different continents to cover the marginal transport costs. Thereby a firm should suffer from decrease in profits due to any increased transports. Using activity based cost (ABC) as calculation method a good does not bear any cost which it is not using. For example a good should not bear the cost of overcapacity in a machine which the good does not fully use, since the same machine can be used for creating other goods during the time the machine is not used for the first good. The only time a good bear the cost of overcapacity is if an asset can solely be used for producing the same good, like for example an injection-mold tool for producing a certain plastic good. Kaplan (1999) argues that expenses are fixed only when managers fail to do anything to reduce them. In the case of the specific injection-mold tool, it is impossible for managers to use it for another good, but the injection machine can however be used for any other good. Having no fixed costs would mean that quantities would not matter for average cost or economies of scale. In the case of no fixed costs, the cost of a single good would not change if changing the quantities. Using true ABC calculation, much of what would be classified as fixed costs in traditional meaning, are actually variable costs if they are used by the good. An example is that a factory building is traditionally considered to be a fixed cost, but if using ABC calculation, the good is considered to be produced using a number of production processes of which one uses a machine which in turn uses a certain number of square meters of the factory building. That same good is using the factory building in the production process and therefore needs to bear the cost of the number of square meters, but only for the amount of time the factory floor is used. The good will not bear the cost of any overcapacity in the factory floor space.

In order to justify a cost for being a plant fixed cost, I need to define what types of costs the management cannot reduce, solely due to the fact that there is an extra production plant. It is very difficult to justify a cost to be such plant fixed costs, especially in a very effective industry. I need to ask the question what is needed in addition when having two plants compared to having one plant. The machinery is definitely not fixed and the factory floor space neither. Perhaps a dual lineup of hierarchical organization is needed. However, if volumes would be doubled in the first factory, more personnel would be hired in the hierarchy as well. Looking at goods produced in an effective plant in Europe today, the white collar costs (sales & admin 6.9 percent) is lower than the blue collar costs (direct labor 21 percent). Can it be that plant fixed costs are just a matter of traditional miscalculation? If that would be the case, we would be in a very interesting situation.

The graph below describe what will happen if all plant fixed costs, G, are classified as marginal costs, c, instead. The strategy of producing in both countries will be superior to any other trade strategy. Using ABC-calculation, more plant fixed costs, G, are actually counted as marginal costs, c. ACB calculation is the one calculation which reflects the true cost of a good produced, since the good will not bear any cost from overcapacity. In the flexible manufacturing market of today, where much of the manufacturing is outsourced to suppliers, there should be no need of a good paying for overcapacity, since overcapacity could easily be rent to produce other goods. A good should only bear cost of overcapacity if that certain capacity only can be used from that same good.

Figure D.4.a Profit from the three production localization strategies given relative market size and no plant fixed costs



Firm fixed costs, F, is fixed costs which is not associated to a specific plant, like for example research and development. Firms with high research and development tend to exist on more markets (Markusen 1995b, p. 172). The average cost of a good is decreasing with increasing quantities due to fixed costs. A firm can have large firm fixed costs and therefore might want to increase quantities by selling in multiple geographical markets.

A good can certainly have both firm fixed costs, F, and plant fixed costs, G. I believe that by being restrictive of classifying a cost as a plant fixed cost, G, an optimal strategy of producing in both countries might be more independent of the

relative market size, γ. Of course, the constraints of visibility of transportation costs can be applied to further analyze these strategies.

I continue with analyzing the theory of specialization. Martens prove that there are incentives to specialize in specific subjects, in order for an individual (or firm) to trade specific knowledge with other individuals (or firms). There are incentives to specialize if the cost of specializing is lower than the revenue of specializing. Specialization occurs through a trial-and-error process, when the individual tries by acting and thereafter learn from any errors visible for the individual. If the individual see an error, he tries again by changing strategy and continues like that until he reach a satisfactory level of errors.

However, if the error is not visible for the individual or the cost of specializing seems to be higher than the revenues for the individual, the individual will not specialize. I argue that there are incentives to specialize in most important areas in a firm. However, I argue that a few subjects are extremely costly to specialize in or that the subjects are so complicated that errors cannot be seen by a professional individual. I believe that the total set of costs drivers (interior points) associated with transporting are so spread out in set of the organization and outside the boundary of the organization that the individual cannot have a sufficient view of them. What is more complicated is that the interior points occur at stochastic locations temporally. A decision maker may only see a fraction of costs and relate them to unimportant noise. If the decision maker cannot see the errors which transportation costs create, there is nothing triggering specialization in transportation costs. Alternatively the decision maker sees many errors, but due to the complex and stochastic nature of transportation costs, the decision maker chooses to not specialize in knowledge of transportation costs due to the costs of specializing. Out in the organization, one transportation cost might be seen by one individual at one department at one time, but to never occur again. It is impossible for the individual out in the organization to relate this cost to transportation costs.

If the errors in transportation cannot be seen or if the costs of specializing in transportation costs are exceeding the revenues from specializing in transportation costs, the individual will not specialize in transportation costs.

If the decision maker does not specialize in transportation costs, he might rely on group knowledge, but if all individuals in the group have similar constraints regarding transportation costs, no one in the group will specialize in transportation costs. I include common knowledge about transportation costs and media's picture of transportation costs in the set of group knowledge.

According to Martens' theory, subjects which are known to the public are, for the individual, considered to be group knowledge if the individual does not have specific knowledge in that subject. An example of incorrect group knowledge is the incorrect view of China as the World Factory and incorrect view that it is cheaper to produce goods in China and transport the goods to other continents.

If neither the decision makers nor the group specialize in transportation costs, the firm might act irrationally and invisible transportation costs would then be allowed by the organization.

Another possible constraint forcing the firm to trade is production capacity constraints. If there for example are production capacity constraints in Europe and there is high demand of goods on the same time in Europe, the firm might look for production capacity from other continents.

The gravity models provides empirical findings suggesting that the further away two countries are from each other, the less quantity they trade with each other. This reduction in trade due to distance is a rational choice which decision makers at firms make. The empirical finding can either be pure transportation costs or information costs according to theory. I define transportation costs as both pure transportation cost and information costs. The rational choice which the decision makers do, may be due to the fact that there is a too costly to get information about a distant supplier or it may suggest that there are some kind of specialization in transportation costs in the knowledge system, which would mean that specialization in transportation cost is profitable.

At this point I can define my alternative hypotheses:

Hypothesis $HS1a_{alt}$: The individual decision makers are not specialized in transportation costs

Hypothesis $HS1b_{alt}$: The individual decision makers have not received by them perceived trustworthy group knowledge.

Hypothesis $HS2_{alt}$: The group which the decision maker is included in, does not have full knowledge of transportation costs

Hypothesis $HC1_{alt}$: The individual decision makers are not constrained by production capacity constraints in certain continents, forcing them to source from other continents.

Hypothesis $HT1_{alt}$: Increased intercontinental transportation decreases profits.

My research question is:

Question $W1$: Who gains and who loses from invisible transportation costs?

DETAIL D.5 – METHODOLOGY

There are five hypotheses to be tested and one research question to be answered. The research question is a theoretical question, which has already been answered in the theoretical analysis part.

In this part I develop empirical methods for testing the hypotheses $HS1a$, $HS1b$, $HS2$, $HC1$ and $HT1$.

If the null specialization hypothesis $HS1a_{null}$ is significantly rejected for the alternative specialization hypothesis $HS1a_{alt}$, there are strong proofs that individual decision makers are not specialized in transportation costs.

If the null specialization hypothesis $HS1b_{null}$ is significantly rejected for the alternative specialization hypothesis $HS1b_{alt}$, there are strong proofs that individual decision makers have not received by them perceived trustworthy group knowledge.

If the null specialization hypothesis $HS2_{null}$ is significantly rejected for the alternative specialization hypothesis $HS2_{alt}$, there are strong proofs that group does not have knowledge in transportation costs.

If $HS1_{null}$ and $HS2_{null}$ both are significantly rejected, there are strong proofs that some of the transportation costs may be invisible and thereby according to the theory I developed, some non-optimal quantities of goods may be traded by the firm. Such non-optimal quantity of intercontinental trade, should according to the theory I developed, lead to a negative profit of the firm. I therefore also investigate if firms' profits decrease if intercontinental transports are increased.

If the null transportation hypothesis $HT1_{null}$ is rejected for the alternative transportation hypothesis $HT1_{alt}$, there are strong proofs suggesting that firms' profits decrease as firms' intercontinental transports increase.

If the null production capacity constraint hypothesis $HC1_{null}$ is rejected for the alternative production capacity constraint hypothesis $HC1_{alt}$, there are strong proofs suggesting that firms are not forced to increase transports because of production capacity constraints.

If all of the hypotheses $HS1a_{null}$, $HS1b_{null}$, $HS2_{null}$ and $HT1_{null}$ are significantly rejected, there are strong proofs suggesting that organizations are constrained by its cognitive system making them to not see transportation costs and thereby act irrational and thereby trading non-optimal quantities of goods between continents, leading to an invisible decrease their profits.

D.5.1 Hypotheses HS1a, HS1b and HS2

Are individuals specialized in costs of intercontinental transports or does the group have knowledge in intercontinental transports?

In order to answer these two questions, I will try to map the cognitive system within a normal organization using a survey of questions. I will try to see if most of the individuals within a group are sensitive to group knowledge regarding transportation costs alternatively if most individuals are specialized in transportation cost. It is difficult to measure every individual's specialization setting because of limited degrees of freedom.

However, I can measure the general sensitivity of the group of individuals to deviation in group knowledge. In the survey, I will divide a large group of individuals into three homogenous groups. The groups will have the same questions, but they will have different advance information. The advance information will function as group knowledge. One group will have advance information which is negative to intercontinental transports (N-group). One group will have advance information which is positive to production in low-cost countries (P-group). One group will have no advance information (O-group). I expect the advance knowledge presented for the P-group, to be similar to common knowledge, which is the advance knowledge the O-group have before and during the survey. Therefore I expect the answers from the P-group and the O-group to be similar and that, given general lack of specialization, the answers of the N-group deviate from the answers from the other two groups.

If the answers of the N-group deviate from the answers of other groups in a certain way, both of the null hypothesis $HS1a_{null}$ and $HS1b_{null}$ may be rejected for the alternative hypotheses $HS1a_{alt}$ and $HS1b_{alt}$. Rejecting $HS1a_{null}$ means that individuals are not in general specialized in intercontinental transportation costs. Rejecting $HS1a_{null}$ means that the individuals have not received by them perceived trustworthy group knowledge regarding intercontinental transports. Rejecting $HS1a_{null}$ and $HS1b_{null}$, which can only be done together, means that the individuals are sensitive to my advance information which also is group knowledge.

Rejecting $HS1a_{null}$ and $HS1b_{null}$ are stronger proofs than not rejecting them. Not rejecting $HS1a_{null}$ and $HS1b_{null}$ does not mean that $HS1a_{alt}$ and $HS1b_{alt}$ are not true. The individuals may be unspecialized ($HS1a_{alt} = true$) but having trustworthy group knowledge ($HS1b_{null} = true$), leading to not rejecting $HS1a_{null}$ and $HS1b_{null}$. The individuals may be specialized ($HS1a_{null} = true$) but not receiving group knowledge ($HS1b_{alt} = true$), leading to not rejecting $HS1a_{null}$ and $HS1b_{null}$. What is important to understand is that if both $HS1a_{null}$ and $HS1b_{null}$ are rejected, there are strong proofs that individuals are not specialized and they do not receive sufficient group knowledge regarding intercontinental transportation costs.

If most individuals are not specialized, it does not mean that all individuals are not specialized. One individual may very well be specialized and supply his knowledge to others within the group. However, if $HS1b_{null}$ is rejected, the individuals in general are not receiving the knowledge of the specializing individual, leading to that the individuals cannot trade the group knowledge regarding intercontinental trade. I will also investigate the individuals' reliance of group knowledge quality.

I will also in the survey test the hypothesis that the group has full knowledge of intercontinental transportation costs. First I need to make an assumption about the true intercontinental transport costs, that they are a large part of the cost of the

good. If the group perceives the intercontinental transport costs to be a large or a very large part of the cost of the good, they have full knowledge of intercontinental transportation costs, given my assumption about intercontinental transportation costs. Rejecting $HS2_{null}$ for the alternative $HS2_{alt}$ would give strong proof that the group does not have full knowledge regarding the intercontinental transportation costs. However, my assumption of intercontinental trade costs can be tested with hypothesis HT1.

D.5.2 Hypothesis HC1

I will also, using the survey, test if individual decision makers are constrained by production capacity constraints, by measuring which extent they have decided to source from other continents due to production capacity constraints in Europe.

D.5.3 The survey method for testing HS1a, HS1b, HS2 and HC1

Of ethical reasons, it is important to understand that I am not measuring the cognitive capacity of the individual or the cognitive capacity of the group (firm), but rather the property settings of the cognitive system of the group. In other words, I am not measuring cognitive capabilities of the individuals or the firm, but rather how the group organizes to use its knowledge in an optimum way and how it affects the group's knowledge regarding intercontinental transportation costs.

When I develop the questions for this survey, it is important that they come in sequence where not too much is revealed about expensive transportation costs for all the three groups. The last few of the questions will however for all groups be affected by information regarding costly transports and thereby the later questions might have a lesser explanatory power compared to the earlier questions.

In order to test $HS1a$ and $HS1b$, the interviewees first of all need to have a relatively high probability of seeing transportation cost structure. The survey will be answered by individuals who I believe have a relatively high probability of directly and indirectly seeing intercontinental transportation costs. A relatively high probability does not necessarily mean a high probability. If a subject is extremely costly to specialize in or if the residual uncertainty ex-post is invisible, there is overall a low probability of seeing intercontinental transportation costs. An example of an individual with low probability of directly or indirectly seeing transportation costs is a CEO or an investor. In the survey I will measure how large part of the individuals which are decision makers regarding sourcing location. If the individuals are decision makers, it can be assumed that they have a relatively high probability of seeing transportation costs. I select purchasers of firm A to the interviewees (Anonymous Purchasers 2010).

The questions regarding decision makers are:

Question	Q1: Who makes the official decision regarding which supplier your firm chooses? Q2: Who influence directly or indirectly the decision maker's choice of supplier? Q3: Who influence directly or indirectly the strategy of which continent to source from?

The purpose of the questions is to identify the interviewees as decision makers and thereby verify that the interviewees have a relatively high probability of seeing transportation costs.

I also need to measure the extent which the individuals trade with other continents.

Question	Q4: Do you often buy articles from other continents?

In order to test $HC1$, I need to measure if the individuals trade only due to production capacity constraints in a certain continent. This is done by letting one of the answers of Q4 imply that intercontinental trade is due to capacity constraints.

I will also measure actual problems with trade, which is done with a series of questions.

I will also test HS1a, HS1b, HS2 by measuring the specialization setting. I will do this mainly by treating the three groups of interviewees with different advance information regarding costs of intercontinental transports. I will measure if there is any treatment effect by using micro econometric techniques often used in medicine research and labor program evaluations.

Question	Q5: Do goods which are sourced all over the world have homogenous cost structure?
Purpose	This is the first specialization question. The only group treated with transportation costs at this point is the group who got negative advance information regarding intercontinental trade (N-group). The group who got positive advance information regarding intercontinental trade (P-group) and the group who got no advance information regarding intercontinental trade (O-group) have not got any information regarding the visible or invisible transportation costs. The purpose of this question is to see if the answers differ between the groups.
Expectation	I expect a lower proportion of the N-group relative to the other groups, to perceive it to be cheaper to produce in low cost countries.

Question	Q6: How do you get information regarding the cost structure in different parts of the world (for example Eastern Europe or China)?

Purpose	This question estimates if the individual purchasers specialize in differences in costs in different continents or if the purchasers use group knowledge.
Expectation	I expect the purchasers to use group knowledge, since I assume it to be very costly for the individual to estimate all type of costs that follows intercontinental trade, for example transportation costs or information costs (artikel med immateriell handel).

Question	Q7: Do you treat all transportation costs when you choose suppliers or negotiate with suppliers?
Purpose	Specialization question. This is the first question where P-group and O-group gets treated with transportation costs. From this question and the remaining questions, all groups have thought of transportation costs.
Expectation	I expect more of the N-group to answer that they do not calculate transportation costs, due to that the N-group are treated with visible and invisible transportation costs in the advance information. I expect the P-group to be more certain about transportation costs, since they have a simplified picture given assumption of complex visible and invisible transportation costs. Since the P-group is more certain about the costs, I expect them to reply that they include all types of transportation costs. I expect the answers of the N-group to be more spread out than the P-group, since the N-group got complex advance information. I expect the O-group to rely on group common knowledge and therefore also have similar results as the P-group, since I expect that the advance information I give is common knowledge used by O-group.

Question	Q8: How do you perceive the total cost of transports between two continents for you firm in general?
Purpose	Individual specialization. If answers differ between the groups, the purchasers use individual specialization, since they rely on the advance information which can be considered as group knowledge.
Expectation	I expect the answers of the groups to differ. I expect N-group to think that transportation is a larger part of the total article cost than the other groups.

Question	Q9: How do you perceive the complexity in calculating the cost of transports between continents?
Purpose	This is a very important specialization question. If the results between the groups differ in this question, it may be so that the purchasers do not specialize in transportation costs, because the purchasers are in such case affected by the advance information which can be considered as group knowledge.
Expectation	I expect a higher density of the N-group to answer that it is quite or very difficult to calculate transportation costs than the other groups.

Question	Q10: How do you believe that your colleagues perceive the total cost of transports between continents for your firm generally?
Purpose	Specialization question. The purpose of this question is to see the individual purchasers' perception of group knowledge. The individual purchaser may use the group knowledge if the purchaser perceives the group knowledge as rational or if the purchaser perceives the group knowledge as irrational at the same time as group pressure is present. I am also comparing the result from Q8, to analyze any deviation of individual specialization knowledge from perception of group knowledge.
Expectation	I do not have any expectations from this question. If there is deviation between individual specialization knowledge and group knowledge, the purchasers may have incorrect perception about the group knowledge. The purchasers may, in order to simplify its relation with the group, use its perceived group knowledge when choosing strategy.

Question	Q11: How do you perceive media's perception of the sum of all costs to purchase from low cost countries?
Purpose	The purpose of this question is the same as Q10, but with media as group instead of the nearest colleagues?
Expectation	I expect the same result as in Q10.

Question	Q12: Do you have enough time resources to analyze costs?
Purpose	This is both a specialization question and a question to analyze constraints of time resources among the purchasers.
Expectation	I do not have any expectation regarding if the purchasers generally have enough time to analyze costs. I expect a lower density of the N-group to perceive that they have enough time to analyze costs, since they are treated with complicated advance information.

Question	Q17: Do you think that your firm should import more from low cost countries?
Purpose	Specialization question. The purpose is to see if there is any difference between the groups. If there is any difference, the individuals might be affected by advance information, which can be considered as group knowledge, suggesting that the purchasers do not specialize in transportation costs. However, since all groups have been treated with almost all kinds of information; advance information, costs, delays and damages, at this point, there may be little difference between the groups advance information. The information value of this question may thereby be very low.

Expectation	I expect that the N-group is less willing to import from other continents. However, all groups have been treated with almost identical advance information and thereby the information value in this question may be low.

I also need information about the individuals experience to see if the groups have homogeneous distributions of expectations. If the groups would have heterogeneous distributions of experience, the answers might be biased.

Question	Q18: How long have you worked at the purchasing department?
Purpose	Not a specialization question. The purpose of the question is to have information about the respondents.

I find six main purposes with the survey:

a) measuring individual specialization regarding intercontinental trade versus reliance of group knowledge regarding intercontinental trade
b) identifying the decision makers of sourcing location
c) measuring capacity constraints of production
d) measuring the activity of trade between continents
e) understanding actual problems caused by intercontinental trade
f) measuring constraints of the cognitive system of the organization.

I believe that all of the hypotheses $HS1a$, $HS1b$, $HS2$ and $HC1$ can be tested with these questions.

To test the specialization hypotheses $HS1a$ and $HS1b$, I need to measure the treatment effect of my advance information as is group knowledge.

D.5.4 Hypothesis HT1

If both $HS1_{null}$ and $HS2_{null}$ are rejected, there are strong proofs that there are invisible trade costs. If such trade costs would be invisible for the individual, an un-optimal quantity would be traded between the continents, resulting in an invisible decrease of profits. If $HC1_{null}$ is rejected, there are strong proofs that the individual decision makers are not restricted to increase imported quantity from other continents, due to production capacity constraints.

$HT1$ is an important hypothesis to test. Testing the hypothesis $HT1$, if a firm's intercontinental trade of goods reduces the profit of a firm, is very central of this thesis. The alternative hypothesis can be significantly tested and the effect of invisible trade costs has on profit is important to measure. The outcome of the $HT1$ test may also strengthen the proofs of $HS1$, $HS2$, $HC1$.

D.5.5 The method for testing HT1

To be able to test the hypothesis $HT1$ I need observations of firms over time. Different firms invest differently in production and sales in different continents at different times. Since firms change its production and sales at different times, it is possible to compare these firms at the same time-unit, to see if firms that transport less between production and sales do worse or better than firms that transport more.

Even though every firm differs temporally in their spatial location of production (Figure B.1.c and B.1.h i-iii) and sales (Figure B.1.c and B.1.i i-iii), some common trends can be exposed. I find that many Swedish firms exported from Sweden already in the 1970's and 80's. In the 90's and the 00's Swedish firms increased international production through different kinds of foreign direct investments and sourcing. To capture a period where most firms produced and sold most of its goods in Sweden and a period where many firms started to produce and sell across continents, I need to include 1970's, 80's, 90's and the 2000's. To be able to find data for these firms I need to go through all these firms' annual reports to find variables of employees, sales, and operating income.

Individual firms differ in their timing of exports and FDI's. I measure the effect between two variables; operating margin (profit), intercontinental trade. By creating a two-way panel where one dimension is time and one dimension is firm, it is possible to control for time unobserved effects and firm specific unobserved effects. Time unobserved effects can be business cycles. Firms specific effects can be different industries, different corporate cultures. The time periods I need are those where the Swedish firms produce mostly in Europe and those where some Swedish firms moved some production abroad.

I do not have data of visibility, ω, for firms over time, but I did reject $HS1a_{null}$ and $HS1b_{null}$, suggesting that such invisibility exists. I know that any invisibility $(1-\omega)>0$ cause profits to decrease due to non-optimal quantities traded between continents. If there is such invisibility in transportation costs $(1-\omega)>0$, I should be able to measure it by measuring the transport elasticity of profit, since I have both profit, π, data and quantity traded, q, data.

The transportation elasticity of profit is

$$\frac{\partial \pi}{\partial q} \leq 0$$

I define the transport elasticity of a firm's profit as the percentage change in a firm's profit over the percentage change in transports:

$$\varepsilon_{transport} \equiv \frac{\frac{\Delta \pi}{\pi}}{\frac{\Delta q}{q}} = \frac{\Delta \pi}{\Delta q} \times \frac{q}{\pi}$$

The definition of elasticity is variable, depending on the values taken by q and π.

The variables

I need a profit measure which is as close as possible to operations, because transports are an operating event and not a financial event. Even though operating profit affects financial profits.

I will use operating margin, π, as profit

$$\pi \equiv \frac{Operating\ Income}{Sales}$$

Transports q is a function

$$q_{i,t}(p_c, s_c) \equiv \sum_{c=1}^{C} \max\left(p_{c,i,t} - s_{c,i,t}; 0\right)$$

of continental share of production and continental share of sales. Continental share of total sales is defined as $s_{c,i,t} = \frac{s_{c,i,t}}{s_{total,i,t}}$.

Continental share of production p_c is a function

$$p_{c,i,t}\left(\frac{e_{c,i,t}}{e_{total,i,t}}, \frac{a_{c,i,t}}{e_{total,i,t}}\right) \equiv \frac{p_{c,i,t}}{p_{total,i,t}} \approx \frac{e_{c,i,t} - a_{c,i,t}}{e_{total,i,t}},$$

of continental employees and continental administrative employees. Employee data is the best estimation variable I could find for estimating where the firm, i, produce goods for a given time period, t. I assume that if a firm increases its number of employees in a continent, it also produce more goods in that continent.

To make the number of employees a good measure for production, I adjust the number of employees by removing the employees working with non-production. Non production employees are employees working with administration, sales, marketing, R&D, logistics, service etc.

Since firms produce some goods by themselves and purchase other goods, I need to include the firm's purchaser staff as employees in production. I assume that the ratio of purchasing staff per continent to total staff per continent for a firm at a given time is constant over all continents.

$$\frac{purchasing_{c,i,t}}{producing_{c,i,t} + purchasing_{c,i,t}} \cong \frac{purchasing_{d,i,t}}{producing_{d,i,t} + purchasing_{d,i,t}} \quad (c \neq d)$$

A problem with bias in the production variable can occur if a firm purchases all or almost all goods. In those cases I need to check so that the production variable is reasonable. However, most of the firms produce most of the goods themselves and I believe that according to the central limit theorem any small bias will cancel out

and that the estimated parameter will be asymptotically unbiased as N=826. What I am interested in is how the firms' continental movements in production and sales given a time-period affect the profit.

Continents may have different marginal cost of production and different marginal revenue from sales and that differences in margins may affect the profit. Therefore I control for in the regression for the continental share of world sales, $s_{c,i,t}$, as is quantity and continental share of world production, $p_{c,i,t}$, as is quantity (Benston 1966).

The Regression Model

I am interested in the effect of transports on profit. Since I want to compare changes in transports over time I will use many time periods, t, and many firms, i. The operating margin, π, will thereby be measured at time periods, t, and between many firms, i

$$\pi_{i,t} \equiv \frac{Operating\ Income_{i,t}}{Sales_{i,t}}$$

I thereby define the quasi-linear relationship in this regression model

$$\pi_{i,t} = \beta_0 + \overbrace{\beta_1 * \sum_{c=1}^{5} max(p_{c,i,t} - s_{c,i,t}; 0)}^{1\ transport\ parameter} + \overbrace{\sum_{d=1}^{4}\sum_{c=1}^{3} \beta_{(c;d)} * s_{c,i,t}}^{4\times3\ margin\ parameters} + \overbrace{\sum_{d=1}^{4}\sum_{c=1}^{3} \beta_{(c;d)} * p_{c,i,t}}^{4\times3\ margin\ parameters} + \overbrace{\sum_{i=1}^{24} \beta_{(f)} * d_i}^{24\ firm\ dummies} + \overbrace{\sum_{t=1}^{39} \beta_{(t)} * d_t}^{39\ year\ dummies} + \varepsilon_{i,t}$$

D.5.6 Data

I will use a survey for testing $HS1a$, $HS1b$, $HS2$, $HC1$. The survey has a number of questions which decision makers regarding international transports will answer. The questions are divided into; determination of who is the decision maker, specialization of transportation costs, accuracy of group knowledge regarding transportation costs, actual problems with transports. In order to test specialization the interviewees will be divided into three groups with different advance information; no advance information (O-group), advance information which is negative to intercontinental trade (N-group), advance information which is positive to intercontinental trade (P-group).

I will use annual report data in order to test hypothesis $HT1$. The annual report data has for every firm and for every time period, information about operating margin, sales per region and employees per region. I will from the sales per region data create a continental share of world sales variable. I will from the employees per continent create continental share of world employees variable. From the continental share of world employees variable, I will by removing by me assumed administrative personnel, create a continental share of world employees used in production, which I use as an instrument for continental share of world production. Since I have continental share of world sales and continental share of world employees, I create a continental exports variable (one per five continents), which is continental share of world production excess continental share of world sales. From the sum of the five continental exports variables I create world transports variable. I may argue that employees are not a good instrument of production. However, any measurement error in continental share of world production is evened out since I have many firms and time periods.

I use annual reports of 26 good providing firms between 1970 and 2008. Most of the firms are Swedish or at some extent Finnish. From the annual reports I use data from the consolidated group's; operating income, total sales, sales per continent, employees per continent.

The data source must have these characteristics:

a) Since I analyze firms' development from 1970 until 2008, the data source must contain all annual reports of all firms
b) The data source must have continental employee data
c) The data source must have continental sales data
d) The data source must have operating income and total sales
e) The employee data, the continental sales data, the operating income data and the total sales data must represent the same firm

Unfortunately, digital databases of annual reports fail all of the requirements above. Regarding requirement (a), in most digital data sources, data is not present for firms as far back as 1970. Most of the firms in digital data sources do not have data as far back as 1980. Regarding requirement (b), employee data is even more limited and unreliable in digital data sources. Regarding requirement (c), digital data sources have dispersed continental sales data. Some years it is present, others not. Operating income and total sales data is present in every existing annual report in conformity with requirement (d). However since requirement (a) is not satisfied, (d) is also violated. Digital data sources also violate requirement (e), since they alter operating income and sales for comparability over time, when a merger, acquisition or divestment occur. If only operating income and sales is adjusted in the data for example due to a divestment, and not number of employees per continent, the variables do not represent the same firm.

In order to fulfill requirement (a) to (e), I need to use printed versions of annual reports. Printed versions of annual reports certifies that every variable in every observation represent the same firm. For example if one variable is representing a merge between two companies and the other variable is representing one of the merged firms, I will have problems. Printed versions are not altered due to a merge between two firms and thereby all variable from the same observation represents the same firm.

Most of the printed annual reports have both continental employee data and continental sales data. Observations that are missing the variables continental employee data or continental sales data, is quite easy to estimate. Missing variable data are relatively few, and any error in an individual estimation will not affect the parameter since the parameter will be asymptotically correct due to a large amount of firms and a large amount of time periods. All existing annual reports have data of operating income and total sales. All annual reports have variables which are not adjusted for acquisitions or divestments and thereby all variables represents the same consolidated firm, given an individual observation.

Some firms do not have annual reports of some periods available for the public, as for instance firms that are not public during those periods. For example the firm Esselte was acquired in July 2002 by a private firm, and therefore Esselte became private as well and did not publish annual reports anymore. However, every Swedish limited company, public or private, must apprize annual reports to Bolagsverket (Swedish Companies Registration Office) and from there I can get annual reports for Esselte for the period 2002 until 2008. Another firm, BRIO did an IPO in 1984 and therefore no data is available before 1984.

Since some firms do not have annual reports for certain years, I need to make different estimation periods in order to make the panel data balanced. I use four panels with different estimation periods; 1970-2008, 1970-1998, 1984-2005, 1993-2008, 1996-2008 (*Table B.1.k*).

Detail D.6 – Analysis of Empirical Results

Detail D.6.1 – Analysis of Empirical Results from Specialization tests

There are six main purposes of the interview; (a) measuring individual specialization regarding intercontinental trade versus reliance of group knowledge regarding intercontinental trade, (b) identifying the decision makers of sourcing location, (c) measuring capacity constraints of production, (d) measuring the activity of trade between continents, (e) understanding actual problems caused by intercontinental trade, (f) measuring constraints of the cognitive system of the organization.

Decision Maker

My investigation suggests that the purchasers are part of the decision making process regarding the choice of sourcing location. Since the purchasers are decision

makers regarding sourcing location, I assume that their work task partly or fully covers trade and the cost which trade causes. Since the purchasers work task at least partly covers trade costs, there is a higher probability that such trade costs are visible for the purchaser than for an individual not working with trade. An example of an individual not working directly with trade is a CEO or an equity investor. I believe that the purchasers may the individuals with highest probability to see the overall cost structure of a purchasing decision, including intercontinental trade costs. However, the highest probability does not necessarily mean high probability. Remember that I assume the trade costs to be very complex and difficult to see and that I assume much of the trade cost to be invisible.

If trade costs are ex-ante or ex-post invisible, there will be a decision error not seen by the individual. If the error is not seen ex-ante or ex-post, the specialization process will not be triggered according to Martens. If the error is seen, but the relative learning cost is perceived to be higher than the relative learning revenue, the specialization process will also not be triggered.

The empirical finding of my interview is that the interviewees are decision makers regarding intercontinental trade and that they also have the highest probability of seeing a trade cost (an error) and thereby a higher probability activating a process of estimating cost of learning about intercontinental trade costs.

Question	Q1: Who makes the official decision regarding which supplier your firm chooses?	
Type	(b) Decision maker.	
Purpose	Identifying the decision makers of the sourcing location. Not a specialization question.	
Analysis	The purchasers perceive that "myself, my manager, higher manager" makes the official decision regarding the choice of supplier.	
Answers	Me	**34.1%**
	My manager	**27.3%**
	Higher manager	**36.4%**
	Other strategy department	
	External consultants	
	Other	

Question	Q2: Who influence directly or indirectly the decision maker's choice of supplier?
Type	(b) Decision maker.
Purpose	Identifying the decision makers of the sourcing location. Not a specialization question.
Analysis	The purchasers perceive that the purchasers themselves, through influence, decide regarding the choice of supplier. This is an important finding. The finding may suggest that the purchasers' work most probably, not only fully or partly covers transportation, but also that the purchasers are decision makers regarding the sourcing of the firm. Therefore the purchasers are individuals or group of individuals with relatively high probability of seeing any transportation cost that may be unseen by others.

Answers	Me	**70.5%**
	My manager	
	Higher manager	
	Other strategy department	
	External consultants	
	Other	

Question	Q3: Who influence directly or indirectly the strategy of which continent to source from?
Type	(b) Decision maker.
Purpose	Identifying the decision makers of the sourcing location. Not a specialization question.
Analysis	Regarding the continent, the purchasers still influence the decision. However, the higher managers have more influence on the strategy of which continent to source from, than the choice of European supplier.

Answer	Me	**56.8%**
	My manager	
	Higher manager	**36.4%**
	Other strategy department	
	External consultants	
	Other	

Information regarding Trade Activity and Production Capacity Constraints

The anonymous firm does not purchase much from other continents. A large part of the purchasers purchase from within Europe. Most of the purchasers purchase very seldom from other continents. The intercontinental trade activity is quite low in this firm. This may be because that the visibility of intercontinental trade costs is high, which may argue against my expectations. Remarkable is that no one is sourcing from other continents due to capacity constraints within Europe. This makes me reject the null hypothesis $HC1_{null}$ for the alternative hypothesis $HC1_{alt}$. It seems fairly reasonable that a whole continent cannot be that constrained in production capacity since the supply of production capacity in Europe is quite large.

Question	Q4: Do you often buy articles from other continents?
Type	(d) Trade activity information. (c) Production capacity constraints information.
Purpose	Estimating capacity constraints in Europe and estimating relative quantities of intercontinental trade. Not a specialization question.

Analysis	It was surprising to me that no purchaser at all has replied that they choose to purchase from other continents than Europe because of capacity constraints. Sourcing from other continents, given assumption of profit loss due to visible and invisible trade costs, can be because of actively chosen strategy combined with constraints within the cognitive system of the group. Most of the purchasers answered that they sometimes or almost never purchase from other continents than Europe. This can, given assumption of high transportation costs, suggest that such transportation costs are visible.	
Answer	No, almost never	34.1%
	Only when capacity constraints in Europe	**0.0%**
	Sometimes from other continents	**47.7%**
	Often from other continents	
	Other	

SPECIALIZATION

By doing this research, I can with a specialization test, see if the individual purchasers rely on group knowledge ($HS1a_{alt} = true$ and $HS1b_{alt} = true$) which I treat them with, or if the individual purchasers have specialized in the trade cost subject ($HS1a_{null}$ not rejected) or if the purchasers already have perceived reliable group knowledge ($HS1b_{null}$ not rejected), leaving them unaffected by my treatment. If the purchasers rely on group information, I assume that they will be affected by the advance information which I treat them with. To see if they are affected, I divide the purchasers into three groups with similar distribution of work experience and work tasks. One of the groups has no advance information (O-group). One of the groups has advance information which is positive to intercontinental production (P-group). I assume people in general (O-group) are positive to intercontinental trade, since people in general may perceive relative cost savings from sourcing from low-cost countries. Therefore I assume the O-group and the P-group to not differ so much. For the O-group and the P-group, the trade costs are not treated (revealed) until late in the question sequence.

The last of the groups has advance information which is negative to intercontinental transports (N-group), since of high trade costs.

If individuals rely on group knowledge, they rely on outside information like my advance information and thereby there are affected by the advance information. If individuals specialize in trade costs, they are independent of group knowledge and thereby independent of the outside advance information and thereby not affected by the advance information. Depending on how the groups differ in answers, the individuals can be seen as specializing in trade costs or relying on group knowledge.

One of the foundations of my thesis is that I assume that the intercontinental trade costs are high relative to production costs. If the purchasers rely on group knowledge, I assume that there is something hindering the purchasers to specialize in trade costs. Perhaps any decision errors of the individuals are not visible ex-ante or ex-post. Perhaps any decision errors of the individuals are visible for the same

individuals, but the specialization cost (learning cost) is perceived to be much higher than the specialization revenue.

The empirical finding of my research is that groups differ in their answers, which suggests that the individuals respond to my treatment and that they rely on my advance information, as is group knowledge. Since they rely on my group knowledge, I reject the null hypothesis $HS1a_{null}$ for the alternative hypothesis $HS1a_{alt} = true$, which means that the individuals are not specialized. Also since they rely on my group knowledge, I reject the null hypothesis $HS1b_{null}$ for the alternative hypothesis $HS1b_{alt} = true$, which means that the individuals have not received by them perceived reliable group knowledge, which would leave them unaffected by treatment. The most important question, Q9, which asks about the complexity of calculating trade costs, the N-group deviates strongly from the other groups. The average treatment effect on Q9 is $+43$ percent and significant and the experience is insignificant, which means that the treatment affects the perceived complexity of calculating transportation costs between continents. The answer of Q6, suggests that the purchasers rely on the group knowledge as the main information source. The answer of question Q7 and Q9 suggests that the N-group perceive the complexity of calculating transportation more complex than the other groups does. The answers of question Q8, Q10 and Q11 suggests that the N-group differs from the others by perceiving transportation costs to be a larger part of the total costs and that the individuals themselves see costs that the group does not see, even though they are part of the group themselves. The answers from the control group in Q8 suggests together with the rejection of $HT1_{null}$, that I reject the null hypothesis $HS2_{null}$ for the alternative hypothesis $HS2_{alt}$. Q12 suggests that the purchasers does not specialize since the N-group see more complexity in calculating costs than the others. Surprising to me was that question Q5 is not in line with my theory, since a higher density of the N-group thinks it is cheaper to source from low-cost countries. The last specialization question Q17 occurs in the sequence after questions with transportation problems, and thereby all groups can be considered to have similar advance information. The answers of question Q17 are similar for all groups, which can be expected after similar advance information. The P-group is slightly more negative to sourcing from low-cost countries which would not be in line with my expectations.

All in all, the answers support my theory that there is nothing triggering the purchasers into specializing in intercontinental trade costs and thereby I reject the null hypothesis $HS1a_{null}$ for the alternative hypothesis $HS1a_{alt}$. The same answers support my theory that there is no group knowledge which is perceived to be reliable by the individuals and thereby I reject the null hypothesis $HS1b_{null}$ for the alternative hypothesis $HS1b_{alt}$. Purchasers have high work load and it may be too costly for them to analyze details. Also it may be questionable if the purchasers see all trade costs (errors), since they occur stochastically at different locations at different times within the organization.

If all purchasers have a very limited specialization in intercontinental trade costs, much of the intercontinental trade costs will be invisible. I assume that for decision makers like an investor or a CEO, specialization in intercontinental transportation costs must be lower than for a purchaser.

Question	Q5: Do goods which are sourced all over the world have homogenous cost structure?
Type	(a) Individual specialization.
Purpose	This is the first specialization question. The only group treated with transportation costs at this point is the group who got negative advance information regarding intercontinental trade (N-group). The group who got positive advance information regarding intercontinental trade (P-group) and the group who got no advance information regarding intercontinental trade (O-group) have not got any information regarding the visible or invisible transportation costs. The purpose of this question is to see if the answers differ between the groups.
Expectation	I expect a lower proportion of the N-group relative to the other groups, to perceive it to be cheaper to produce in low cost countries.
Analysis	It was surprising to me that a higher amount of N-group sample perceived it to be cheaper to source from low-cost countries, relative to the other groups. The average treatment effect is insignificant and the experience is insignificant, which means that the there is no strong proof that the treatment affects the perception of differences in cost over the world.

Answer

	N-group	*O-group*	*P-group*
I perceive it as much cheaper for my firm to buy from low cost countries	**37.5%**	20.0%	29.4%
Generally speaking costs are homogeneous, however in some continents the prices differ	31.3%	**40.0%**	23.5%
Costs are roughly similar, including all costs	25.0%	**30.0%**	**35.3%**
Other			

	Coeff	p-val (Std err)	p-val (Std err) BS(50)
Treatment effect, $\Delta(D_i)$	-.121	0.258 (.105)	0.309 (.119)
Experience, $\beta(X_i)$			
Interaction effect, $\gamma(D_i X_i)$			
Intercept	.432	0.000 (.063)	0.000 (.060)

Question	Q6: How do you get information regarding the cost structure in different parts of the world (for example Eastern Europe or China)?

Type	(a) Individual specialization. (a) Group knowledge.
Purpose	This question estimates if the individual purchasers specialize in differences in costs in different continents or if the purchasers use group knowledge.
Expectation	I expect the purchasers to use group knowledge, since I assume it to be very costly for the individual to estimate all type of costs that follows intercontinental trade, for example transportation costs or information costs (artikel med immateriell handel).
Analysis	In line with my expectations, most of the purchasers use group knowledge. I believe that it is very costly for the purchaser to analyze the costs by specializing in the area and that it is perceived by the purchasers that the revenue from such specialization is much lower than the costs. It is thereby, given the cost versus revenue information, rational by the purchasers to not specialize in intercontinental sourcing costs.
Answer	It is common knowledge (group) I analyze by myself (individual) I use my experience (individual) I often talk to my colleagues (group) I often get information from another department who calculate costs (group) I often get information from media (Dagens Industri etc) (group) I look at how other firms have done (group) I get information from my firm regarding this (group) Other Individual: **28.6%** Group: **66.7%**

Question	Q7: Do you treat all transportation costs when you choose suppliers or negotiate with suppliers?
Type	(a) Individual Specialization.
Purpose	Specialization question. This is the first question where P-group and O-group gets treated with transportation costs. From this question and the remaining questions, all groups have thought of transportation costs.
Expectation	I expect more of the N-group to answer that they do not calculate transportation costs, due to that the N-group are treated with visible and invisible transportation costs in the advance information. I expect the P-group to be more certain about transportation costs, since they have a simplified picture given assumption of complex visible and invisible transportation costs. Since the P-group is more certain about the costs, I expect them to reply that they include all types of transportation costs. I expect the answers of the N-group to be more spread out than the P-group, since the N-group got complex advance information. I expect the O-group to rely on group common knowledge and therefore also have similar results as the P-group, since I expect that the advance information I give is common knowledge used by O-group.
Analysis	The answers are in line with my expectations. Most of the P-group perceive that they include all transportation costs in their calculations. Most of the N-group claims that they do not calculate transportation costs or that they only calculate transportation costs a few times. Most of the O-group answer that they calculate transportation costs only a few times.

Answer		*N-group*	*O-group*	*P-group*
	No, transportation costs are so low that they do not matter so much			
	No, the logistics department is handling transports	33.3%		
	Rarely I treat transportation prices from the supplier	26.7%	**60.0%**	
	Mostly I treat transportation prices from the supplier			
	Yes, I include all kinds of costs (prices from the carrier and so on)	**20.0%**		**58.8%**
	Other			

Question	Q8: How do you perceive the total cost of transports between two continents for you firm in general?
Type	(a) Individual Specialization.
Purpose	Individual specialization. If answers differ between the groups, the purchasers use individual specialization, since they rely on the advance information which can be considered as group knowledge.
Expectation	I expect the answers of the groups to differ. I expect N-group to think that transportation is a larger part of the total article cost than the other groups.
Analysis	Unfortunately, a large part of the N-group answered 'Other', which makes it difficult to analyze. Perhaps the N-group see it as more complex to answer the question than the other groups. The answers of the P-group and the N-group are not in line with my expectations, since the P-group, O-group and the N-group answer nearly the same. However, the N-group has many answering 'Other', which can be because they see it as more complex to answer the questions than the other groups. If half of the 'Other' would become for example 'transportation is a large part of the total article cost', the N-group would be significantly different from the other groups. Also the N-group has fewer answers on the question 'transportation is a small part of the total article cost', which together with the 'Other' answers, could be considered as if the N-group would differ from the other groups, which would be in line with my expectations. The average treatment effect and the interaction effect are both significant and $\frac{0.292-0.315X_i}{0.447} = +65\% - 70\%X_i$, where $X_i = 1$ if the individual has more than 10 years of experience. I conclude that the treatment affects the perceived total cost of transports between continents and that the more experienced purchasers are less affected by treatment and perhaps more specialized in transports than the inexperienced. The answers of the O-group and the P-group gives some proofs that the group does not have full knowledge in transportation costs, given that my assumption about that intercontinental transportation costs are a large part of the purchasing price. Further in the analysis of the empirical results from trade tests, I reject the null hypothesis $HT1_{null}$ for the alternative hypothesis $HT1_{alt}$, which proves that intercontinental transports at some extent has invisible costs, which results in non-optimal quantities traded which causes the profits to decrease. Together with the rejection of $HT1_{null}$, the proofs that the group does not have full knowledge of transportation costs between continents makes me also reject the null

hypothesis $HS2_{null}$ for the alternative hypothesis $HS2_{alt}$.

Answers

	N-group	*O-group*	*P-group*
As a very large part of the purchasing price			
As a fairly large part of the purchasing price	33.3%	20.0%	35.3%
As a fairly small part of the purchasing price	40.0%	**60.0%**	47.1%
As an obscure part of the purchasing price			
Other	**26.7%**		

	Coeff	p-val (Std err)	p-val (Std err) BS(50)
Treatment effect, $\Delta(D_i)$	.292	0.113 (.180)	0.009 (.112)
Experience, $\beta(X_i)$	.120	0.443 (.156)	0.528 (.191)
Interaction effect, $\gamma(D_i X_i)$	-.315	0.238 (.263)	0.133 (.210)
Intercept	.447	0.000 (.106)	0.000 (.125)

Question: Q9: How do you perceive the complexity in calculating the cost of transports between continents?

Type: (a) Individual specialization.

Purpose: This is a very important specialization question. If the results between the groups differ in this question, it may be so that the purchasers do not specialize in transportation costs, because the purchasers are in such case affected by the advance information which can be considered as group knowledge.

Expectation: I expect a higher density of the N-group to answer that it is quite or very difficult to calculate transportation costs than the other groups.

Analysis: The result is in line with my expectation. A higher density of the N-group, relative to the other groups, answer that it is quite or very difficult to calculate the total transportation costs. Since the answer density between the groups differs, the purchasers may be affected by the advance information. Advance information can be considered as group knowledge and thereby the purchasers does not rely on individual specialize in transportation costs. The average treatment effect is $\frac{0.207}{0.481} = +43\%$ and significant and the experience is insignificant, which means that the treatment affects the perceived complexity of calculating transportation costs between continents.

Answer

	N-group	*O-group*	*P-group*
As very difficult	**26.7%**		
As fairly difficult	**40.0%**	**30.0%**	**47.1%**
As fairly easy		**60.0%**	**29.4%**
Very easy, just ask the carrier			
Other			

	Coeff	p-val (Std err)	p-val (Std err) BS(50)
Treatment effect, $\Delta(D_i)$	.207	0.036 (.095)	0.001 (.060)

	Experience, $\beta(X_i)$			
	Interaction effect, $\gamma(D_i X_i)$			
	Intercept	.481	0.000 (.057)	0.000 (.053)

Question	Q10: How do you believe that your colleagues perceive the total cost of transports between continents for your firm generally?
Type	(a) Group knowledge.
Purpose	Specialization question. The purpose of this question is to see the individual purchasers' perception of group knowledge. The individual purchaser may use the group knowledge if the purchaser perceives the group knowledge as rational or if the purchaser perceives the group knowledge as irrational at the same time as group pressure is present. I am also comparing the result from Q8, to analyze any deviation of individual specialization knowledge from perception of group knowledge.
Expectation	I do not have any expectations from this question. If there is deviation between individual specialization knowledge and group knowledge, the purchasers may have incorrect perception about the group knowledge. The purchasers may, in order to simplify its relation with the group, use its perceived group knowledge when choosing strategy.
Analysis	The individual purchasers perceive that the group has different knowledge than the purchasers themselves.

Answer	*All*
As a very large part of the purchasing price	
As a fairly large part of the purchasing price	
As a fairly small part of the purchasing price	**66.7%**
As an obscure part of the purchasing price	
Other	

Question	Q11: How do you perceive media's perception of the sum of all costs to purchase from low cost countries?
Type	(a) Group knowledge.
Purpose	The purpose of this question is the same as Q10, but with media as group instead of the nearest colleagues?
Expectation	I expect the same result as in Q10.
Analysis	The result is same as in Q10.

Answer		*All*
	Large relative to the cost to purchase from Europe	
	Small relative to the cost to purchase from Europe	**76.2%**
	Other	

Question	Q12: Do you have enough time resources to analyze costs?
Type	(a) Individual Specialization. (f) Cognitive Constraints of the Organization.
Purpose	This is both a specialization question and a question to analyze constraints of time resources among the purchasers.
Expectation	I do not have any expectation regarding if the purchasers generally have enough time to analyze costs. I expect a lower density of the N-group to perceive that they have enough time to analyze costs, since they are treated with complicated advance information.
Analysis	In general, the purchasers perceive that they have, at least sometimes, enough time to analyze costs. The N-group deviated as I expected from the other groups, since the N-group has a lower density of purchasers perceiving to have enough time. The average treatment effect is insignificant and the experience is insignificant, which means that the there is no strong proof that the treatment affects the perception of time constraints. However, since this is transportation question has preceded by many other transportation questions, both the treated and the control group are treated by the questions itself. For every question, the control group gets more information about transportation costs and thereby Y_{0i} increases for every question and thereby the treatment effect from the advance information, $Y_{1i} - Y_{0i}$, decreases for every question.

Answer		*N-group*	*O-group*	*P-group*
	Yes	**26.7%**	**40.0%**	**35.3%**
	Sometimes	**40.0%**		29.4%
	Rarely		30.0%	
	No, there is a lack of time resources			
	No, production and transportation costs are not my area			
	I am specializing in other areas			
	Other			

	Coeff	p-val (Std err)	p-val (Std err) BS(50)
Treatment effect, $\Delta(D_i)$	.002	0.994 (.235)	0.995 (.307)
Experience, $\beta(X_i)$	-.257	0.213 (.203)	0.463 (.350)
Interaction effect, $\gamma(D_i X_i)$	.029	0.933 (.343)	0.967 (.688)
Intercept	.535	0.000 (.138)	0.001 (.165)

Question	Q17: Do you think that your firm should import more from low cost countries?
Type	(a) Individual Specialization.
Purpose	Specialization question. The purpose is to see if there is any difference between the groups. If there is any difference, the individuals might be affected by advance information, which can be considered as group knowledge, suggesting that the purchasers do not specialize in transportation costs. However, since all groups have been treated with almost all kinds of information; advance information, costs, delays and damages, at this point, there may be little difference between the groups advance information. The information value of this question may thereby be very low.
Expectation	I expect that the N-group is less willing to import from other continents. However, all groups have been treated with almost identical advance information and thereby the information value in this question may be low.
Analysis	Most of the purchaser answer that they do not think that it is good for the firm to import from low cost countries. There are no significant differences between the groups. The average treatment effect is insignificant and the experience is insignificant, which means that the there is no strong proof that the treatment affects the perception of if the firm should import more from low cost countries. However, since this is the last transportation question, both the treated and the control group are treated by the questions itself. For every question, the control group gets more information about transportation costs and thereby Y_{0i} increases for every question and thereby the treatment effect from the advance information, $Y_{1i} - Y_{0i}$, decreases for every question.

Answer

	N-group	*O-group*	*P-group*	*All*
Yes		60.0%		
No	**53.3%**		**64.7%**	**54.8%**

	Coeff	p-val (Std err)	p-val (Std err) BS(50)
Treatment effect, $\Delta(D_i)$	.189	0.574 (.333)	0.338 (.197)
Experience, $\beta(X_i)$	-.235	0.419 (.288)	0.790 (.881)
Interaction effect, $\gamma(D_i X_i)$	-.349	0.477 (.486)	0.528 (.553)
Intercept	.695	0.001 (.196)	0.005 (.245)

ACTUAL PROBLEMS WITH TRADE

The questions Q13 to Q16 suggest that there are more problems sourcing from other continents. Most of the problems consist of belated transports and not damaged goods. The purchasers answer that most of the time, there are no problems. Since this question is regarding what has actually been seen buy the purchasers, I do not analyze any difference between the groups.

Question	Q13: Do you experience more transportation problems sourcing from other continents than sourcing from Europe?
Type	(e) Information about actual problems with trade.

Purpose	Not a specialization question, since the question is regarding problems that has actually been seen by the purchasers. The purpose of the question is to get a picture of the problems regarding intercontinental transportation. The purchasers i study source from many continents to a European assembly plant.	
Expectation	I expect that the purchasers find more problems sourcing from other continents than Europe.	
Analysis	In line with my expectations most of the purchasers perceives that there are more problems importing from other continents than Europe. One purchaser argue that the technology and the quality was not enough developed in some continents.	
Answers		*All*
	No, there is no large difference	
	No, not that I know. I specialize in other areas. It is another department which specializes within transportation problems	
	More problems to purchase from Europe	
	More problems to purchase from other Continents	**61.9%**
	Other	

Question	Q14: Which kinds of problems occur when transporting between continents?	
Type	(e) Information about actual problems with trade.	
Purpose	Not a specialization question, since the question is regarding problems that has actually been seen by the purchasers. The purpose of the question is to get a picture of the problems regarding intercontinental transportation. The purchasers i study source from many continents to a European assembly plant.	
Expectation	I do not have any expectations regarding the kinds of problems that occur when transporting between continents.	
Analysis	Most purchasers answer that belated transports are the most common problem.	
Answer		*All*
	None that I see	
	Damaged goods	
	Delayed transports	**64.3%**
	Other	

Question	Q15: Does it often occur that articles are delayed when transporting (even within the same continent)?
Type	(e) Information about actual problems with trade.
Purpose	Not a specialization question, since the question is regarding problems that has actually been seen by the purchasers. The purpose of the question is to get a picture of the problems regarding intercontinental transportation. The purchasers i study source from many continents to a European assembly plant.
Expectation	I expect that most of the purchasers to answer that there are most often no delays.
Analysis	In line with my expectations, the most of the purchasers answer that there are most often no delays.

Answer	*All*
Yes, they are often delayed	
No, they are mostly not delayed	**73.8%**
It is not my department who treats delays. I specialize within other areas	
Other	

Question	Q16: Does it often occur that articles are damaged when transporting (even within the same continent)?
Type	(e) Information about actual problems with trade.
Purpose	Not a specialization question, since the question is regarding problems that has actually been seen by the purchasers. The purpose of the question is to get a picture of the problems regarding intercontinental transportation. The purchasers i study source from many continents to a European assembly plant.
Expectation	I expect that most of the purchasers to answer that there are most often no damages.
Analysis	In line with my expectations, the most of the purchasers answer that there are most often no damages.

Answer	*All*
Yes, they are often damaged	
No, they are mostly not damaged	**78.6%**
It is not my department who treats damaged goods. I specialize within other areas	
Other	

INFORMATION ABOUT THE PURCHASERS

The groups have similar distributions in work experience.

Question	Q18: How long have you worked at the purchasing department?

Purpose	Not a specialization question. The purpose of the question is to have information about the respondents.
Expectation	I have no expectations on the answers.
Analysis	The groups have similar experience distributions.

Answer

	N-group	*O-group*	*P-group*	*All*
6 months	6.7%	0.0%	17.6%	9.5%
1 year	13.3%	20.0%	0.0%	9.5%
2 years	13.3%	30.0%	5.9%	14.3%
3 years	13.3%	20.0%	5.9%	11.9%
4 years	13.3%	10.0%	23.5%	16.7%
Between 5 to 10 years	13.3%	0.0%	17.6%	11.9%
More than 10 years	26.7%	20.0%	29.4%	26.2%

DETAIL D.6.2 – ANALYSIS OF EMPIRICAL RESULTS FROM TRADE TESTS

I find some evidence for that the hypothesis $HT1_{alt}$ is true; there is a negative relationship between intercontinental transports and operating margin. As can be seen in table *D.6.2.a*, for every percentage unit increase in intercontinental transports, the operating margin will decrease with 0.21 percentage units. If transports increase by 10 percentage units from 10 percent to 20 percent, there will be a decrease in operating margin by 2.1 percentage units, which is a quite high change in operating margin for competitive industries. Alternatively 1 percent increase in intercontinental transports will decrease profits by 1 percent.

Marginal revenues in different continents are controlled for by marginal profits with respect to revenue which is a world share of sales quantity variables. Marginal costs in different continents are controlled for by marginal profits with respect to costs which are the world share of production quantity variables. Few of the variables representing marginal revenue and marginal costs are significant and I believe that is may be due to the competitive differences in different industries or that there is not much marginal difference between the continents. The variables representing marginal revenue and marginal costs are, even though insignificant, important to be kept constant by inclusion in the model, due to a possible co-linearity of both trade and profit. I believe that the insignificance is most probable due to that there is no difference between the production and sales margins between the continents.

Table D.6.2.a – OLS regression of intercontinental transports on operating margin controlling for marginal revenue and marginal cost per quantity and decade. Fixed effect on firm and time dimension. Clustered on firm dimension due to time dimension autocorrelation.

		Operating Margin	1970-2008 Lin-Lin (Log-Lin)	1970-1998 Lin-Lin (Log-Lin)	1984-2005 Lin-Lin (Log-Lin)	1993-2008 Lin-Lin (Log-Lin)	1996-2008 Lin-Lin (Log-Lin)
		Intercontinental Transports	-.1757** (-.6896***)	-.0837 (-.0244)	-.2127*** (-.8645***)	-.2169*** (-1.028***)	-.1893** (-1.006***)
Share of World Sales (MR)	EU	1970	-.3539**	-.2124			
		1980	-.1552	-.0944	-.1711		
		1990	-.1548	-.0828	-.2070*	-.3706**	-.3578*
		2000	-.1648		-.0919	-.3106***	-.3395**
	Asia	1970	.0223	.1628			
		1980	.0811	.0387	.1487		
		1990	.2390*	.1755	.1879	.1901	.3396
		2000	.0193		.1076	.0294	.0608
	North America	1970	-.2119	-.1202			
		1980	.0088	.1093	.0635		
		1990	-.1395	-.0280	-.1394	-.2140	-.1672
		2000	-.1080		-.0480	-.1330	-.2038
Share of World Production (MC)	EU	1970	-.0642	-.0711			
		1980	.0178	.0644	.1691*		
		1990	.0022	-.0907*	.0688	.2982	.1913
		2000	-.2189		-.0933	-.0352	-.0470
	Asia	1970	-.3593**	-.1351			
		1980	-.1530	-.0057	.1520		
		1990	-.0184	-.1138	.0744	.2524	.1350
		2000	-.0868		.0064	.1161	.0878
	North America	1970	.2053	.2255			
		1980	.0141	.0079	.08745		
		1990	-.0185	-.1423	.0599	.2028	.0439
		2000	-.3453**		-.1780	-.1690	-.1855

It is clear that increased transports decrease profits, but I need to analyze what can cause an increase in transportation. If a variable is causing transportation, then transportation is an endogenous variable. An endogenous variable may be correlated with the composite error term, because a variable explaining the endogenous variable is collinear with the endogenous variable and excluded from the model, and thereby bias the estimated parameter of the endogenous variable. I have in theory and empirical results concluded that constraints in visibility of transportation costs may be a cause of an un-optimal amount of transportation. Can there be other

causes of a profit un-optimal increase in transports? Fixed costs constraints may in theory force firms to export to other continents in order to increase volume and gain from economies of scale. Fixed costs can be R&D and expensive machinery. However, regarding R&D, there is no reason to not set up an extra plant in the new continent, since there are no fixed costs according to activity based cost calculation. Thereby R&D should not cause transports if the firm all transportation cost is visible. Also expensive high capacity machinery can be replaced with one low capacity machinery in each continent. Thereby transports could be diminished. The only reason, so far, not to enter a new continent by building a new plant, is invisibility of transportation costs. Another reason to transport between continents may be production capacity constraints within the continent where goods are sold, so that the firm may need to import goods to the continent. However, from my empirical findings I can reject that theory, because not a single purchaser answered that they have imported because of production capacity constraints. Also there are thousands of subcontracting firms in a single continent which can produce goods for roughly any other firm in need of any good.

Because I measure how changes in transports cause changes in profits, I find that a key question in this analysis is what can and cannot change over time. Can visibility of transportation costs change over time? If it is extremely difficult and costly to specialize in transportation costs year 1970, it may also be just at difficult and expensive in year 2008. Can group knowledge change over time? If it is nearly impossible to specialize in transportation costs, the group has to rely on guess work. Herd mentality may cause such group knowledge to change over time. If media starts to market China as the most effective producer in the world and Africa as a starving nation, firms may very well choose to source from China instead of Tunisia. Can direct costs of transport change over time? Yes it can. Hummels find that due to a decrease in relative air freight to ocean freight costs, over half of US exports are air-shipped, excluding Canada and Mexico (Hummels 2001, p.1,4). I did not include direct transportation cost changes in my thesis, which may be a weak point in my thesis. Changes in direct transportation costs may cause changes in the endogenous variable trade. Some systemic changes in direct transportation costs may be caught in the time intercepts, but still the idiosyncratic changes in transports are not caught in the time intercepts, but in the error term, which may bias my estimated effect of increased transports on profit. However, transportation cost is linear to profit and therefore it might not end up in the error term and thereby the measurement is not biased. Can technology and knowledge about technology change over time? Definitely, the technological level can change over time. I control for technological changes direct effect on profit in the continental marginal costs and the continental marginal revenue, but changes in technology may itself cause changes in transports which makes transports endogenous to technological change. Can there be a change in competition? A market may be subject to change in competition if more firms are entering or exiting, or if customers' taste is changing. Changes in mark-up profit may force firms to enter or exit continents and thereby cause changes in trade. The

firms I am analyzing are not so niched. They produce vehicles, mining equipment, paper, clothes, medicine and telecom equipment. Demand for such goods does not change over time within developed countries, unless because of changes in the business-cycles, which is caught by the time intercepts. Technological advancement in a continent may increase demand in that continent, but it does not force the firm to export. The firm can instead set up a new plant in the continent where demand has increased. Supply can change because of mergers and bankruptcies, which may increase mark-up profits. But there are no new car brands, mining equipment firms, telecom firms, paper producing firms the last 40 years which could decrease mark-up profits forcing firms to enter new markets. However, if firms are entering new continents, mark-up profits within that continent may decrease. For example Toyota, Hyundai, Subaru, KIA, Nissan, Mazda and Honda are car manufacturers which have entered new continents the last 40 years. Technological increase and decreased direct visible transportation costs may cause firms to enter new markets, which in turn reduce mark-up profits and may force firms in the entered market to enter new continents in order to enjoy economies of scale. The Ricardian comparative advantage must be remembered and that an increase in the supply side technology within a continent may also increase the demand for technology within the same continent. However, even though a decrease in mark-up profit forces the firm to enter into a new continent, nothing is forcing the firm to not set up a new production facility in the entered continent.

I also need to analyze the event structure of intercontinental trade. A purchaser may choose ex-ante to start purchasing from a firm on the other side of the earth, because of lower price and visible transportation costs than purchasing locally. The purchaser chooses ex-ante to invest in a manufacturing capital on the other side of the earth. Ex-post the investment, the purchaser see that it was much more expensive to purchase from the other side of the earth than first calculated. However, if the investment is a true sunk cost, any exit costs and the equilibrium between the marginal cost and the marginal revenue can cause the firm to continue producing in the investment even though the investment was not profitable (Roberts Tybout 1997). Therefore, a transportation cost which may be invisible today but not necessarily invisible tomorrow can leave a strategy trace by the firm's continuance to transport tomorrow. Also must be noted that other marginal costs than transportation costs may be ex-ante invisible which may affect quantity traded and therefore there might be a possibility that I might be measuring other invisible costs than transportation costs. Unprofitable sunk investments without without trade would be captured in the intercontinental margins regressor while unprofitable sunk investments with intercontinental trade would be captured in the same regressor as intercontinental trade quantity. What contradicts that I measure other costs than transportation costs is the support from the existence of invisible trade costs by the rejection of $HS1a_{null}$ and $HS1b_{null}$. I still believe that transportation cost drivers are much more difficult than other cost drivers due to its location and temporal stochastic nature. Therefore I believe that I measure transportation costs.

To sum up what can cause transportation of goods I find that:

- Invisibility in transportation costs caused by
  - Cost of specializing in transportation costs (constant over time).
  - 'Guess work' and herd mentality group knowledge about transportation costs and production strategies (changes over time).
- Visible direct transportation costs (changes over time)

I have earlier rejected:

- Hypothesis $HS1a_{null}$ for the alternative $HS1a_{alt}$ that the individual decision makers are not specialized in transportation costs.
- Hypothesis $HS1b_{null}$ for the alternative hypothesis $HS1b_{alt}$ that the individual decision makers have not received by them perceived trustworthy group knowledge.
- Hypothesis $HC1_{null}$ for the alternative hypothesis $HC1_{alt}$ that the individual decision makers are not constrained by production capacity constraints in certain continents, forcing them to source from other continents.

Now I reject hypothesis $HT1_{null}$ for the alternative $HT1_{alt}$ that increased intercontinental transportation decrease profits.

Since I reject hypothesis $HT1_{null}$ I find stronger proofs of invisibility which make me also, together with my empirical findings of the specialization test, able to reject hypothesis $HS2_{null}$ for the alternative $HS2_{alt}$ that the group which the decision maker is included in, does not have full knowledge in transportation costs.

Detail D.7 – Conclusions and Further Research

My evidences all point in the same direction, which suggests that there may be invisible costs causing profit-un-optimal quantity of trade. The equity holders of an importing firm bear alone all invisible trade costs, if those costs are located within the importing firm, which is proved by my extensions to theory and my empirical testing. The customers of a firm do not pay for invisible trade costs, since such trade costs does not change quantities or prices on the demand curve. If an invisible cost is located within another exporting firm, the equity holders of that exporting firm are carrying the cost. If a cost is visible by both the importing and exporting firms, quantities will adjust by trading a smaller quantity in order to maximize profits given the marginal cost and the welfare loss, from a smaller quantity traded, will be shared between the firms and their customers and suppliers, which previous research proved.

The states of visibility of a cost may differ, ex-ante and ex-post decision to trade. If a cost is ex-ante invisible and ex-post invisible, the decision making process of a decision maker will never be influenced by the cost. If a cost is ex-ante invisible but

ex-post visible, the decision maker may still ex-post decide to continue with the same strategy as decided upon ex-ante, even if the decision maker would have took another strategy if the cost was visible ex-ante. An example is if the future cash flows of a so called sunk fixed investment cost would not cover that sunk cost. If the cost is visible ex-ante, the investment would not occur. But if the cost is invisible ex-ante the investment might occur and the firm might ex-post sustain with trade, even though the trade cost would be ex-post visible, given a positive optimal quantity given that the marginal cost is equal to the marginal revenue.

A cost which is invisible for one individual within a firm is not necessarily invisible for another individual within the same firm. Direct costs, like container shipping invoices from suppliers, have a higher probability being ex-ante visible than more stochastic costs which can occur anytime anywhere within the boundary of the firm, for example corrosion damage due to ocean shipping on two out of thirty components to be assembled on trucks in a truck factory. A specific decision maker can see both cost drivers ex-ante, only one of them or none of them. Given that the specific decision maker can see the cost drivers, he may be able to estimate them, given that the cost of estimating them (specializing) is not too high relative to the revenue of estimating them. The visibility of deterministic and stochastic transportation cost drivers and the cost relative to the revenue of specializing in estimating the cost of transportation are determining if an individual is triggered to specialize in estimating transportation marginal costs. If the cost drivers are invisible for the individual he will not specialize in estimating transportation costs. If it is more costly to gain information regarding transportation cost than is the revenue from the information, the individual will not specialize in transportation costs. I conclude that it is, both ex-ante and ex-post, extremely difficult to see transportation costs drivers and to estimate transportation cost, due to the stochastic location and temporal nature of transportation cost drivers. My theory and empirical evidences support my conclusion. I also find that specialization in transportation cost does not change over time, but inaccurate group knowledge about transportation cost may change over time, due to for example herd mentality.

I find that firms do not transport between continents due to production capacity constraints within the continent where the good is sold.

Margins can differ per continent and time, but I find no significance of any differences in margins which may suggest that margins are similar in all continents. In the case of similar margins per continent the only reason for transports would be plant fixed costs, which can be avoided. I control for marginal effect of quantity sold per continent on profit and marginal effect of quantity produced per continent on profit. Since marginal effects can change over time I split the control variables into four decades. Margins can change over time, due to technological improvement in production (supply side) and change in technological demand (demand side). I find that change in demand or supply is not really an incentive to trade, so there is no bias from changes in demand or supply.

Direct transportation costs can change over time, but I do not control for them in my thesis, which may be a weak point in my thesis. Some of the changes in transportation cost may be caught in the time intercepts, but there may still be some bias in my estimated parameter. However, there may be a linear relationship between profit and direct transportation cost and profit may thereby absorb some movement in direct transportation cost, leaving the residual unaffected and the parameter unbiased.

Other subjects which can affect profits are differences in importers and exporters time zones and differences in importers and exporters cultures. Such subjects are constant over time and controlled for in the marginal effect on quantity sold and produced per continent variables. Also the distance between continents may cause information frictions (Portes 2004) which makes it costly to trade. However, I see such information frictions just as a visible or invisible trade cost.

I also noted that it may be fixed sunk costs that I measured in my model instead of transportation costs, however I have more support of that it is invisibility than fixed sunk costs in my estimated parameter.

I also note that many successful firms produce within or near the same continent where the goods are sold, like for example H&M, Zara, Sandvik, Nokia, Toyota, Scania, and Volvo. Examples of not so successful firms who do not produce near the same continent where the goods are sold are; Ericsson, Brio, Saab Automobile.

Most empirical economic geography research is regarding quantities, which is not sufficient for a rigorous economic analysis which needs to contain profits, costs, revenue and quantities. I analyze profits, costs, revenue and quantities and thereby I contribute with a more rigorous theoretical and empirical model. However, I need to be careful not to say that I am the first person writing a thesis in this way, since there is usually someone who has done something similar. The gravity models does perhaps contradict my theory, because the gravity models show some rationality among decision makers because of that quantities of trade reduce the further away two countries are, but perhaps gravity models show that there is some, but not full visibility of trade costs. My estimated numbers are somewhat similar to Hummels, but I use firm level micro-data and Hummels uses aggregated macro-data.

I now put down my foot and say that firms may suffer from invisibility of trade costs and that it is the equity holders who pay for the costs, since the operational profits are reduced and the profit to equity holders are a residual of operations and cash flows to creditors. I do not have any recommendation in how to increase visibility, since it may be too costly to increase visibility in transport costs. The only recommendation I can give, is to transform plant level fixed cost to marginal cost of production and set up one plant in each continent, like the successful firms have done. Transforming plant level fixed costs to marginal cost of production may be done by letting the plant be open to a wider market of production. For example a

sub contractor can own the fixed assets and thereby the fixed assets can be used by more firms.

I recommend some subjects to be further researched. Changes in direct trade costs may be incentive to increase or decrease trade.

It would also be interesting to include firms with other head-quarters than firms with European head-quarters, because there may be an effect of distance from head-quarters which could be controlled for. It would in that case be interesting to include firms with head-quarters in USA, Asia or perhaps Latin America.

It would be interesting to empirically identify the marginal cost of production function, marginal cost of transports function, visibility function and the marginal revenue function. If that would be possible, it could be possible to separate the effect on profit of invisibility from visibility.

It would be interesting to develop a model for long run and short run equilibrium on profit and quantities. Perhaps the quantities will go down in the long run which would make the customers pay more in the long run.

It would be interesting to not only measure the intercontinental transports effect on mean profit, but also intercontinental transports effect on standard deviation of profit. I suppose that increase in transports increases standard deviation of profit.

It would be interesting to develop a model of marginal loss in revenue due to transports. Perhaps the demand shifts if goods are late or old, like in the iceberg transport cost models.

Appendix A.5 – Methodology Econometrics

A.5.3 Econometrics of Treatment Effects

Measuring treatment effects is complicated, since to be able to measure a treatment effect for an individual, this individual need to have an outcome with or without treatment, which is counterfactual since either the individual is treated or it is not treated. The question is; what would be the outcome for this treated individual if he would not have been treated vice versa. The outcome for an individual if is treated is y_1 and the outcome for the same individual if not is treated y_0. The problem is one of missing data, since both y_0 and y_1 cannot be observed since an individual cannot be in both states (Heckman 2007, p.4880, Wooldridge 2002, p.604).

The observed outcome for individual i is (Wooldridge 2002, p.605)

$$y_i = y_{0i} + D_i(y_{1i} - y_{0i}) = \begin{cases} y_{1i} \; if \; D_i = 1 \\ y_{0i} \; if \; D_i = 0 \end{cases}$$

Where D_i is an indicator for treatment for individual i and y_{1i} is the outcome for individual i if treated and y_{0i} is the outcome for individual i if not treated. The

effect of treatment, $y_1 - y_0$, is counterfactual, since the individual cannot be in both states.

There are three main types of average treatment parameters to be estimated (Heckman 2007, p.4882):

- Average Treatment Effect: $ATE = E(Y_{1i} - Y_{0i})$
- Treatment on the Treated: $TT = E(Y_{1i} - Y_{0i}|D_i = 1)$
- Treatment on the Untreated: $TUT = E(Y_{1i} - Y_{0i}|D_i = 0)$

Which also can be stated conditional on a control variable, X:

- Average Treatment Effect: $ATE(X_i) = E(Y_{1i} - Y_{0i}|X_i)$
- Treatment on the Treated: $TT(X_i) = E(Y_{1i} - Y_{0i}|X_i, D_i = 1)$
- Treatment on the Untreated: $TUT(X_i) = E(Y_{1i} - Y_{0i}|X_i, D_i = 0)$

Since the effect of treatment, $y_1 - y_0$, can have different distributions across the individuals, i, I need to go through the different types of distributions of the effect of the treatment. The question is, how does the treatment effect, $\Delta_i = y_{1i} - y_{0i}$ vary with i? There are four main distributions of treatment effects (Heckman 2007, p.4892-4894):

1) Homogeneous Treatment Effects
    a. $y_{1i} - y_{0i} = \Delta$ does not vary with i.
2) Homogeneous Treatment Effects conditional on X
    a. Individuals with the same X have the same treatment effect
    b. $\Delta_i = y_{1i} - y_{0i} = \Delta(X_i)$
3) Heterogeneous Treatment Effects without Essential Heterogeneity
    a. Δ_i varies freely with i, but the individual i does not select into treatment based on the effect on the treatment effect $y_{1i} - y_{0i}$ (conditional on X)
    b. $y_{1i} - y_{0i} \perp\!\!\!\perp D_i|X_i$ where $\perp\!\!\!\perp$ denote "independent"
4) Heterogeneous Treatment Effects with Essential Heterogeneity
    a. Δ_i varies freely with i, and the individual i do select into treatment based on the effect on the treatment effect $y_{1i} - y_{0i}$ (conditional on X)
    b. $y_{1i} - y_{0i} \not\perp\!\!\!\perp D_i|X_i$ where $\not\perp\!\!\!\perp$ denote "not independent"

I believe that different purchasers are affected in different ways from my treatment. First of all they have different grades of specialization into intercontinental transportation costs. Secondly, they have different experience regarding purchasing and transportation costs. Thirdly, the longer a purchaser has worked at a department, the larger the cognitive group of colleagues is, because the purchasers' network of colleagues is always expanding. Therefore, I assume that there is no

homogeneous treatment effect unconditional of length of employment (as in 1). The length of employment may affect the effect of treatment, so i assume that there is a variable X_i, controlling for length of employment (as in 2, 3 and 4).

However, even though purchasers have worked different length of time, they may specialize in different areas due to their relative cost and revenue from selecting into these areas. Also, the purchasers may have stochastically stumbled into different areas of specialization and group information, since one individual's cognitive group is not the same as another's. Therefore I believe that, even by controlling for the length of employment, X_i, the Δ_i is a stochastic parameter and therefore I assume that there is no homogeneous treatment effect conditional of length of experiment (as in 2). The distribution of Δ_i follows a stochastic process and is therefore heterogeneous (as in 3 and 4).

If the effect of treatment has some benefit or cost to the individual, i, the individual may then decide upon being treated depending on such benefit or cost and then $y_{1i} - y_{0i}$ and D_i are not independent, $y_{1i} - y_{0i} \not\perp\!\!\!\perp D_i|X_i$. In that case, the treatment effect, $y_1 - y_0$, is not representing the whole population of individuals and estimating such treatment effect will cause *selection bias*.

Because

$$E(y_1|D = 1) \neq E(y_1)$$

And

$$E(y_0|D = 0) \neq E(y_0)$$

Therefore

$$E(y_1|D = 1) - E(y_0|D = 0) \neq E(y_1 - y_0)$$

There is a way in which I can avoid heterogeneous treatment with essential heterogeneity (as in 4) in my interview. This is a simple interview, but I must be careful not to reward the interviewees by doing the interview in a way which is connected to the decision to joining the interview. For example I must not announce that the interviewees will get great knowledge in hidden transportation costs. The only benefit from joining the interview is altruistic satisfaction from helping a student (Fehr 2000, p. 160). Because the advance information, as is the treatment, is not known to the interviewee, the variable D_i is not really defined for this interview. Even if the decision variable, D_i, would be defined, the decision variable, D_i, would be independent of the treatment effect, $y_{1i} - y_{0i}$, resulting in $y_{1i} - y_{0i} \perp\!\!\!\perp D_i|X_i$, which is because of that I keep the treatment secret from the purchasers and that I make sure that the purchasers have no benefit from the treatment effect associated with the decision to participate.

In case the purchasers would know about any treatment effect, those individuals who would gain from treatment may select into treatment and those would not gain from treatment would choose not to participate in the interview.

Assume that all have the same treatment effect, i.e. homogeneous treatment effect, $\Delta_i = \Delta$. The outcome treatment effect variable, Y, is then related to the decision variable, D.

$$Y = \overbrace{Y_0 + \underbrace{D}_{0 \; or \; 1} \times \underbrace{\Delta}_{Y_1 - Y_0}}^{Y_0 \; or \; Y_1}$$

This results in (Wooldridge 2002, p. 606)

$$E(Y|D = 1) = E(Y_1|D = 1)$$

And because Y_1 and D is independent

$$E(Y|D = 1) = E(Y_1|D = 1) = E(Y_1)$$

And the same with

$$E(Y|D = 0) = E(Y_0)$$

If putting restriction on Y_0 that it is independent of D, but not putting restriction on Y_1, one can write

$$E(Y|D = 1) - E(Y|D = 0) = \overbrace{\Delta}^{TT = E(Y_1 - Y_0|D=1)} + \overbrace{E(Y_0|D = 1) - E(Y_0|D = 0)}^{Selection\ bias}$$

If Y_0 is independent of D then $E(Y_0|D = 1)$ and $E(Y_0|D = 0)$ are equal and the selection bias is 0. The selection bias states; if the treated had not received treatment, would they have similar outcomes as the non-treated? Another statement is; do the treated have better ability than those who are not treated? Heckman names this bias "selection bias" which is correct. However, the bias described above could also have been named "ability bias", especially since there is another selection bias, which Heckman names "sorting bias". Sorting bias also only occurs if the individual actively participate in the treatment due to benefits of the treatment effect (Heckman 2007, p. 4901).

$$E(Y|D = 1) - E(Y|D = 0)$$

$$= \overbrace{E(Y_1 - Y_0|D = 1)}^{TT} + \overbrace{E(Y_0|D = 1) - E(Y_0|D = 0)}^{Selection\ bias}$$

$$= \overbrace{\overbrace{E(Y_1 - Y_0)}^{ATE} + \overbrace{E(Y_1 - Y_0|D = 1) - E(Y_1 - Y_0)}^{Sorting\ gain}}^{TT} + \overbrace{E(Y_0|D = 1) - E(Y_0|D = 0)}^{Selection\ bias}$$

If $Y_1 - Y_0$ is independent of D then $E(Y_1 - Y_0|D = 1)$ and $E(Y_1 - Y_0)$ are equal and the sorting gain is 0. The sorting gain is the gain which individuals sorted into the treatment would benefit compared to the average population (Heckman 2007, p. 4901).

If the treatment effect is distributed as heterogeneously treatment effect with essential heterogeneity (as in 4), then and only then the sorting gain and the selection bias can be positive. If I am careful not give the interviewees any benefit from the treatment or letting the interviewees know about the treatment, I will have heterogeneous treatment effect without essential heterogeneity (as in 3). Since I will have heterogeneous treatment effects without essential heterogeneity the sorting gain and the selection bias will be zero and thereby the OLS will be equal to the ATE (Wooldridge, p. 606) as the OLS can estimate the difference in sample means of the treated sample and the untreated sample.

$$\overbrace{E(Y|D = 1) - E(Y|D = 0)}^{OLS} = \overbrace{E(Y_1 - Y_0)}^{ATE}$$

To be on the safe side, if the individuals of some reason would select into treatment due to the benefit of the treatment effect, I can do a random experiment where I randomly allocate individuals into treated and untreated groups. Even in a regime of self-selection, $(Y_0, Y_1) \not\perp\!\!\!\perp D$, randomizing the allocation of individuals into groups using a random variable, R, will make the treatment effect independent of the selection to group, $y_{1i} - y_{0i} \perp\!\!\!\perp R$ (Heckman 2007, p. 4881).

If $y_{1i} - y_{0i} \perp\!\!\!\perp R$, then

$$\overbrace{E(Y|R = 1) - E(Y|R = 0)}^{OLS} =$$

$$= \overbrace{\overbrace{E(Y_1 - Y_0)}^{ATE} + \overbrace{E(Y_1 - Y_0|R = 1) - E(Y_1 - Y_0)}^{Sorting\ gain}}^{TT} + \overbrace{E(Y_0|R = 1) - E(Y_0|R = 0)}^{Selection\ bias}$$

$$= \overbrace{\overbrace{E(Y_1 - Y_0)}^{ATE} + \overbrace{E(Y_1 - Y_0) - E(Y_1 - Y_0)}^{Sorting\ gain=0}}^{TT} + \overbrace{E(Y_0|R = 0) - E(Y_0|R = 0)}^{Selection\ bias=0}$$

So,

$$\overbrace{E(Y|R = 1) - E(Y|R = 0)}^{OLS} = \overbrace{E(Y_1 - Y_0)}^{ATE}$$

I am mostly interested in the average treatment effect. Since the treatment effect, Δ_i, is randomly distributed in heterogeneous treatment effect (as in 3 and 4), any estimated regression coefficient will be random (Heckman 2007, p. 4893).

The estimated model for an average treatment effect is

$$Y_i = \alpha + \overbrace{\hat{\Delta}}^{homo\ geneous} \underbrace{D_i}_{0\ or\ 1} + \overbrace{\widehat{\beta X_i}}^{conditional\ on} + \overbrace{\widehat{\gamma D_i X_i}}^{interaction\ term} + \varepsilon_i$$

The estimated model for a random treatment effect is

$$Y_i = \alpha + \overbrace{\hat{\Delta}_i}^{hetero\ geneous} \underbrace{D_i}_{0\ or\ 1} + \overbrace{\widehat{\beta X_i}}^{conditional\ on} + \overbrace{\widehat{\gamma D_i X_i}}^{interaction\ term} + \varepsilon_i$$

It can be interesting to look into the distribution of the random treatment effect, Δ_i. However, I will have a small sample and I am satisfied by looking at an average treatment effect. I will look at an average treatment effect instead of at the distribution of a random treatment effect.

The higher the value in Y_1, the more visible is the trade cost. Therefore an increase in Y, from Y_0 to Y_1 reflects a change in visibility of trade costs. If the treatment, which is the advance information about trade costs, affect Y, then Y should move in a positive direction from Y_0 to Y_1. Thereby I expect the coefficient, which is the average treatment effect, to be positive and that the p-value hopefully will be significant. Since I will have a small sample, the p-value may be insignificant, even though the same test on a large sample would be significant. I will try to estimate the true model and if it is insignificant I will try to estimate the model in reduced form which lack the conditional term and the interaction term. I will asymptotically refine the sample by bootstrapping the standard errors (Schmidheiny 2010, p. 2). Bootstrapping standard errors picks random samples from the small sample and calculates standard errors and confidence intervals without affecting the estimated treatment effect parameter.

I expect a low R-square since the variance in the treatment activity only explain a small part of the variance in the treatment effect.

A.5.4 Econometrics of Time-Series, Production, Trade and Profit

According to Gujarati (2003, p. 207), a sample regression function, of for example two regressors and one regressand, can be expressed as:

$$Y_i = \hat{\beta}_1 + \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} + \hat{u}_i$$

Ordinary least squares (OLS) regression attempts to minimize the residual sum of squares, $\sum \hat{u}_i^2$

$$\min \sum \hat{u}_i^2 = \sum \left(Y_i - \hat{\beta}_1 - \hat{\beta}_2 X_{2i} - \hat{\beta}_3 X_{3i}\right)^2$$

with respect to the unknown parameters, $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$. First order conditions (2003, p. 243) are:

$$\frac{\partial \sum \hat{u}_i^2}{\partial \hat{\beta}_1} = 2\sum \left(Y_i - \hat{\beta}_1 - \hat{\beta}_2 X_{2i} - \hat{\beta}_3 X_{3i}\right)(-1) = 0$$

$$\frac{\partial \sum \hat{u}_i^2}{\partial \hat{\beta}_2} = 2\sum \left(Y_i - \hat{\beta}_1 - \hat{\beta}_2 X_{2i} - \hat{\beta}_3 X_{3i}\right)(-X_{2i}) = 0$$

$$\frac{\partial \sum \hat{u}_i^2}{\partial \hat{\beta}_3} = 2\sum \left(Y_i - \hat{\beta}_1 - \hat{\beta}_2 X_{2i} - \hat{\beta}_3 X_{3i}\right)(-X_{3i}) = 0$$

Or

$$\sum \hat{u}_i = 0$$

$$\sum \hat{u}_i X_{2i} = 0$$

$$\sum \hat{u}_i X_{3i} = 0$$

And therefore

$$\sum \hat{Y}_i X_{2i} = \hat{\beta}_1 \sum X_{2i} + \hat{\beta}_2 \sum X_{2i}^2 + \hat{\beta}_3 \sum X_{2i} X_{3i}$$

$$\sum \hat{Y}_i X_{3i} = \hat{\beta}_1 \sum X_{3i} + \hat{\beta}_2 \sum X_{2i} X_{3i} + \hat{\beta}_3 \sum X_{3i}^2$$

According to Gujarati (2003, p. 208). Solving for the unknown parameters, $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$

$$\hat{\beta}_1 = \bar{Y} - \hat{\beta}_2 \bar{X}_2 - \hat{\beta}_3 \bar{X}_3$$

$$\hat{\beta}_2 = \frac{(\sum y_i x_{2i})(\sum x_{3i}^2) - (\sum y_i x_{3i})(\sum x_{2i} x_{3i})}{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i} x_{3i})^2}$$

$$\hat{\beta}_3 = \frac{(\sum y_i x_{3i})(\sum x_{2i}^2) - (\sum y_i x_{2i})(\sum x_{2i} x_{3i})}{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i} x_{3i})^2}$$

$\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$ are estimates of their respective true parameters β_1, β_2 and β_3. By minimizing the residual sum of square, $\sum \hat{u}_i^2$, the estimates are asymptotically close to their true values.

A.5.4.1 Heterscedasticity

However, if different firms are included in the sample and if different time periods are included in the sample, the firms have different means and standard deviations of their variables as well as the different times have different means and different standard deviations of their variables in the regression analysis. I am first of all interested in regression coefficients, $\hat{\beta}_k$, common for all firms at all times. Therefore I first of all need to estimate unique intercepts for every firm and unique intercepts

for every time period. For example car component manufacturers might in general have lower operating margins than mining tool manufacturers due to market differences, like for example competition. Also some time periods may in general have lower operating margins than others, like for example the banking crisis in year 2008.

Eventual systematic differences in the mean of the operating margins can affect the estimated parameters in a way that it becomes biased and therefore different firms' and different time periods' systematic differences need to be controlled for by different intercepts. Such intercepts can be achieved by binary regressors or, if the intercepts are not correlated with the parameters, be put in a composite error term, which consists of the systematic intercept and the random error.

According to Gujarati (2003, p. 387) an assumption of OLS is homoscedasticity which means that the variance of each disturbance term, u_i^2, is constant for all observations and equal to the true variance of the error term, σ^2.

$$E(u_i^2) = \sigma^2$$

However, since I suspect that different groups of observations have different standard errors, the true variance of the error term is conditional of every observation, i and the error term is therefore not constant and homoscedastic but heteroscedastic.

$$E(u_i^2) = \sigma_i^2$$

Heteroscedasticity does not affect the unbiasedness of the estimated parameters, because heteroscedasticity does not violate linearity or unbiasedness properties of least-squares estimators, according to Gujarati (2003, p. 100).

For example a two variable, X and Y, regression has this linear estimator

$$\hat{\beta}_2 = \frac{\sum x_{2i} Y_i}{\sum x_{2i}^2} = \sum k_i Y_i$$

Where

$$k_i = \frac{x_{2i}}{(\sum x_{2i}^2)}$$

k_i has these properties

- $\sum k_i = 0$ because a variables sum of deviations $\sum x_{2i}$ from that same variable is always 0
- $\sum k_i^2 = \left(\frac{\sum x_{2i}}{(\sum x_{2i}^2)}\right)^2 = \frac{\sum x_{2i}^2}{\sum x_{2i}^4} = \frac{1}{(\sum x_{2i}^2)}$
- $k_i^2 = \frac{x_{2i}^2}{(\sum x_{2i}^2)^2}$

- $\sum k_i\, x_{2i} = \sum \frac{x_{2i}}{(\sum x_{2i}^2)} x_{2i} = \sum \frac{x_{2i}^2}{(\sum x_{2i}^2)} = \frac{\sum x_{2i}^2}{\sum x_{2i}^2} = 1$

Substituting the population regression function $Y_i = \beta_1 + \beta_2 X_{2i} + u_i$ which contains the true parameters β_1 and β_2 and the error u_i into the definition of the estimated parameter.

$$\hat{\beta}_2 = \sum k_i(\beta_1 + \beta_2 X_{2i} + u_i)$$

$$\hat{\beta}_2 = \beta_1 \overbrace{\sum k_i}^{0} + \beta_2 \overbrace{\sum k_i X_{2i}}^{1} + \sum k_i u_i$$

$X_{2i}$is assumed to be nonstochastic and therefore k_i is assumed to be nonstochastic. u_i is expected to be zero.

$$\hat{\beta}_2 = \beta_2 + \sum k_i \overbrace{E(u_i)}^{0}$$

So regardless of the properties of scedasticity of the variance, the estimated parameters will be asymptotically equal to the true population parameter and unbiased.

$$\hat{\beta}_2 = \beta_2$$

However, the estimated variance of a parameter is sensitive to the properties of scedasticity. The variance of the estimated parameter is according to Gujarati (2003, p. 101)

$$Var(\hat{\beta}_2) = E\left(\hat{\beta}_2 - E(\hat{\beta}_2)\right)^2 = E(\hat{\beta}_2 - \beta_2)^2 = E\left(\sum k_i u_i\right)^2$$

$$= E(k_1^2 u_1^2 + k_2^2 u_2^2 + \cdots + k_n^2 u_n^2 + 2k_1 k_2 u_1 u_2 + \cdots + 2k_{n-1} k_n u_{n-1} u_n)$$

If there is homoscedasticity, the expectations of variance of each observations error is equal to the observation constant residual sum of squares, $E(u_i^2) = \sigma^2$. For simplicity, existence of correlation between every observation can be assumed to be zero, $E(u_i u_j) = 0$ for every $i \neq j$. The estimated variance of the parameter in homoscedasticity is

$$Var(\hat{\beta}_2) = \sigma^2 k_i^2 = \frac{\sigma^2}{\sum x_{2i}^2}$$

Howver, if there is heteroscedasticity, the estimated variance of the parameter is different according to Gujarati (2003, p. 37), because in heteroscedasticity the variance of each observations error is equal to each individual observations variance in residual square.

$$E(u_i^2) = \sigma_i^2$$

$$Var(\hat{\beta}_2) = k_1^2 E(u_1^2) + \cdots + k_n^2 E(u_n^2) = k_1^2 \sigma_1^2 + \cdots + k_n^2 \sigma_n^2$$

$$Var(\hat{\beta}_2) = \sum k_i^2 \sigma_i^2$$

The estimated variance in heteroscedasticity is

$$Var(\hat{\beta}_2) = \sum \left(\frac{x_{2i}}{\left(\sum x_{2i}^2\right)^2} \right)^2 \sigma_i^2 = \frac{\sum x_{2i}^2 \sigma_i^2}{\left(\sum x_{2i}^2\right)^2}$$

Since OLS use homoscedastic standard errors, regressing a heteroscedastic sample will, even though the parameters still are unbiased, result in inconsistent standard errors of the parameters and thereby may result in incorrect inference due to overestimated or underestimated parameter variance (2003, p. 399). Populations with greater variability will dominate the RSS (2003, p. 397) and therefore, if my sample has heteroscedastic properties, I would like to give more weight to populations with greater variability. There is no straight forward way of testing if my sample has heteroscedastic properties, because there is mostly one sample of the regressand corresponding to the regressor (2003, p. 400). For example there is only one operating profit associated with the amount of transports, because both variables are real numbers. Finding the σ_i^2 for every observation, i, is impossible because there are only one observation to calculate from and thereby it is impossible to detect heteroscedasticity. There are a few rules of thumbs that can be used, but every rule of thumbs has its drawbacks.

However, I believe that there may heteroscedasticity in my sample because:

- The more a firm trades (regressor), the higher the variability in operating margins (regressand) because more trade not only deterministically reduce operating margins, but more trade also increase the stochastic variations in operations. For example, according to Hummels (2001, p. 8), for every day a good is transported, the more likely it is that the good is damaged, which is a stochastic process. For every day a good is transported, the value of the good is costing a deterministic interest rate, deterministically reducing the mean of the operating margin.
- Every firm has by nature different variations in operating margins (regressand), affecting the variability in the firms' individual intercept control variables (regressors). The control variables are thereby heteroscedastic.

I will plot the OLS residuals in order to detect firm dimension heteroscedasticity and time dimension heteroscedasticity. If there is heteroscedasticity in any of the dimensions, I need to correct for heteroscedasticity in that same dimension using a method of estimation.

A method of estimation called generalized least-squares (GLS), takes variability in variations into account, according to Gujarati (2003, p. 395). A two variable model can be variation normalized if the heteroscedastic variances, σ_i^2, are known.

$$Y_i = \beta_1 + \beta_2 X_{2i} + u_i$$

$$\frac{Y_i}{\sigma_i} = \beta_1 \left(\frac{X_{1i}}{\sigma_i}\right) + \beta_2 \left(\frac{X_{2i}}{\sigma_i}\right) + \left(\frac{u_i}{\sigma_i}\right)$$

Where X_{1i}=1. For simplicity the equation can be rewritten

$$Y_i^* = \beta_1^* X_{1i}^* + \beta_2^* X_{2i}^* + u_i^*$$

The variance of the transformed error, u_i^*, is

$$Var(u_i^*) = E(u_i^*)^2 = E\left(\frac{u_i}{\sigma_i}\right)^2$$

The heteroscedastic variance is known, so it does not need to be embedded by expectation

$$Var(u_i^*) = \frac{1}{\sigma_i^2} E({u_i}^2)$$

Since the variance of the error term, u_i^2, is expected to be equal to the variance of the residual, σ_i^2

$$Var(u_i^*) = \frac{1}{\sigma_i^2} E\left(\sigma_i^2\right) = 1$$

The variance of the error term is now a constant equal to one. Since I do not know the true value of the variance of the residual, σ_i^2, I follow Gujarati's recommendation (2003, p. 417, p. 483) to estimate the variances and covariances using FGLS heteroscedasticity-consistent variances. The FGLS method is only asymptotically valid and therefore the FGLS robust standard errors can only be used in large sample regression, which I have.

The reason why heteroscedasticity can be a problem is not that the estimated parameters are biased, but the incorrect parameter variances can make it impossible to make statistical inferences. If there is heteroscedasticity and I disregard them, it could result in that I find strong proofs that transports have a statistical effect on operating margins even though there in reality is no proof of a statistical effect (p 399). The opposite situation could also occur, so that I cannot find proofs of that transports have statistical effects even though there in reality is a statistical effect. Since I have a large sample, the FGLS method to estimate the standard errors can be used and thereby there is no cost for me using GLS compared to OLS. As I assume different types of heteroscedasticity in my sample, I find it safer to use GLS than OLS.

A.5.4.2 Perfect or Near Multicollinearity

Perfect Multicollinearity is an exact linear relationship among some explanatory variables, according to Gujarati (p 342). Such exact linear relationship exists if the sum of all variables, X_k, multiplied with constants, γ_k, is equal to zero:

$$\gamma_1 X_1 + \gamma_2 X_2 + \cdots + \gamma_K X_K = 0$$

In such equation, in order for one variable to change, at least one of the other variables needs to change. The point of making a regression, is to check the effect of an independent variables change on a dependent variable, keeping all other independent variables constant. However, if an exact linear relationship between the independent variables exists, an independent variable cannot change at the same time as the other independent is kept constant. However, if there is a stochastic error term, v_i, in the equation, one independent variable can move at the same time as the others are kept constant.

$$\gamma_1 X_1 + \gamma_2 X_2 + \cdots + \gamma_K X_K + v_i = 0$$

Gujarati analyze the parameter estimation problem more rigorously (p 345). The equation of estimating a parameter $\hat{\beta}_2$ is

$$\hat{\beta}_2 = \frac{(\sum y_i x_{2i})(\sum x_{3i}^2) - (\sum y_i x_{3i})(\sum x_{2i} x_{3i})}{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i} x_{3i})^2}$$

Assume that there is a linear relationship between variable X_{2i} and X_{3i} so that $X_{3i} = \varphi X_{2i}$.

$$\hat{\beta}_2 = \frac{(\sum y_i x_{2i})(\varphi^2 \sum x_{2i}^2) - (\varphi \sum y_i x_{2i})(\varphi \sum x_{2i}^2)}{(\sum x_{2i}^2)(\varphi^2 \sum x_{2i}^2) - \varphi^2 (\sum x_{2i}^2)^2} = \frac{0}{0}$$

$\hat{\beta}_2$ is indeterminate as there is a perfect linear relationship between two regressors.

I need to check so that I do not have a perfect linear relationship between the regressors. I have three main types of regressors and they are all related:

- Continents share of firm's world sales (5 variables for 5 continents), $s_{c,i,t}$, where $\sum_{c=1}^{5} s_{c,i,t} = 1$
- Continents share of firm's world production (5 variables for 5 continents), $p_{c,i,t}$, where $\sum_{c=1}^{5} p_{c,i,t} = 1$
- Intercontinental transports, which is a function of the above sales and production variables.

As can be seen, there is a perfect linear relationship between the sales variables. If for example the continent Europe would increase sales from 10 to 12 percentage units of the firm's world sales, at least one other continent needs to reduce its world share of sales. The situation is the same for the production variables. A solution for

this is to remove one or more variables, so that a perfect linear relationship disappears from the regressors. If for example the North America variable would disappear, the European sales variable can increase without the necessity to decrease any of the other 3 continents variables since $\sum_{c=1}^{4} s_{c,i,t} \leq 1$.

The transports variable, $\tau_{i,t}(p_c, s_c)$, is a function of the sales and the production variables and thereby dependent on them.

$$\tau_{i,t}(p_c, s_c) \equiv \sum_{c=1}^{C} \max\left(p_{c,i,t} - s_{c,i,t}; 0\right)$$

The question is, can transports change at the same time as the other regressors are kept constant? If sales and production for all five continents are included, transports cannot change without any pair of for example sales variables changing. If one of the ten sales and production variables are excluded, transports can vary freely without affecting the other nine regressors. However, because of the perfect multicollinearity relationship between the sales variables and the perfect multicollinearity relationship between the production variables, concluded above, I need to exclude at least one variable each of sales and production. If I exclude two variables, one from the five sales variables and one from the five production variables, then the each of sales variables, the production variables and the transport variable can in theory vary solely.

Even if there is no perfect multicollinearity, there can be near multicollinearity, which can cause minor problems. Near multicollinearity occurs when two regressors are almost, but not perfectly linear. According to Gujarati (2003, p. 347), an outside term, v_i, can affect the relationship between the two variables to become not perfectly linear.

$$X_{3i} = \varphi X_{2i} + v_i$$

In the case of a stochastic outside term, v_i, which is not linear to any of the parameters, X_{2i} or X_{3i}. The nonlinear relationship between the regressand, x_{2i}, and the stochastic outside term, v_i, is expressed as $\sum v_i x_{2i} = 0$ and the estimated parameter becomes

$$\hat{\beta}_2 = \frac{(\sum y_i x_{2i})(\varphi^2 \sum x_{2i}^2 + \sum v_i^2) - (\varphi \sum y_i x_{2i} + \sum y_i v_i)(\varphi \sum x_{2i}^2)}{(\sum x_{2i}^2)(\varphi^2 \sum x_{2i}^2 + \sum v_i^2) - (\varphi \sum x_{2i}^2)^2}$$

If the relationship between the parameters, X_{2i} and X_{3i}, is very strong but not perfect, v_i will be very small and the estimated parameter, $\hat{\beta}_2$ will be near indeterminate, become very sensitive to changes in the regressors. Another effect is that the variance will be very high. However, even though the estimated parameter will be sensitive small changes in the regressors, the parameter will be unbiased.

Also even though the variance is very high, it will be still have the property of minimum variance and the variance will thereby be efficient.

The sensitivity of the estimated parameters from multicollinearity is simply from the fact that the sample is too scarce from information to be able to separate the effect of the partially collinear regressors. Therefore small changes in the regressors will be considered as largely changing the informative properties of the data and therefore the parameter will change largely. Following the scarcity of information, the variance of the estimated parameter will be very high, informing that the estimated parameter is insignificant.

The problem of near multicollinearity is simply that it is difficult to see the individual effect a regressor has on a regressand, but the estimated parameters will be unbiased and its variance will be efficient. There is in fact only one regressand I am really interested in, which is the effect that intercontinental transports have on operating margin. I will consider all the other variables as control variables. I am not interested in the individual intercepts of firms or time periods. I may have some interest in the sales and production marginal effect on profits, but the main use of the sales and production regressors is to control for them in the regression, since the transport variable is a function of them.

KEY POINTS

Multicollinearity means that some regressors have some linear relationship. I believe that there can be multicollinearity between some of the regressors in my sample. Multicollinearity does not bias any of the estimated parameters. Multicollinearity does not bias any of the variances of the parameters (variances are effective), but the variances can be higher due to multicollinearity. This is due to the fact that since variables are linear, it can be difficult for the OLS to distinguish which variable that has which effect on the regressand. Even though the variances are effective, it can be problematic for me to make statistical inferences, due to the high variances. I need to avoid perfect multicollinearity by analyzing the mathematical relationships between the variables. For example all continents' shares of world sales variables cannot be included due to that they always sum to one, vice versa for the production variables. Among the regressors, there are variables which I have interest in (transports mainly and at some extent continental share of sales and continental share of production) and control variables. If the variables I have interest in are significant I do not need to worry about multicollinearity, otherwise I need to test for multicollinearity and execute alternative regressions where I exclude suspected collinear variables just to see their estimated parameter and their significance.

If the estimated transportation parameter is significant in my model, I do not have any problems with multicollinearity. If I want to see the marginal effect of continental sales and continental production on profit, I may need to remove one or two extra of those variables until the continental sales and continental production become significant.

A.5.4.3 UNIT ROOT AND AUTOCORRELATION

According to Gujarati (page 450), if the error term is generated by the following mechanism

$$u_t = \rho u_{t-1} + \varepsilon_t$$

Where ρ is the correlation term between the current error, u_t, and the lagged error, u_{t-1}, the error term is following and autoregressive process of order one, $AR(1)$.

As has been shown above in the heteroscedasticity part, the relation between the true population parameter, β_2, and the sample estimated parameter, $\hat{\beta}_2$, is

$$\hat{\beta}_2 = \beta_2 + \sum k_i \overbrace{E(u_i)}^{0}$$

The variance term, k_i, does not affect the estimated parameter because the expectation of the error term, $E(u_i)$, is zero.

$$\hat{\beta}_2 = \beta_2$$

Just like in the heteroscedasticity case, the autocorrelation does not affect the unbiasedness property of the estimated parameter, $\hat{\beta}_2$. $\hat{\beta}_2$ is still asymptotically unbiased.

However, just as in the heteroscedasticity case, the variance of the estimated parameter, $Var(\hat{\beta}_2)$, is shown by Gujarati to be inefficient (page 452), because the variance of an estimated parameter which does neither have the heteroscedasticity or autocorrelation properties is

$$Var(\hat{\beta}_2) = \frac{\sigma^2}{\sum x_{2t}^2}$$

While the variance of an error term, u_t, following the autoregressive process of order one, $AR(1)$, is

$$Var(\hat{\beta}_2)_{AR(1)} = \frac{\sigma^2}{\sum x_{2t}^2}\left[1 + 2\rho\frac{\sum x_t x_{t-1}}{\sum x_t^2} + \cdots + 2\rho^{n-1}\frac{\sum x_1 x_n}{\sum x_t^2}\right]$$

If the regressor, X, also follow an $AR(1)$ process

$$X_t = \rho X_{t-1} + \varepsilon_t$$

the variance of the estimated parameter, $\hat{\beta}_2$, is

$$Var(\hat{\beta}_2)_{AR(1)} = \frac{\sigma^2}{\sum x_{2t}^2}\left(\frac{1 + r\rho}{1 - r\rho}\right)$$

Which can be larger or smaller than the OLS estimator.

Gujarati show that using GLS, an unbiased estimator with efficient variance in an $AR(1)$ process is

$$\hat{\beta}_2^{GLS} = \frac{(1-\rho^2)x_1 y_1 + \sum_{t=2}^{n}(x_t - \rho x_{t-1})(y_t - \rho y_{t-1})}{(1-\rho^2)x_1^2 + \sum_{t=2}^{n}(x_t - \rho x_{t-1})^2}$$

And the variance is

$$Var(\hat{\beta}_2^{GLS}) = \frac{(1-\rho^2)x_1 y_1 + \sigma^2}{(1-\rho^2)x_1^2 + \sum_{t=2}^{n}(x_t - \rho x_{t-1})^2}$$

If the there is no autocorrelation, then the autocorrelation is $\rho = 0$, and then the variance of the OLS estimator is as efficient as the GLS one, since they are the same by definition. So if there is autocorrelation or no autocorrelation, the GLS estimator will be asymptotically efficient and unbiased. Since I have large sample, there is no

cost of using a GLS estimator. Also, if I for example find that there is autocorrelation in the time dimension, I can cluster the standard errors in the firm dimension and thereby correct the estimated variances for autocorrelation, given that I have a large sample which I have. However, I will make some simple tests for any suggestion of autocorrelation, heteroscedasticity and multicollinearity in my sample.

A very special case of autocorrelation occurs when the autocorrelation is $|\rho_{t-1,t}| = 1$. In the case of a variable, Y_t, having the autocorrelation $|\rho_{t-1,t}| = 1$, Y_t is following this process

$$Y_t = \rho_{t-1,t} Y_{t-1} + u_t$$

$$Y_t = Y_{t-1} + u_t$$

Where u_t is a white noise error term. As can be seen, the present value of, Y_t, is generated by last periods value Y_{t-1}, and an independent error term, u_t. The mean value of Y, μ_Y, is calculated from past values of Y. The todays value would not move towards that mean value, μ_Y, because it would only move towards the direction of the error, u_t.

Gujarati (p 799) proves that the expected value of Y, is constant and equal to its initial value

$$Y_t = Y_0 + \sum u_t$$

$$E(Y_t) = E\left(Y_0 + \sum u_t\right) = Y_0$$

Since $E(u_t) = 0$ and Y_0 is known.

The variance is however increasing as t increases since

$$Var(Y_t) = E\left(Y_0 + \sum u_t\right)^2 = Y_0^2 + E\left(\sum u_t^2\right)$$

If the variance has homoscedastic property assumed to be known and Y_0 is assumed to be zero

$$Var(Y_t) = E\left(\sum \sigma_t^2\right) = E\left(\sum \sigma^2\right) = t\sigma^2$$

So, when $|\rho_{t-1,t}| = 1$, the expected value of Y is constant and the variance of Y is increasing with the time periods, t. When $|\rho_{t-1,t}| = 1$, the direction of Y at today, t, is decided solely by the error term u_t and Y is said to follow a random walk.

If the autocorrelation instead would be $|\rho_{t-1,t}| < 1$, the todays variable Y would follow the same process

$$Y_t = \rho_{t-1,t} Y_{t-1} + u_t$$

But the todays value, Y_t, would return to its mean, μ_Y, since last year's value would not have such high influence. Since Y is mean reverting when $|\rho_{t-1,t}| < 1$, the expected value of Y is a constant

$$E(Y_t) = E\left(\frac{\sum Y_{t-1}}{t-1}\right) = \mu_Y$$

Also the expected variance would be a constant

$$Var(Y_t) = E(Y_t - \mu_Y)^2 = \sigma^2$$

The autocovariance would also be

$$\gamma_k = E\big((Y_t - \mu_Y)(Y_{t+k} - \mu_Y)\big)$$

If the expected value, the variance and the autocovariance for a variable is constant (time invariant), the variable is said to be stationary, and thereby statistical estimations can be done from all time periods and not only from the current time period, which only consist of one observation.

If $|\rho_{t-1,t}| = 1$, the expected value, Y_0, is constant but consists only of one period and the variance is increasing to be asymptotically infinite. If the autocorrelation is $|\rho_{t-1,t}| = 1$, the variable is said to be nonstationary and etimations cannot be done from all time periods. A process generating a variable with $|\rho_{t-1,t}| = 1$ is also called a unit root process, since if $|\rho_{t-1,t}| = 1$ then

$$Y_t - Y_{t-1} = u_t$$

And using a lag operator, L

$$LY_t = Y_{t-1}$$

$$L^2 Y_t = Y_{t-2}$$

Then

$$(1 - L)Y_t = u_t$$

If setting

$$(1 - L) = 0$$

Then

$$L = 1$$

And the root of the polynomial operator L^2 is unit, or one.

In order to make use of all my samples, I need to see that all variables follow a stationary process. In order to make statistical inference about stationarity I need to use methods testing for existence or methods testing for nonexistence of unit root.

One method of testing for stationarity is

$$Y_t = \rho_{t-1,t} Y_{t-1} + u_t$$

Subtracting Y_{t-1} on both sides

$$Y_t - Y_{t-1} = (\rho_{t-1,t} - 1) Y_{t-1} + u_t$$

Which can be rewritten as

$$\Delta Y_t = \delta Y_{t-1} + u_t$$

If δ is tested to be statistically significant from zero, the variable Y generated by a stationary process and hence there is no unit root. If δ is not statistically significant from zero, no conclusion can be made regarding if the variable Y is stationary or not. Therefore, I need to be cautious using the variable Y, if it cannot be proved to be stationary.

According to Gujarati there are two specific tests which I can use for proving that the variable Y is stationary, $I(0)$; the Dickey-Fuller test and the Augmented Dickey-Fuller test. The Augmented Dickey-Fuller test takes three forms.

Y_t is a random walk: $\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + u_t$

Y_t is a random walk with drift β_1: $\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + u_t$

Y_t is a random walk with drift β_1

around a stochastic trend t: $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + u_t$

Even though the variable Y is not mean reverting to its own mean, it can mean revert to its mean with a drift, β_1, or around a trend, t. If the estimated parameter, δ, is significantly different from zero in any of the three forms, the autocorrelation $|\rho_{t-1,t}| < 1$ and there is strong proof for nonexistence of a unit root and that the variable Y is generated by a stationary process. Since the regression test assumes the error term, u_t, to not be serially correlated, any correlation can be removed with the terms $\sum_{i=1}^{m} \alpha_i \Delta Y_{t-i}$ which is the augmentation of the ordinary Dickey-Fuller test. The importance of the test is the strength of correlation between the current time period's value and the previous time period's value, which is estimated with the parameter δ. Since most firms have 39 time periods, I do not want to use too many lagged observations adjusting for autocorrelation in the error term, u_t. I will use Akaike's Information Criteria (AIC) and Schwartz Information Criteria (SIC).

According to Gujarati (p 822), I can also check if the regressor and the regressand both have a unit root, that they both have are integrated of order one, $I(1)$, for a specific firm. In that case I can also check if the regressor and the regressand are cointegrated, so that they cancel out the stochastic trends in the two series. For example if the regressor increases stochastically, without mean reverting, over the time periods, the regressand might do the exactly same thing. In that case the regression between the regressor and the regressand might be meaningful, even if they do not revert to their own mean, the regressor and the regressand may have a common trend which they revert to as a mean. I can first check if both the regressor and the regressand are integrated of order one, $I(1)$, and then I regress them and see if the error, u_t, is integrated of order zero, $I(0)$, which means that the error does not have any autocorrelation $|\rho_{t-1,t}| = 1$ and that the error is stationary.

My strategy is that, if the nonexistence of unit root, $I(0)$, cannot be proved for all of the regressors and the regressand (for a specific firm), and that regressors and regressand are not all simultaneously unproved to be such nonexistence of unit root, $I(0)$, or that the regressors and the regressand are all simultaneously unproved to be such nonexistence of unit root, $I(0)$, while it cannot be proved that the regressors and the regressand together are cointegrated, $I(0)$, it would be safest to take action against a possible unit root.

A way to test for cointegration between the regressors and the regressand, is to check for unit root in the error term of the regressor, u_t, using a modified version of the Dickey-Fuller or the Augmented Dickey-Fuller tests, called Engle-Granger (EG) or the Augmented Engle-Granger (AEG) tests. The equation generating the error term to test, is

$$Y_t = \beta_1 + \beta_2 X_{2t} + u_t$$

And the variable to test for unit root is not any of the regressors or the regressand, but the error term, u_t. The Augmented Engle-Granger test takes three forms.

u_t is a random walk: $\Delta u_t = \delta u_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta u_{t-i} + \varepsilon_t$

u_t is a random walk with drift β_1: $\Delta u_t = \beta_1 + \delta u_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta u_{t-i} + \varepsilon_t$

u_t is a random walk with drift β_1

around a stochastic trend t: $\Delta u_t = \beta_1 + \beta_2 t + \delta u_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta u_{t-i} + \varepsilon_t$

The difference between the DF, ADF and the EG, AEG tests is that since the estimated error, u_t, is based on the estimated cointegrating parameter, β_2, the DF and the ADF critical significance values are not correct. Engle-Granger have calculated appropriate critical values for their cointegration test.

If my sample cannot be proved to not having unit root or proved to be cointegrated, I can try to remove firms which has variables which possibly suffer

from unit root problem, or I can try to make the regression first-difference stationary

$$(Y_t - Y_{t-1}) = \Delta Y_t = u_t$$

According to Gujarati (2003, p. 800) ΔY_t is stationary, since its mean is constant around 0 and variances can also be assumed to be constant.

KEY POINTS

Autocorrelation does not affect the unbiasedness property of the estimated parameter. But just like in the heteroscedasticity case, autocorrelation affects the variance of the estimated parameter to be inefficient and it may therefore be difficult to make statistical inference. And just like in the heteroscedasticity case, the GLS regression will correct for autocorrelation in the variables and the error term.

Unit root is when a variable is perfectly correlated with its own lag, and a variable generated by a unit root process has asymptotically infinite variance and the estimated parameter will converge to zero asymptotically. It is important that I check for unit root, at the individual firm level, with the DF and the ADF tests, so that I do not destroy the model analysis with meaningless nonstationary data. My main rule is to exclude a firm which has a variable is generated with a unit root process.

If a regressor and a regressand both are generated by a unit root process, they may be cointegrated so that the regressor's and the regressand's individual unit root processes cancel out each other, and then the cointegrated time-series becomes stationary and meaningful. My exceptional rule is that if two variables both are generated by a unit root process and they are cointegrated, I can include them in the regression. I therefore need to test firms suffering from unit root, if its variables are for cointegrated, using the EG and the AEG tests.

A.5.4.4 MODEL SPECIFICATION ERROR

If the model is incorrectly specified, some biasedness in the estimated parameters and some effects on the variances of the parameters can occur. According to Gujarati (2003, p. 509), there are five main types of model specification errors; omission of a relevant variable, inclusion of an unnecessary variable, adoption of the wrong functional form, errors of measurement, incorrect specification of the stochastic error term.

Gujarati (2003, p. 510) analyze the effect of omitting a variable from the model, beginning with the biasedness property of estimated parameters.

Assume that the true population model is

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + u_i$$

But the estimated model is

$$Y_i = \alpha_1 + \alpha_2 X_{2i} + v_i$$

The deviation from the true population regression model can be rewritten as

$$y_i = \beta_2 x_{2i} + \beta_3 x_{3i} + (u_i - \bar{u})$$

Multiplying by x_{2i} on both sides, the normal equations are

$$\sum y_i x_{2i} = \beta_2 \sum x_{2i}^2 + \beta_3 \sum x_{2i} x_{3i} + \sum x_{2i}(u_i - \bar{u})$$

Dividing by $\sum x_{2i}^2$ on both sides

$$\frac{\sum y_i x_{2i}}{\sum x_{2i}^2} = \beta_2 + \beta_3 \frac{\sum x_{2i} x_{3i}}{\sum x_{2i}^2} + \frac{\sum x_{2i}(u_i - \bar{u})}{\sum x_{2i}^2}$$

Since the slope of the x_2 effect on y is

$$b_{12} = \frac{\sum y_i x_{2i}}{\sum x_{2i}^2}$$

And the slope of the omitted x_3 effect on the x_2 is

$$b_{23} = \frac{\sum x_{2i} x_{3i}}{\sum x_{2i}^2}$$

Then

$$b_{12} = \beta_2 + \beta_3 b_{23} + \frac{\sum x_{2i}(u_i - \bar{u})}{\sum x_{2i}^2}$$

Expectations on error is zero and then the expectations on the function is

$$E(b_{12}) = \beta_2 + \beta_3 b_{23}$$

Since $E(b_{12}) = E(\hat{\alpha}_2)$

$$E(\hat{\alpha}_2) = \beta_2 + \beta_3 b_{23}$$

The expectation of the estimated sample $\hat{\alpha}_2$ is equal to the true population parameter β_2 and the bias term, $\beta_3 b_{23}$, which consists of the true population parameter β_3 union the of the omitted x_3 effect on the x_2. $\hat{\alpha}_2$ is therefore biased unless the true parameter, β_3 is zero (which it is not if it is included in the true model) or if X_2 and X_3 are uncorrelated.

Gujarati (2003, p. 512) continue with the unbiasedness property of the estimated variances of $\hat{\alpha}_2$ and $\hat{\beta}_2$. The estimated sample model is a one regressor model

$$Var(\hat{\alpha}_2) = \frac{\sigma^2}{\sum x_{2i}^2}$$

The true population model is a two regressor model

$$Var(\hat{\beta}_2) = \frac{\sigma^2}{\sum x_{2i}^2(1 - r_{23}^2)}$$

Where r_{23} is the correlation coefficient between the variables X_2 and X_3. $Var(\hat{\beta}_2)$ is the unbiased variance of the parameter since it is from the true model. Then $Var(\hat{\alpha}_2)$ is biased. It may seem that $Var(\hat{\alpha}_2) < Var(\hat{\beta}_2)$ since $0 < r_{23} < 1$. However, it is not necessary that $Var(\hat{\alpha}_2) < Var(\hat{\beta}_2)$ since the estimated variance of the error term, $\hat{\sigma}^2$, may be lower for the true population model.

$$\hat{\sigma}^2 = \frac{RSS}{df}$$

Since the residual sum of squares for a true model may be lower even if the degree of freedom is lower. I believe that in a sample like mine, which consists of around 900 observations, the effect on the degrees of freedom of an extra parameter may be much smaller than the than the reduction of the residual sum of squares and therefore in my case I believe that omitting one variable has the effect $Var(\hat{\alpha}_2) > Var(\hat{\beta}_2)$. The $\hat{\beta}_2$ is anyway efficient while the $\hat{\alpha}_2$ is unefficient.

Gujarati (2003, p. 513) continue with analyzing the effect of including an irrelevant variable, beginning with the biasedness property of estimated parameters.

Assume that the true population model is

$$Y_i = \beta_1 + \beta_2 X_{2i} + u_i$$

But the estimated model is

$$Y_i = \alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_{3i} + v_i$$

The estimated parameter for the true model, $\hat{\beta}_2$, is unbiased

$$\hat{\beta}_2 = \frac{\sum y x_2}{\sum x_2^2}$$

Since the estimated model includes an extra irrelevant variable we obtain

$$\hat{\alpha}_2 = \frac{(\sum y_i x_{2i})(\sum x_{3i}^2) - (\sum y_i x_{3i})(\sum x_{2i} x_{3i})}{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i} x_{3i})^2}$$

The deviation from the true population regression model can be rewritten as

$$y_i = \beta_2 x_{2i} + (u_i - \bar{u})$$

The expectation of y_i is

$$E(y_i) = \beta_2 x_{2i}$$

And the expectation of $\hat{\alpha}_2$ is then

$$E(\hat{\alpha}_2) = \beta_2 \frac{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i}x_{3i})^2}{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i}x_{3i})^2} = \beta_2$$

The estimated parameter for the variable X_2 in the estimated model, $E(\hat{\alpha}_2)$, is then expected to be equal to the unbiased parameter, β_2, from same variable in the true population model.

Then Gujarati analyze the expectation of the included irrelevant variable

$$\hat{\alpha}_3 = \frac{(\sum y_i x_{3i})(\sum x_{2i}^2) - (\sum y_i x_{2i})(\sum x_{2i}x_{3i})}{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i}x_{3i})^2}$$

The expectation of y_i is still

$$E(y_i) = \beta_2 x_{2i}$$

And therefore

$$E(\hat{\alpha}_3) = \frac{(\sum x_{2i}x_{3i})(\sum x_{2i}^2) - (\sum x_{2i}x_{3i})(\sum x_{2i}^2)}{(\sum x_{2i}^2)(\sum x_{3i}^2) - (\sum x_{2i}x_{3i})^2} = 0$$

The estimated parameter for the variable X_2 in the estimated model, $E(\hat{\alpha}_2)$, is then expected to be zero, which is equal to the unbiased parameter, β_2, from same variable in the true population model.

Gujarati (2003, p. 513) then continue to analyze the unbiansedness property of the estimated variances of $\hat{\alpha}_2$ and $\hat{\beta}_2$. The true population model is a one regressor model

$$Var(\hat{\beta}_2) = \frac{\sigma^2}{\sum x_{2i}^2}$$

The estimated sample model is a two regressor model

$$Var(\hat{\alpha}_2) = \frac{\sigma^2}{\sum x_{2i}^2(1 - r_{23}^2)}$$

$$\frac{Var(\hat{\alpha}_2)}{Var(\hat{\beta}_2)} = \frac{1}{1 - r_{23}^2}$$

Where r_{23} is the correlation coefficient between the variables X_2 and X_3. $Var(\hat{\beta}_2)$ is the unbiased variance of the parameter since it is from the true model. Then $Var(\hat{\alpha}_2)$ is biased. One can see that $Var(\hat{\alpha}_2) > Var(\hat{\beta}_2)$ since $0 < r_{23} < 1$.

I believe that I have too few variables, since many other things than transports, marginal revenues and marginal sales affect profits. Therefore I believe that my estimated parameters may be slightly biased and have inefficient variances, given that there is some correlation between the included variables which parameters that I am estimating and the excluded variables which parameters I am not estimating. I therefore need to think carefully if there can be any variables excluded from the model that is linear with my main variable of interest, transports.

Gujarati (2003, p. 524) also explain the effect of errors of measurement. There are two types of measurement errors which have different effects on unbiasedness property of the estimated parameters and the estimated variance of the estimated parameters; measurement errors in the regressand, measurement error in the regressors.

Measurement errors in the regressand are not as severe as measurement errors in the regressors. Consider this true model

$$Y_i^* = \alpha + \beta X_i + u_i$$

If the regressand, Y_i^*, is not completely measurable, an observable variable, Y_i, can be used instead so that

$$Y_i = Y_i^* + \varepsilon_i$$

The estimated regression model is then

$$Y_i = \alpha + \beta X_i + (u_i + \varepsilon_i) = \alpha + \beta X_i + v_i$$

Where $v_i = u_i + \varepsilon_i$ is the composite error term.

I return to Gujarati's (2003, p. 100) the unbiasedness property of the estimated parameter. For example a two variable, X and Y, regression has this linear estimator

$$\hat{\beta}_2 = \frac{\sum x_{2i} Y_i}{\sum x_{2i}^2} = \sum k_i Y_i$$

Where

$$k_i = \frac{x_{2i}}{(\sum x_{2i}^2)}$$

k_i has these properties

- $\sum k_i = 0$ because a variables sum of deviations $\sum x_{2i}$ from that same variable is always 0
- $\sum k_i^2 = \left(\frac{\sum x_{2i}}{(\sum x_{2i}^2)}\right)^2 = \frac{\sum x_{2i}^2}{\sum x_{2i}^4} = \frac{1}{(\sum x_{2i}^2)}$
- $\sum k_i x_{2i} = \sum \frac{x_{2i}}{(\sum x_{2i}^2)} x_{2i} = \sum \frac{x_{2i}^2}{(\sum x_{2i}^2)} = \frac{\sum x_{2i}^2}{\sum x_{2i}^2} = 1$

Substituting the population regression function $Y_i = \beta_1 + \beta_2 X_{2i} + u_i + \varepsilon_i$ which contains the true parameters β_1 and β_2 and the error u_i into the definition of the estimated parameter.

$$\hat{\beta}_2 = \sum k_i(\beta_1 + \beta_2 X_{2i} + u_i + \varepsilon_i)$$

$$\hat{\beta}_2 = \beta_1 \overbrace{\sum k_i}^{0} + \beta_2 \overbrace{\sum k_i X_{2i}}^{1} + \sum k_i u_i + \sum k_i \varepsilon_i$$

$X_{2i}$is assumed to be nonstochastic and therefore k_i is assumed to be nonstochastic. u_i and ε_i is expected to be zero.

$$\hat{\beta}_2 = \beta_2 + \sum k_i \overbrace{E(u_i)}^{0} + \sum k_i \overbrace{E(\varepsilon_i)}^{0}$$

So regardless of the properties of the regressand, Y_i, the estimated parameters will be asymptotically equal to the true population parameter and unbiased.

$$\hat{\beta}_2 = \beta_2$$

Gujarati (2003, p. 525) continue with analyzing how the variances of the estimated parameters are affected from measurement errors in the regressand, Y_i. For a two variable model, if the regressand has no measurement errors, the variance of the estimated parameter is

$$Var(\hat{\beta}) = \frac{\sigma_u^2}{\sum x_i^2}$$

If the regressand has measurement errors, ε_i, the variance of the estimated parameter is

$$Var(\hat{\beta}) = \frac{\sigma_u^2 + \sigma_\varepsilon^2}{\sum x_i^2}$$

In the presence of measurement errors, ε_i, the measurement error variance, σ_ε^2, is positive and therefore the variance of the estimated parameter, $\hat{\beta}$, is effective and higher than the variance of the estimated parameter would be if there would be no measurement errors, ε_i.

Measurement errors in the regressor are more severe than measurement errors in the regressand. Consider this true model

$$Y_i = \alpha + \beta X_i^* + u_i$$

If the regressor, X_i^*, is not completely measurable, an observable variable, X_i, can be used instead so that

$$X_i = X_i^* + w_i$$

The estimated regression model is then

$$Y_i = \alpha + \beta(X_i - w_i) + u_i = \alpha + \beta X_i + z_i$$

Where $z_i = u_i - \beta w_i$ is the composite error term. The composite error term, z_i, is not independent of the regressor, X_i

$$Cov(z_i, X_i) = E\left(\overbrace{z_i}^{u_i - \beta w_i} - \overbrace{E(z_i)}^{0}\right)\left(\overbrace{X_i - E(X_i)}^{w_i}\right)$$

$$= E(u_i - \beta w_i)(w_i)$$

$$= \overbrace{E(u_i w_i)}^{\substack{0 \text{ if } u \text{ and } w \\ \text{uncorrelated}}} - E(-\beta w_i^2)$$

$$= -\beta\sigma_w^2$$

and therefore the regressor, X_i, is correlated with the error term, z_i, even if the mean of the measurement error, w_i, is zero $\overline{w_i} = 0$.

The estimated parameter is

$$\hat{\beta}_2 = \sum k_i(\beta_1 + \beta_2 X_{2i} + z_i)$$

$$\hat{\beta}_2 = \beta_1 \overbrace{\sum k_i}^{0} + \beta_2 \overbrace{\sum k_i X_{2i}}^{1} + \sum k_i z_i$$

Where

$$k_i = \frac{x_{2i}}{\left(\sum x_{2i}^2\right)}$$

And

$$k_i z_i = \frac{Cov(z_i, X_i)}{\left(\sum x_{2i}^2\right)} = \frac{-\beta\sigma_w^2}{\sum x_{2i}^2}$$

And

$$\hat{\beta}_2 = \beta_2 + E\left(\frac{-\beta_2 \overbrace{\overbrace{\sigma_w^2}}^{\substack{\neq 0 \text{ if} \\ \text{measurement} \\ \text{error}}}}{\sum x_{2i}^2}\right)$$

Therefore, if there are measurement bias then $\sigma_w^2 > 0$ and then the estimated parameter, $\hat{\beta}_2$, will not be asymptotically equal the true population parameter, β_2. The estimated parameter is thereby biased and inconsistent.

Gujarati returns to the variance of the estimated parameter. For a two variable model, if the regressand has no measurement errors, the variance of the estimated parameter is

$$Var(\hat{\beta}) = \frac{\sigma_u^2}{\sum x_i^2}$$

If the regressor has measurement errors, w_i, the variance of the estimated parameter is

$$Var(\hat{\beta}) = \frac{\sigma_u^2 + \sigma_w^2}{\sum x_i^2}$$

Which is efficient but higher than without measurement errors in the regressors.

I believe that I might have measurement error in the production variables, since I proxy the production variables from employee data. I have data of the number of employees per continent for every firm and time period. In order to get a measure of the continental share of world production, I will use continental share of world employees and deduct the number with, by me assumed, continental share of world administrative personnel. I do believe that there are four main measurement problems with my production regressors:

a) Continental production employee data might not be a good proxy for in which continent a firm produces its physical goods.
b) The assumed continental share of world administrative employees might be incorrect, leading to incorrect measure of production employee data.
c) The continental total employee data are in some time periods for some firms assumed by me, due to varying detail in reporting of employee data.
d) I assume that the relative amount of outsourcing production to in house production is equal in all continents, which may be a strong and incorrect assumption, leading to measurement bias in data for firms of high ratio of outsourcing.

The relative size of measurement errors of type a), b), c) and d) might be different.

In order to estimate the validity of data regarding the risk of measurement errors from a), I will do comparisons with other variables assumed to be linear with the unobservable continental share of production, like factory size in square meters per continent, and similar variables which is not frequently reported. However, variables like factory size might not be as linear to production as employee data is, since the firm might have different strategies in different continents regarding leasing and owning factory buildings. I will also read the annual reports to try to get an overall

impression of the changes in production locations, and then compare the overall impression with the changes in continental share of world employee data, which I believe may create a better estimate than aggregated factory size.

In order to estimate the validity of data regarding the risk of measurement errors from b), I will contact firms in order to get some type of validation of this data. Some annual reports also report share of administrative personnel.

Regarding the risk of measurement problems from c), there are only very few years missing data and only for some firms that missing variables are assumed. Also the assumptions will be quite accurate, since I variables from most other years for the firm is visible.

The risk of measurement errors from d) may be higher. I assume that each firm has the same amount ratio of outsourcing to in-house production in all continents. If the assumption is true, then I also use the amount of people administrating the outsourcing as a proxy for production. This assumption may be strong, but not completely improbable. However, if the ratio of outsourcing to in-house production is too high (like H&M which has outsourced all goods sold since the creation of the firm), the number of employees per continent is probably a bad proxy for where goods are produced, since a single purchasers may purchase goods produced by hundreds of people. A purchaser then becomes a proxy for producing personnel and producing personnel, and producing personnel is a proxy for the amount of goods produced. One more problem is that purchasers may be centralized to the firms headquarter in the country of origin. The lower the ratio of outsourcing to in-house production is, the lower the measurement error in production. The more equal the ratio of outsourcing to in-house production is per continent, the lower is the measurement error in production.

Regarding measurement error in sales, it is quite low and mostly generated by reporting of the firms itself, since the sales amount per continent is presented for of the most continents at most of the times for most of the firms. Any missing observations can be calculated and/or assumed.

The intercontinental transport variable is solely a function of intercontinental sales and production variables, so it may as well have measurement errors, derived from its parameters intercontinental production and intercontinental sales.

The regressand, operating margin, is taken directly from the annual reports, so I assume that the regressand does not have much measurement errors. Also measurement errors in the regressand are not as severe as having measurement errors in the regressors, since measurement errors in the regressand does not destroy the unbiasedness property of the estimated parameters.

Since I need to make different assumptions for different firms, due to their differences in reporting and the differences in the nature of the firms, measurement errors may also be firm specific. As Gujarati proved, measurement errors in both

the regressand and the regressors leave traces in a composite error term, consisting of white noise error term and measurement error term. Since there may be dependence between the firm and the measurement error, and that my model will have firm individual intercepts, those intercepts may be correlated with the control variable. If the intercepts are included in the composite error term, which may consist of white noise, firm individual intercept and measurement error, there might be more correlation between the control variables and the error term, which may bias the estimated parameters. Therefore I cannot put the firm individual intercepts in the composite error term, but instead I can put the firm individual intercepts as a dummy regressor. If the firm individual intercept is put as a dummy regressor, and it is correlated with the production regressor containing the measurement error, the intercept may cancel out some of the measurement error. A random effects estimator puts the firm individual intercept in the error term and a fixed effects estimator puts the firm individual intercepts as binary dummy regressors. Because of the assumed correlation between the intercepts and the production variables due to measurement errors, I will use firm fixed effects. For the time dimension I do not find any theoretical reason why specific time periods should have systemic measurement errors. Therefore I assume that regarding measurement errors, none of the regressors of interest like the production variables, have dependency to the time individual intercepts. So I find no theoretical reasons why the time individual intercepts cannot be put in the composite error term and therefore I can use the Hausman test to check if the time random effects estimator is more efficient than the time fixed effects estimator.

KEY POINTS

Including extra irrelevant variables does not affect the unbiasedness property of the estimated parameter or the efficiency of the variance of the estimated parameter. However, excluding relevant variables can bias the included estimated parameter and make the variance of the included estimated parameter inefficient, given that there is correlation between that same included variable and the excluded variable. I believe that I have excluded many variables, since many other things than transportation, marginal revenues and marginal costs affect profits. The important question is if those excluded variables are correlated with the included main variable of interest, transports. I will need to think carefully for such excluded variables. If there are no such excluded variables correlated with the included main variables of interest, there is no problem in my model. Since I believe that I have excluded many variables, there are many variables explaining the regressand which is not in my model and therefore I expect the R^2 to be quite low, which per se is not a problem.

Measurement error in the regressand will be very small in my sample and any measurement error in the regressand may not bias the estimated parameter

A.5.4.5 ESTIMATION OF PARTIAL ELASTICITIES

The elasticity I measure is a constant parameter of partial elasticity. However, in reality elasticities are variable and depending on the combination of the variables measured (Wooldridge 2003, p.16-17).

Therefore I can also measure a constant parameter elasticity variable with either $\pi \; or \; q$ or variable with both π and q.

Assume q_j is a continuous variable and $\mu(q)$ is appropriately differentiable.

$\Delta E(\pi|q) \approx \frac{\delta \mu(q)}{\delta q_j} \times \Delta q_j$, holding $x_1, \dots, x_{j-1}, x_{j+1}, \dots, x_k$ fixed (Wooldridge 2003, p15)

Regression $E(\pi|q) = \beta q$

First order condition $\frac{\delta E(\pi|q)}{\delta q_1} = \beta_1$ is the slope

Elasticity as defined above (Wooldridge 2003, p.16)

$$\varepsilon_{transport} = \frac{\delta\pi}{\delta q_j} \times \frac{q_j}{\pi} = \frac{\delta f(q)}{\delta q_j} \times \frac{q_j}{f(q)}$$

Replace $f(q)$ with the conditional mean $\mu(q)$ (Wooldridge 2003 p16)

$$\varepsilon_{transport} = \frac{\delta E(\pi|q)}{\delta q_j} \times \frac{q_j}{E(\pi|q)} = \frac{\delta \mu(q)}{\delta q_j} \times \frac{q_j}{\mu(q)}$$

If $E(\pi|q) > 0$ and $q_j > 0$ since ln of those can't be 0 or less (Wooldridge 2003, p.16)

$$\frac{\delta \ln\big(E(\pi|q)\big)}{\delta E(\pi|q)} = \frac{1}{E(\pi|q)}$$

So

$$\delta \ln\big(E(\pi|q)\big) = \frac{\delta E(\pi|q)}{E(\pi|q)}$$

And

$$\frac{\delta \ln(q)}{\delta q_j} = \frac{1}{q_j}$$

So

$$\delta \ln(q) = \frac{\delta q_j}{q_j}$$

Replace in above and I have the estimation of the constant partial elasticity (Wooldridge 2003, p.17)

$$\varepsilon_{transport} = \frac{\delta \mu(q)}{\delta q_j} \times \frac{q_j}{\mu(q)} = \frac{\delta \ln\big(E(\pi|q)\big)}{\delta \ln(q)}$$

Now derive estimation of the elasticity variable with q.

$$\varepsilon_{transport} = \frac{\delta \mu(q)}{\delta q_j} \times \frac{q_j}{\mu(q)} = \frac{\delta \ln\big(E(\pi|q)\big)}{q} \times q$$

Now derive estimation of the elasticity variable with $E(\pi|q)$.

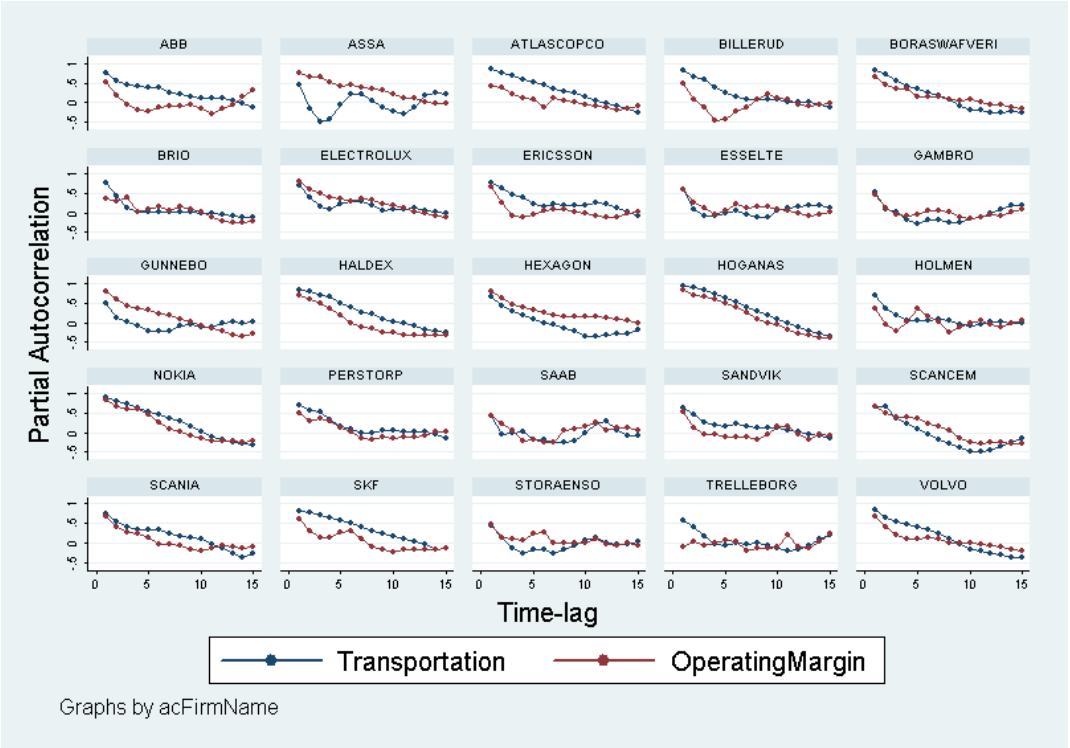
$$\varepsilon_{transport} = \frac{\delta \mu(q)}{\delta q_j} \times \frac{q_j}{\mu(q)} = \frac{E(\pi|q)}{\delta \ln(q)} \times \frac{1}{E(\pi|q)}$$

Appendix A.2 – Robustness Tests

A.2.1 Check for Autocorrelation

I checked for autocorrelation in the time dimension. I assumed that there is no autocorrelation in the firm dimension. The method I use is analyzing a partial autocorrelation diagram

Figure A.2.1.a – Partial autocorrelation of transportation and operating margin



It is easy to see that there is autocorrelation in both the transportation variable and the operating margin variable. I therefore need to control for autocorrelation using GLS autocorrelation robust standard errors.

A.2.2 Check for Unit Root

Cameron (2010 p279) recommends to use Im, Pesaran and Chin (2003) test for unit root, which tests against the alternative hypothesis there is no unit root in the major part of the panel

$$H_a: \rho_1 < 1, \dots, \rho_{N_0} < 1$$

for a fraction $\frac{N_0}{N}$ of the ρ_n.

Table A.2.2.a – Im, Pesaran and Chin (2003) test for unit root

	Lags	1	2	3	4	5
p-value	**Operating Margin**	0.000	0.009	0.085	0.316	0.473
	Transport	0.008	0.029	0.048	0.049	0.121

I thereby reject that there is a Unit Root process in the panel (*Table A.2.2.a*). I will still check for unit root at firm level and co-integration (*Table A.2.2.b*).

Table A.2.2.b –Test for unit root at firm level for operating margin and transports and co-integration between the variables

	Operating Margin			**Transportation**			**Co-integration**		
Trend		*			*			*	
Drift			*			*			*
ABB	A	A	R	A	R	R	R	R	R
ASSA	A	A	A	R	A	R	A	A	R
Atlas Copco	A	A	R	A	A	R	R	R	R
Billerud	R	R	R	A	A	R	R	R	R
Borås Wäfveri	A	A	A	A	A	R	A	A	A
BRIO	R	A	R	A	A	A	A	A	A
Electrolux	A	R	R	R	R	R	A	R	R
Ericcson	R	R	R	A	A	R	R	R	R
Esselte	R	R	R	R	R	R	R	R	R
Gambro	R	R	R	R	A	R	R	R	R
Gunnebo	A	A	R	R	A	R	R	A	R
Haldex	A	A	R	A	A	R	R	R	R
Hexagon	A	A	A	A	A	A	A	A	A
Holmen	R	R	R	R	R	R	R	R	R
Höganäs	A	A	R	A	A	R	A	A	R

Nokia	A	A	R	A	A	R	A	A	R
Perstorp	R	R	R	A	A	R	R	R	R
Saab	R	R	R	R	R	R	R	A	R
Sandvik	R	R	R	A	A	R	R	R	R
Scancem	A	A	R	A	A	R	R	R	R
Scania	A	A	R	A	A	R	R	R	R
SKF	R	A	R	A	A	A	R	R	R
Stora Enso	R	R	R	R	A	R	A	A	R
Trelleborg	R	R	R	A	A	R	R	R	R
Volvo	R	A	R	A	A	A	R	A	R

A.2.3 Check for Multicollinearity

Since the p-values of the parameter I am interested in, Transports, is significant for all variations of regressions, I conclude that there is no multicollinearity of there variable of primary interest. The parameters of secondary interest, the production and sales margins per continent, are mostly significant and the always have the same slopes is I do alternative regressions. Thereby my data does not suffer from multicollinearity.

A.2.4 Check for Heteroscedasticity

I checked heteroscedasticity in residual in both the time (*Figure A.2.4.a)* and firm dimension (*Figure A.2.4.b)*

Figure A.2.4.a – Standard deviation of variables and OLS residual over years

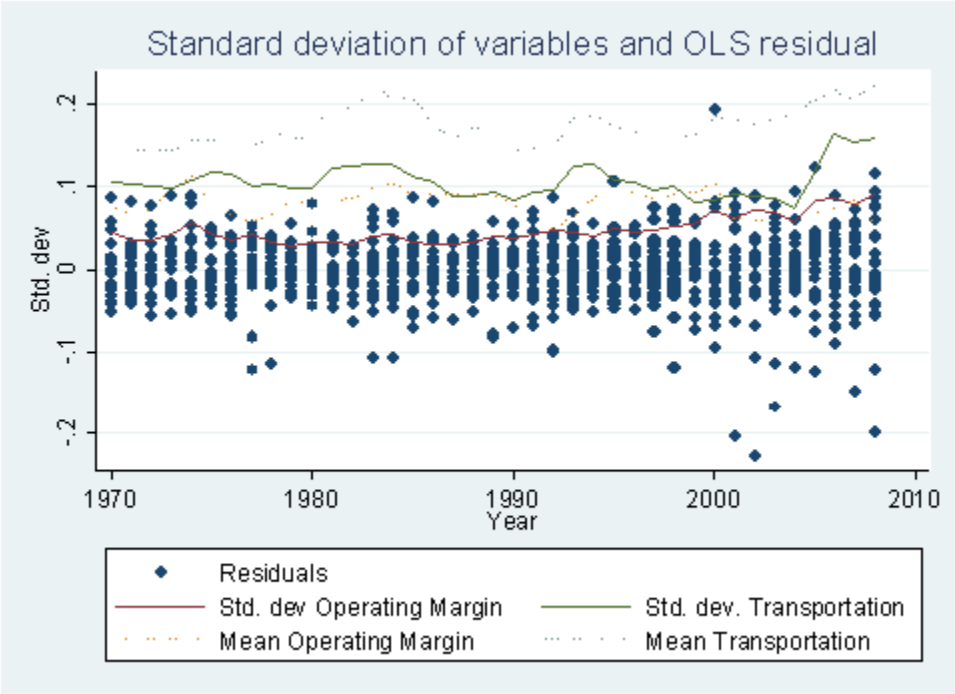
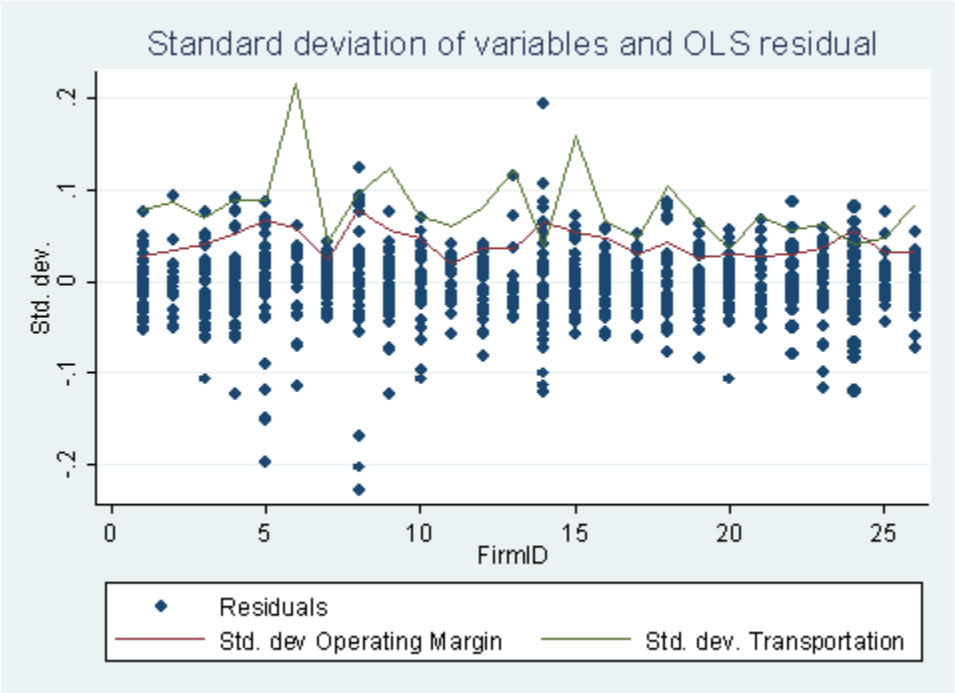


Figure A.2.4.b – Standard deviation of variables and OLS residual over firms



There are some heteroscedasticity in both firm and time dimension. Time dimension has more heteroscedasticity in the end of the time dimension, perhaps because firms take larger risks lately or that firms are exposed for more competition lately or simply because of the two crises which occurred in 2001, 2002 and 2007 and 2008. I believe that the crises are the reason, because the standard deviation in the residual increases then. In this case I do not need to control for heteroscedasticity in the time dimension, since it is due to very few outliers.

In the firm dimension there is some more heteroscedasticity, but not much at all. This is natural since some firms are more volatile than others, which I assumed in the methodology.

I conclude that I can use GLS correcting for autocorrelation in the time dimension and heteroscedasticity in the firm dimension.

A.2.5 Check for Efficiency of Random Effects Model

Since the GLS regression includes the firm and time individual intercepts in the error term, I need to check if the random effects of the firm and time intercepts are efficient using the Hausman test.

Table A.2.5.a – The Hausman test for efficiency of intercepts in the composite error term

		p-value	Theory	Decision
Random Effects	**Time**	0.9998	Intercepts not correlated with composite error	Accept due to p-value and theory
	Firm	1.0000	Measurement errors can be firm individual and thereby the intercepts can be correlated with the composite error	Reject due to theory

My decision is that if I am going to use random effects, I can only use it in the time dimension (*Table A.2.5.a)*.

A.2.6 Check for Robustness in the Estimated Parameter

The estimated parameter and its variances can be sensitive to change in time periods, different industries, data random sampling, autocorrelation, heteroscedasticity or change in estimation techniques. I need to estimate the parameter in all these different settings to see if the estimated parameter is robust to these changes. I will use two main dimensions of robustness checks; different

sampling strata, different regression models. The strata are divided into different time series and exclusion of firms.

The sampling strata for time periods are;

- 1970-2008 (T)
- 1970-1998 (U)
- 1984-2005 (V)
- 1993-2008 (X)
- 1996-2008 (Y)

The sampling strata for exclusion of firms are;

- (row A) None, include all firms
- (row B) Exclusion of firms which have variables which may follow a unit root process at the same time as the regressors and the regressand are not co-integrated. Such unit root process may be driving the estimated parameters in different directions at the same time as the variances increase.
- (row C) Exclusion of firms which have variables which may follow a unit root process (including co-integrated and non-cointegrated). A few firms with co-integrated variables may be driving the estimated parameters. It is important to look for differences between parameters estimated including co-integrated variables and without co-integrated variables. A difference between the two strata does not necessarily mean that the stratum with co-integrated variables is wrong.
- (rows D-G) Exclusion of different industries. Different industries may be differently affected from trade and therefore it is good to exclude industries to see if the estimated parameter changes. However, it is important to understand that every industry only have a very few firms and that the strata excluding industries may not have high explanatory power.
- (rows H-I) Exclusion by random sampling. I do two random samples of two groups with odd and even firm ids. If the estimated parameters of the two random samples differ, the estimated parameter may not be generalizable to all firms. However, such sample is small (between 9 to 12 firms) and may be more sensitive to with firm systemic measurement errors.
- (row J) Exclusion of non-positive variables. In my data I have zero and negative variables and the logarithm for such values is not defined. Since I have logarithm regression models, I need to transform zero and negative values with low positive values. Such transformation may bias the estimated parameters of the log model. In order to check for such transformation bias, I will try to exclude zero or negative variables. A problem with this stratum is that by removing zero or negative variables, only good profit outcomes and transportation outcomes will be estimated, which itself may create a bias. So to see if such bias exists, I will look at the linear models

(column k-m), to see if the estimated parameters of the stratum without zero or negative values (row J) differ from the stratum including zero or negative values (row A). If the estimated parameters differ, the stratum is biased and cannot be used to see if the log models (column n-p) are biased, because then also the log models will suffer from the same bias. If the linear models does not differ, the log models (column n-p) may be compared and if the stratum with zero or negative values (row A) differ from the stratum without zero or negative values (row J), the transformation of zero or negative values may bias the estimated log models for all strata. Note that the panel will also become unbalanced in this stratum.

It is important to understand the mechanics of the firm idiosyncratic and the within firm systematic measurement errors. Looking at a single firm, there may be systematic measurement errors over its time series. Looking at many firms, I believe that such measurement errors may differ between the firms, so measurement errors are idiosyncratic between the firms. Since every stratum excludes some number of firms, any within firm systemic measurement error may be more systemic in the stratum of fewer firms. According to the central limit theorem, increasing the sample to more than 20 firms in a stratum may reduce overall systemic measurement error to become more random error. Therefore the stratum including all firms (row A) is the stratum which is more generalizable. The other strata are to see how robust the estimates parameters and its variances are to changes in sample.

First, I look at the difference between the time series. The early time series (1970-2008 and 1970-1998) have estimated parameters more close to 0 and less significant than the late time series (1984-2005, 1993-2008 and 1996-2008) which have more negative estimated parameters. This may be because many Swedish firms traded less with other continents in the 1970s and the 1980s, than in the 1990s and the 2000s or that the Swedish firms were more rational in the 1970s and the 1980s.

Second, I look into how excluding different industries affects the estimated parameters and its variances. Telecom (row E) can be seen for time series 1970-2008, 1970-1998, 1984-2005, and 1996-2008 to have some signs of a negative effect on trade. However, there are only two telecom firms in the sample and thereby the proof is not so strong. Both firms may for example have measurement errors. For all time series, except for the 1970-2008, there are no signs that the forest industry (row F) has any deviating effect on the estimated parameter. For all time series, there are no signs of the chemistry industry (row G) to have any deviating effect on the estimated parameter. However, there are only one to two firms in the chemistry industry. Excluding the heavy machinery industry has an effect on the estimated parameter making it not to be significant for all time periods except 1970-2008, but this is natural, since there are only 7 or 9 firms left after excluding the heavy machinery industry.

Third, I look at the randomly split sample (row H and I). There seems to be somewhat higher values in one of the two samples than the other, for all time periods. There difference is not large, however, the sample contains between 9 to 12 samples and thereby there may be systemic measurement bias in both samples. Including all firms (row A) is a more reliable estimated parameter.

Forth, I look at time series problems, starting with unit root and autocorrelation. Comparing the estimated parameters including non-unit root processes and co-integrated and non-co-integrated unit root processes (row A), including non-unit root processes and co-integrated unit root processes (row B), including only non-unit root processes (row C), I see that there is no driving effect of neither the estimated parameter or its variance. Thereby the time series which could not be proven to not follow a unit root process does not affect the estimated parameter.

Fifth, I continue with looking at time series problems, and I can see by comparing the standard deviations of the parameters of a standard fixed effect OLS (column k) with a fixed effect OLS with firm clustered standard error and heteroscedasticity robust standard error (column m) that there are in general no large difference between the standard errors. At a few places the autocorrelation clustered and heteroscedasticity robust standard errors (column m) are insignificantly large while the standard OLS (column k) is small and significant. However, there are no systematic differences. The significance of the estimated parameter is however decided by the clustered autocorrelation and heteroscedasticity robust standard error (column m).

Sixth, I continue with comparing three different elasticity models; log-log (column n), lin-log (column o) and log-lin (column p). The log-lin model is the most significant for all time series and strata. However, the log-log and the lin-log are also for most time periods and strata significant.

Seventh, I remove zero or negative variables, in order to see if the transformation of the zero or negative variables has any effect on the elasticity models (column n-p). However, I find that by removing the zero or negative variables, the estimated parameters of the linear model (row J, column k-m) are insignificant for all time periods except 1970-1998 and thereby the removal of the variables itself is causing a bias since only positive profits and positive transportation observations are included. The linear model contains the true values (not transformed) of the variables. Thereby it is not possible to measure any transformation bias in the elasticity models (row J, column n-p) for other time periods than 1970-1998. However, looking at time period 1970-1998, the estimate linear parameter (row J, column k) is only slightly biased but significant (row J, column m). Comparing the elasticity models without zero or negative variables (row J, column n-p) with the elasticity models with zero or negative variables (row A, column n-p) I can see that the estimated parameters are similar, especially for the log-log and the lin-log. Thereby there are

no proofs that the estimated elasticities are suffering from a variable transformation bias.

Lastly, I compare the time (and firm) fixed effects model (column k) with the time random effects model (column l). I find that for many strata, the estimated parameter of the random effects model differs from the fixed effects model, which suggests that the random effects model is slightly biased since the fixed effects model is always correct.

I conclude that there are no large differences between the strata, or the models. All estimated parameters are negative as expected. The exclusion of industry strata does not prove the data to not be robust. The random sampling strata do not prove the data to not be robust. The exclusion of zero or negative variables stratum does not prove the transformation to bias the estimated parameters. There are no signs of problems of unit root, autocorrelation or heteroscedasticity.

The lin-lin stratum and model to be able to be most generalized to all firms which trade goods, is the linear fixed effects model with autocorrelation clustered time series and heteroscedasticity robust standard errors (row A, column m). The lin-lin model shows that for every percentage unit of increased intercontinental transports, the operating margin decrease by between 0.176 to 0.217 percentage units.

The elasticity stratum and model to be able to be most generalized to all firms which trade goods, is the log-lin model (row A, column p). However, note that I only presented the estimated parameter of this model with the constant mean of the transport variable, $\bar{\tau}$. This model of elasticity is actually an elasticity variable with the variable transport variable, τ. The elasticity is dependent on the values of the transport variable, but for simplicity I presented only one value which is the mean. The log-lin model shows that for an average transporting firm (average because of the mean transport variable), a one percent increase in intercontinental transports, the operating margin decrease by between 0.69 to 1.47 percent.

Table A.2.6.a (i-v) – Sensitivity of estimated parameters to different strata and different models

Regressand: Operating Margin, π	Regressor: Transports, τ	Control Regressors: • Marginal Revenue per continent, MR_C • Marginal Cost per continent, MC_C • Time individual intercept, δ_t • Firm individual intercept, δ_f					
Stratum		Model	Linear FE(f,t) OLS	Linear FE(f), RE(t) FGLS	Linear FE(f,t) OLS Cluster(f), Robust	Log-Log FE(f,t) OLS Cluster(f), Robust	Lin-Log FE(f,t) OLS Cluster(f), Robust	Log-Lin FE(f,t) OLS Cluster(f), Robust
1970-2008	Incl. all	N: 741 F: 19 Balanced	$\tau = -.176\ ;\ \sigma = .036$ $t = -4.88\ ;\ p = .000$ $R^2 = 0.32$	$-.180\ ;\ .036$ $-5.05\ ;\ .000$ 0.42	$-.176\ ;\ .065$ $-2.72\ ;\ .014$ 0.32	$-.497\ ;\ .216$ $-2.30\ ;\ .033$ 0.26	$\frac{\tau}{\bar{\pi}} = -.277\ ;\ .010$ $-2.17\ ;\ .043$ 0.32	$\tau \times \bar{\tau} = -.690\ ;\ 1.42$ $-2.90\ ;\ .010$ 0.30
	Excl. non coint. unit root	N: 702 F: 18 Bal.	$-.158\ ;\ .035$ $-4.52\ ;\ .000$ 0.32	$-.168\ ;\ .034$ $-4.91\ ;\ .000$ 0.42	$-.158\ ;\ .065$ $-2.43\ ;\ .026$ 0.32	$-.351\ ;\ .179$ $-1.96\ ;\ .067$ 0.26	$-.171\ ;\ .008$ $-1.89\ ;\ .075$ 0.33	$-.658\ ;\ 1.43$ $-2.68\ ;\ .016$ 0.29
	Excl. all unit root	N: 624 F: 16 Bal.	$-.166\ ;\ .037$ $-4.47\ ;\ .000$ 0.33	$-.182\ ;\ .036$ $-5.02\ ;\ .000$ 0.43	$-.166\ ;\ .072$ $-2.30\ ;\ .036$ 0.33	$-.426\ ;\ .162$ $-2.62\ ;\ .019$ 0.31	$-.211\ ;\ .009$ $-2.03\ ;\ .061$ 0.35	$-.676\ ;\ 1.46$ $-2.78\ ;\ .014$ 0.31
	Excl. heavy ind.	N: 273 F: 7 Bal.	$.216\ ;\ .223$ $0.97\ ;\ .335$ 0.29	$.111\ ;\ .193$ $0.58\ ;\ .564$ 0.33	$.216\ ;\ .382$ $0.56\ ;\ .593$ 0.37	$-.090\ ;\ .324$ $-0.28\ ;\ .791$ 0.36	$-.411\ ;\ .035$ $-1.22\ ;\ .267$ 0.38	$1.05\ ;\ 5.39$ $1.23\ ;\ .266$ 0.30
	Excl. telecom ind.	N: 663 F: 17 Bal.	$-.133\ ;\ .036$ $-3.67\ ;\ .000$ 0.36	$-.128\ ;\ .036$ $-3.55\ ;\ .000$ 0.46	$-.133\ ;\ .067$ $-1.98\ ;\ .065$ 0.36	$-.397\ ;\ .205$ $-1.94\ ;\ .071$ 0.30	$-.241\ ;\ .010$ $-1.87\ ;\ .080$ 0.36	$-.538\ ;\ 1.42$ $-2.37;\ .031$ 0.32
	Excl. forest ind.	N: 624 F: 16 Bal.	$-.188\ ;\ .034$ $-5.55\ ;\ .000$ 0.44	$-.186\ ;\ .034$ $-5.54\ ;\ .000$ 0.50	$-.188\ ;\ .069$ $-2.71\ ;\ .016$ 0.44	$-.474\ ;\ .236$ $-2.04\ ;\ .063$ 0.31	$-.239\ ;\ .010$ $-1.79\ ;\ .093$ 0.40	$-.837\ ;\ 1.52$ $-3.07\ ;\ .008$ 0.36
	Excl. chem. ind.	N: 702 F: 18 Bal.	$-.174\ ;\ .038$ $-4.62\ ;\ .000$ 0.32	$-.183\ ;\ .037$ $-4.89\ ;\ .000$ 0.43	$-.174\ ;\ .067$ $-2.62\ ;\ .018$ 0.32	$-.509\ ;\ .227$ $-2.25\ ;\ .038$ 0.26	$-.291\ ;\ .011$ $-2.18\ ;\ .044$ 0.33	$-.667\ ;\ 1.48$ $-2.67\ ;\ .016$ 0.30
	Rnd. samp. odd firm ids	N: 390 F: 10 Bal.	$-.126\ ;\ .038$ $-3.28\ ;\ .001$ 0.47	$-.119\ ;\ .037$ $-3.20\ ;\ .001$ 0.61	$-.126\ ;\ .093$ $-1.35\ ;\ .210$ 0.47	$-.201\ ;\ .256$ $-0.79\ ;\ .451$ 0.44	$-.173\ ;\ .012$ $-1.08\ ;\ .308$ 0.48	$-.577\ ;\ 1.91$ $-1.83\ ;\ .100$ 0.38
	Rnd. samp. even firm ids	N: 351 F: 9 Bal.	$-.358\ ;\ .108$ $-3.33\ ;\ .001$ 0.43	$-.373\ ;\ .105$ $-3.56\ ;\ .000$ 0.35	$-.358\ ;\ .204$ $-1.75\ ;\ .118$ 0.43	$-.559\ ;\ .324$ $-1.73\ ;\ .122$ 0.35	$-.344\ ;\ .014$ $-2.27\ ;\ .053$ 0.50	$-1.08\ ;\ 4.34$ $-1.45\ ;\ .186$ 0.39
	Excl. neg. vars.	N: 669 F: 9 Unb.	$-.028\ ;\ .036$ $-0.80\ ;\ .426$ 0.27	$-.086\ ;\ .037$ $-2.35\ ;\ .019$ 0.52	$-.028\ ;\ .059$ $-0.48\ ;\ .636$ 0.27	$-.177\ ;\ .081$ $-2.19\ ;\ .042$ 0.28	$-.119\ ;\ .007$ $-1.52\ ;\ .146$ 0.32	$-.161\ ;\ .848$ $-1.09\ ;\ .289$ 0.26

Regressand: Operating Margin, π	Regressor: Transports, τ	Control Regressors: • Marginal Revenue per continent, MR_C • Marginal Cost per continent, MC_C • Time individual intercept, δ_t • Firm individual intercept, δ_f					
Stratum		Model	Linear FE(f,t) OLS	Linear FE(f), RE(t) FGLS	Linear FE(f,t) OLS Cluster(f), Robust	Log-Log FE(f,t) OLS Cluster(f), Robust	Lin-Log FE(f,t) OLS Cluster(f), Robust	Log-Lin FE(f,t) OLS Cluster(f), Robust
1970-1998	Incl. all	N: 609 F: 21 Balanced	$\tau = -.084\ ;\ \sigma = .049$ $t = -1.72\ ;\ p = .087$ $R^2 = 0.28$	$-.124\ ;\ .047$ $-2.65\ ;\ .008$ 0.47	$-.084\ ;\ .073$ $-1.15\ ;\ .264$ 0.28	$-.148\ ;\ .135$ $-1.10\ ;\ .284$ 0.18	$\frac{\tau}{\bar{\pi}} = -.134\ ;\ .006$ $-1.82\ ;\ .084$ 0.25	$\tau \times \bar{\tau} = -.024\ ;\ 1.47$ $-0.10\ ;\ .923$ 0.24
	Excl. non coint. unit root	N: 580 F: 20 Bal.	$-.054\ ;\ .050$ $-1.09\ ;\ .274$ 0.30	$-.102\ ;\ .048$ $-2.12\ ;\ .034$ 0.47	$-.054\ ;\ .071$ $-0.77\ ;\ .451$ 0.30	$-.113\ ;\ .145$ $-0.78\ ;\ .447$ 0.19	$-.090\ ;\ .006$ $-1.31\ ;\ .207$ 0.26	$.032\ ;\ 1.50$ $0.12\ ;\ .906$ 0.25
	Excl. all unit root	N: 522 F: 18 Bal.	$-.063\ ;\ .054$ $-1.18\ ;\ .238$ 0.35	$-.125\ ;\ .052$ $-2.41\ ;\ .016$ 0.49	$-.063\ ;\ .075$ $-0.84\ ;\ .412$ 0.35	$-.084\ ;\ .103$ $-0.81\ ;\ .428$ 0.28	$-.085\ ;\ .008$ $-0.99\ ;\ .336$ 0.32	$-.059\ ;\ .990$ $-0.35\ ;\ .730$ 0.30
	Excl. heavy ind.	N: 261 F: 9 Bal.	$-.506\ ;\ .213$ $-2.37\ ;\ .018$ 0.47	$-.590\ ;\ .197$ $-2.99\ ;\ .003$ 0.45	$-.506\ ;\ .198$ $-2.55\ ;\ .034$ 0.47	$-.119\ ;\ .344$ $-0.35\ ;\ .738$ 0.27	$-.106\ ;\ .022$ $-0.49\ ;\ .635$ 0.32	$-.324\ ;\ 2.39$ $-0.84\ ;\ .427$ 0.37
	Excl. telecom ind.	N: 551 F: 19 Bal.	$-.026\ ;\ .054$ $-0.50\ ;\ .614$ 0.27	$-.077\ ;\ .049$ $-1.55\ ;\ .121$ 0.48	$-.027\ ;\ .076$ $-0.35\ ;\ .727$ 0.27	$-.136\ ;\ .132$ $-1.03\ ;\ .317$ 0.16	$-.129\ ;\ .007$ $-1.64\ ;\ .118$ 0.23	$.166\ ;\ 1.89$ $0.10\ ;\ .919$ 0.23
	Excl. forest ind.	N: 522 F: 18 Bal.	$-.074\ ;\ .045$ $-1.65\ ;\ .099$ 0.34	$-.117\ ;\ .043$ $-2.73\ ;\ .006$ 0.56	$-.074\ ;\ .070$ $-1.05\ ;\ .307$ 0.34	$-.117\ ;\ .134$ $-0.87\ ;\ .397$ 0.17	$-.094\ ;\ .006$ $-1.31\ ;\ .208$ 0.27	$-.176\ ;\ 1.45$ $-0.12\ ;\ .905$ 0.25
	Excl. chem. ind.	N: 551 F: 19 Bal.	$-.066\ ;\ .050$ $-1.33\ ;\ .185$ 0.27	$-.109\ ;\ .048$ $-2.28\ ;\ .023$ 0.47	$-.066\ ;\ .074$ $-0.89\ ;\ .385$ 0.27	$-.156\ ;\ .147$ $-1.06\ ;\ .303$ 0.16	$-.140\ ;\ .007$ $-1.64\ ;\ .119$ 0.22	$.032\ ;\ 1.57$ $0.13\ ;\ .901$ 0.21
	Rnd. samp. odd firm ids	N: 319 F: 11 Bal.	$.038\ ;\ .052$ $0.72\ ;\ .471$ 0.29	$-.022\ ;\ .050$ $-0.44\ ;\ .660$ 0.60	$.038\ ;\ .079$ $0.47\ ;\ .645$ 0.29	$.043\ ;\ .113$ $0.38\ ;\ .713$ 0.21	$-.059\ ;\ .008$ $-0.60\ ;\ .562$ 0.22	$.247\ ;\ 1.46$ $1.07\ ;\ .311$ 0.22
	Rnd. samp. even firm ids	N: 290 F: 10 Bal.	$-.490\ ;\ .145$ $-3.38\ ;\ .001$ 0.34	$-.488\ ;\ .144$ $-3.38\ ;\ .001$ 0.43	$-.490\ ;\ .113$ $-4.32\ ;\ .002$ 0.34	$-.537\ ;\ .170$ $-3.16\ ;\ .011$ 0.30	$-.377\ ;\ .016$ $-3.00\ ;\ .015$ 0.44	$-.373\ ;\ 1.24$ $-1.63\ ;\ .138$ 0.34
	Excl. neg. vars.	N: 558 F: 21 Unb.	$-.119\ ;\ .045$ $-2.64\ ;\ .008$ 0.25	$-.174\ ;\ .045$ $-3.87\ ;\ .000$ 0.54	$-.119\ ;\ .067$ $-1.77\ ;\ .092$ 0.25	$-.186\ ;\ .070$ $-2.67\ ;\ .015$ 0.21	$-.158\ ;\ .005$ $-2.59\ ;\ .018$ 0.23	$-.264\ ;\ .815$ $-1.78\ ;\ .090$ 0.25

Regressand: Operating Margin, π	Regressor: Transports, τ	Control Regressors: • Marginal Revenue per continent, MR_C • Marginal Cost per continent, MC_C • Time individual intercept, δ_t • Firm individual intercept, δ_f					
	Model	Linear FE(f,t) OLS	Linear FE(f), RE(t) FGLS	Linear FE(f,t) OLS Cluster(f), Robust	Log-Log FE(f,t) OLS Cluster(f), Robust	Lin-Log FE(f,t) OLS Cluster(f), Robust	Log-Lin FE(f,t) OLS Cluster(f), Robust
	Stratum						
1984-2005	Incl. all N: 462 F: 21 Balanced	$\tau = -.213\ ;\ \sigma = .039$ $t = -5.39\ ;\ p = .000$ $R^2 = 0.25$	$-.193\ ;\ .037$ $-5.23\ ;\ .000$ 0.48	$-.213\ ;\ .070$ $-3.03\ ;\ .007$ 0.25	$-.396\ ;\ .184$ $-2.15\ ;\ .044$ 0.23	$\frac{\tau}{\bar{\pi}} = -.250\ ;\ .009$ $-2.20\ ;\ .039$ 0.24	$\tau \times \bar{\tau} = -.865\ ;\ 1.38$ $-3.55\ ;\ .002$ 0.27
	Excl. non coint. unit root N: 418 F: 19 Bal.	$-.150\ ;\ .040$ $-3.74\ ;\ .000$ 0.21	$-.132\ ;\ .038$ $-3.51\ ;\ .000$ 0.48	$-.150\ ;\ .082$ $-1.82\ ;\ .085$ 0.22	$-.218\ ;\ .177$ $-1.23\ ;\ .233$ 0.21	$-.140\ ;\ .008$ $-1.43\ ;\ .170$ 0.24	$-.609\ ;\ 1.50$ $0.12\ ;\ .906$ 0.25
	Excl. all unit root N: 374 F: 17 Bal.	$-.157\ ;\ .043$ $-3.67\ ;\ .000$ 0.21	$-.160\ ;\ .042$ $-3.81\ ;\ .000$ 0.49	$-.157\ ;\ .096$ $-1.63\ ;\ .122$ 0.21	$-.320\ ;\ .191$ $-1.67\ ;\ .114$ 0.25	$-.177\ ;\ .010$ $-1.57\ ;\ .135$ 0.24	$-.600\ ;\ 1.93$ $-1.78\ ;\ .094$ 0.22
	Excl. heavy ind. N: 154 F: 7 Bal.	$.266\ ;\ .315$ $0.84\ ;\ .400$ 0.32	$.372\ ;\ .257$ $1.45\ ;\ .148$ 0.60	$.266\ ;\ .398$ $0.67\ ;\ .528$ 0.32	$.041\ ;\ .239$ $0.17\ ;\ .870$ 0.51	$-.382\ ;\ .028$ $-1.49\ ;\ .187$ 0.42	$.825\ ;\ 6.19$ $0.71\ ;\ .506$ 0.45
	Excl. telecom ind. N: 418 F: 19 Bal.	$-.152\ ;\ .039$ $-3.89\ ;\ .000$ 0.32	$-.151\ ;\ .035$ $-4.29\ ;\ .000$ 0.53	$-.152\ ;\ .059$ $-2.58\ ;\ .019$ 0.32	$-.310\ ;\ .167$ $-1.86\ ;\ .080$ 0.27	$-.189\ ;\ .008$ $-1.89\ ;\ .074$ 0.28	$-.625\ ;\ 1.16$ $-3.26\ ;\ .004$ 0.30
	Excl. forest ind. N: 396 F: 18 Bal.	$-.216\ ;\ .037$ $-5.83\ ;\ .000$ 0.34	$-.189\ ;\ .035$ $-5.46\ ;\ .000$ 0.54	$-.216\ ;\ .077$ $-2.79\ ;\ .013$ 0.34	$-.372\ ;\ .198$ $-1.87\ ;\ .078$ 0.26	$-.234\ ;\ .010$ $-1.86\ ;\ .080$ 0.29	$-.964\ ;\ 1.52$ $-3.41\ ;\ .003$ 0.30
	Excl. chem. ind. N: 440 F: 20 Bal.	$-.217\ ;\ .041$ $-5.28\ ;\ .000$ 0.25	$-.197\ ;\ .039$ $-5.12\ ;\ .000$ 0.49	$-.217\ ;\ .071$ $-3.05\ ;\ .007$ 0.25	$-.394\ ;\ .191$ $-2.07\ ;\ .053$ 0.23	$-.253\ ;\ .010$ $-2.13\ ;\ .046$ 0.24	$-.878\ ;\ 1.37$ $-3.61\ ;\ .002$ 0.27
	Rnd. samp. odd firm ids N: 220 F: 10 Bal.	$-.190\ ;\ .048$ $-3.96\ ;\ .000$ 0.38	$-.199\ ;\ .046$ $-4.32\ ;\ .000$ 0.66	$-.190\ ;\ .103$ $-1.85\ ;\ .098$ 0.38	$-.189\ ;\ .202$ $-0.94\ ;\ .372$ 0.23	$-.172\ ;\ .009$ $-1.39\ ;\ .198$ 0.23	$-.761\ ;\ 2.16$ $-2.06\ ;\ .069$ 0.27
	Rnd. samp. even firm ids N: 242 F: 11 Bal.	$-.251\ ;\ .077$ $-3.26\ ;\ .001$ 0.32	$-.257\ ;\ .074$ $-3.47\ ;\ .001$ 0.42	$-.251\ ;\ .111$ $-2.27\ ;\ .047$ 0.32	$-.639\ ;\ .335$ $-1.91\ ;\ .086$ 0.34	$-.315\ ;\ .020$ $-1.36\ ;\ .205$ 0.37	$-1.24\ ;\ 2.69$ $-2.54\ ;\ .029$ 0.39
	Excl. neg. vars. N: 429 F: 21 Unb.	$-.031\ ;\ .033$ $-0.93\ ;\ .352$ 0.20	$-.036\ ;\ .032$ $-1.11\ ;\ .267$ 0.60	$-.031\ ;\ .046$ $-0.67\ ;\ .512$ 0.20	$-.075\ ;\ .079$ $-0.96\ ;\ .350$ 0.24	$-.100\ ;\ .007$ $-1.23\ ;\ .233$ 0.25	$-.123\ ;\ .528$ $-1.34\ ;\ .195$ 0.21

Regressand: Operating Margin, π	Regressor: Transports, τ	Control Regressors: • Marginal Revenue per continent, MR_C • Marginal Cost per continent, MC_C • Time individual intercept, δ_t • Firm individual intercept, δ_f					
Stratum		Model	Linear FE(f,t) OLS	Linear FE(f), RE(t) FGLS	Linear FE(f,t) OLS Cluster(f), Robust	Log-Log FE(f,t) OLS Cluster(f), Robust	Lin-Log FE(f,t) OLS Cluster(f), Robust	Log-Lin FE(f,t) OLS Cluster(f), Robust
1993-2008	Incl. all	N: 352 F: 22 Balanced	$\tau = -.217\ ;\ \sigma = .042$ $t = -5.15\ ;\ p = .000$ $R^2 = 0.27\ ;\ \mathrm{N} = 352$	$-.164\ ;\ .041$ $-3.97\ ;\ .000$ $0.55\ ;\ 462$	$-.217\ ;\ .074$ $-2.92\ ;\ .008$ $0.27\ ;\ 352$	$-.456\ ;\ .234$ $-1.94\ ;\ .066$ $0.27\ ;\ 352$	$\frac{\tau}{\bar{\pi}} = -.205\ ;\ .009$ $-1.87\ ;\ .075$ $0.29\ ;\ 352$	$\tau \times \bar{\tau} = -1.03\ ;\ 1.67$ $-3.35\ ;\ .003$ $0.26\ ;\ 352$
	Excl. non coint. unit root	N: 304 F: 19 Bal.	$-.217\ ;\ .049$ $-4.40\ ;\ .000$ $0.20\ ;\ 304$	$-.179\ ;\ .051$ $-3.49\ ;\ .000$ $0.51\ ;\ 304$	$-.217\ ;\ .086$ $-2.51\ ;\ .022$ $0.20\ ;\ 304$	$-.427\ ;\ .260$ $-1.65\ ;\ .117$ $0.21\ ;\ 304$	$-.194\ ;\ .010$ $-1.65\ ;\ .116$ $0.31\ ;\ 304$	$-.937\ ;\ 1.77$ $-2.95\ ;\ .009$ $0.19\ ;\ 304$
	Excl. all unit root	N: 256 F: 16 Bal.	$-.243\ ;\ .053$ $-4.57\ ;\ .000$ $0.20\ ;\ 256$	$-.220\ ;\ .055$ $-3.99\ ;\ .000$ $0.52\ ;\ 256$	$-.243\ ;\ 0.93$ $-2.62\ ;\ .019$ $0.20\ ;\ 256$	$-.510\ ;\ .296$ $-1.72\ ;\ .106$ $0.18\ ;\ 256$	$-.224\ ;\ .012$ $-1.68\ ;\ .113$ $0.29\ ;\ 256$	$-1.02\ ;\ 1.95$ $-2.91\ ;\ .011$ $0.19\ ;\ 256$
	Excl. heavy ind.	N: 112 F: 7 Bal.	$.107\ ;\ .322$ $0.34\ ;\ .738$ $0.09;\ 112$	$.078\ ;\ .311$ $0.25\ ;\ .801$ $0.41\ ;\ 112$	$.108\ ;\ .404$ $0.27\ ;\ .798$ $0.09\ ;\ 112$	$.048\ ;\ .552$ $0.09\ ;\ .934$ $0.28\ ;\ 112$	$-.453\ ;\ .033$ $-1.50\ ;\ .184$ $0.20\ ;\ 112$	$1.15\ ;\ 6.21$ $0.88\ ;\ .415$ $0.18\ ;\ 112$
	Excl. teleco m ind.	N: 320 F: 20 Bal.	$-.186\ ;\ .042$ $-4.45\ ;\ .000$ $0.33\ ;\ 320$	$-.113\ ;\ .041$ $-2.79\ ;\ .005$ $0.61\ ;\ 320$	$-.186\ ;\ .057$ $-3.27\ ;\ .004$ $0.33\ ;\ 320$	$-.224\ ;\ .136$ $-1.65\ ;\ .115$ $0.34\ ;\ 320$	$-.111\ ;\ .007$ $-1.27\ ;\ .221$ $0.35\ ;\ 320$	$-.795\ ;\ 1.01$ $-4.59\ ;\ .000$ $0.30\ ;\ 320$
	Excl. forest ind.	N: 304 F: 19 Bal.	$-.220\ ;\ .041$ $-5.42\ ;\ .000$ $0.39\ ;\ 304$	$-.161\ ;\ .039$ $-4.19\ ;\ .000$ $0.62\ ;\ 304$	$-.220\ ;\ .077$ $-2.85\ ;\ .011$ $0.39\ ;\ 304$	$-.534\ ;\ .257$ $-2.07\ ;\ .053$ $0.35\ ;\ 304$	$-.214\ ;\ .009$ $-1.77\ ;\ .093$ $0.40\ ;\ 304$	$-1.18\ ;\ 1.73$ $-3.54\ ;\ .002$ $0.35\ ;\ 304$
	Excl. chem. ind.	N: 336 F: 21 Bal.	$-.209\ ;\ .044$ $-4.74\ ;\ .000$ $0.26\ ;\ 336$	$-.162\ ;\ .043$ $-3.78\ ;\ .000$ $0.55\ ;\ 336$	$-.209\ ;\ .078$ $-2.67\ ;\ .015$ $0.26\ ;\ 336$	$-.442\ ;\ .246$ $-1.80\ ;\ .087$ $0.27\ ;\ 336$	$-.188\ ;\ .009$ $-1.67\ ;\ .110$ $0.29\ ;\ 336$	$-1.02\ ;\ 1.75$ $-3.12\ ;\ .005$ $0.26\ ;\ 336$
	Rnd. samp. odd firm ids	N: 176 F: 11 Bal.	$-.205\ ;\ .053$ $-3.84\ ;\ .000$ $0.48\ ;\ 176$	$-.155\ ;\ .050$ $-3.10\ ;\ .002$ $0.71\ ;\ 176$	$-.205\ ;\ .100$ $-2.07\ ;\ .065$ $0.48\ ;\ 176$	$-.284\ ;\ .180$ $-1.58\ ;\ .146$ $0.46\ ;\ 176$	$-.190\ ;\ .010$ $-1.32\ ;\ .215$ $0.56\ ;\ 176$	$-1.03\ ;\ 1.75$ $-3.34\ ;\ .008$ $0.38\ ;\ 176$
	Rnd. samp. even firm ids	N: 176 F: 11 Bal.	$-.334\ ;\ .087$ $-3.85\ ;\ .000$ $0.26\ ;\ 176$	$-.326\ ;\ .085$ $-3.85\ ;\ .000$ $0.45\ ;\ 176$	$-.334\ ;\ .208$ $-1.60\ ;\ .140$ $0.26\ ;\ 176$	$-1.022\ ;\ .628$ $-1.63\ ;\ .135$ $0.25\ ;\ 176$	$-.381\ ;\ .024$ $-1.40\ ;\ .192$ $0.24\ ;\ 176$	$-1.61\ ;\ 4.75$ $-1.76\ ;\ .109$ $0.41\ ;176$
	Excl. neg. vars.	N: 321 F: 22 Unb.	$.032\ ;\ .045$ $0.72\ ;\ .474$ $0.20\ ;\ 321$	$.031\ ;\ .045$ $0.70\ ;\ .485$ $0.59\ ;\ 321$	$.032\ ;\ .058$ $0.56\ ;\ .582$ $0.20\ ;\ 321$	$-.026\ ;\ .084$ $-0.31\ ;\ .756$ $0.14\ ;\ 321$	$-.020\ ;\ .007$ $-0.27\ ;\ .792$ $0.23\ ;\ 321$	$-.083\ ;\ .863$ $-0.55\ ;\ .590$ $0.15\ ;\ 321$

Regressand: Operating Margin, π	Regressor: Transports, τ	Control Regressors: • Marginal Revenue per continent, MR_C • Marginal Cost per continent, MC_C • Time individual intercept, δ_t • Firm individual intercept, δ_f					
Stratum		Model	Linear FE(f,t) OLS	Linear FE(f), RE(t) FGLS	Linear FE(f,t) OLS Cluster(f), Robust	Log-Log FE(f,t) OLS Cluster(f), Robust	Lin-Log FE(f,t) OLS Cluster(f), Robust	Log-Lin FE(f,t) OLS Cluster(f), Robust
1996-2008	Incl. all	N: 229 F: 23 Balanced	$\tau = -.189\ ;\ \sigma = .046$ $t = -4.08\ ;\ p = .000$ $R^2 = 0.27$	$-.123\ ;\ .046$ $-2.69\ ;\ .007$ 0.58	$-.189\ ;\ .085$ $-2.22\ ;\ .037$ 0.27	$-.327\ ;\ .295$ $-1.11\ ;\ .280$ 0.24	$\frac{\tau}{\bar{\pi}} = -.073\ ;\ .012$ $-0.49\ ;\ .632$ 0.25	$\tau \times \bar{\tau} = -1.01\ ;\ 1.90$ $-2.85\ ;\ .009$ 0.25
	Excl. non coint. unit root	N: 260 F: 20 Bal.	$-.224\ ;\ .054$ $-4.14\ ;\ .000$ 0.20	$-.183\ ;\ .055$ $-3.30\ ;\ .001$ 0.52	$-.224\ ;\ .087$ $-2.58\ ;\ .018$ 0.20	$-.472\ ;\ .334$ $-1.41\ ;\ .174$ 0.21	$-.182\ ;\ .014$ $-1.14\ ;\ .269$ 0.22	$-.996\ ;\ 1.88$ $-2.99\ ;\ .008$ 0.16
	Excl. all unit root	N: 221 F: 17 Bal.	$-.265\ ;\ .058$ $-4.54\ ;\ .000$ 0.21	$-.225\ ;\ .062$ $-3.64\ ;\ .000$ 0.54	$-.265\ ;\ .087$ $-3.05\ ;\ .008$ 0.21	$-.555\ ;\ .377$ $-1.47\ ;\ .161$ 0.23	$-.227\ ;\ .016$ $-1.23\ ;\ .238$ 0.28	$-1.15\ ;\ 1.95$ $-3.26\ ;\ .005$ 0.17
	Excl. heavy ind.	N: 91 F: 7 Bal.	$.204\ ;\ .352$ $0.58\ ;\ .564$ 0.03	$.167\ ;\ .333$ $0.50\ ;\ .615$ 0.43	$.204\ ;\ .470$ $0.43\ ;\ .679$ 0.03	$.540\ ;\ .812$ $0.66\ ;\ .531$ 0.07	$-.243\ ;\ .040$ $-0.65\ ;\ .538$ 0.12	$1.63\ ;\ 8.34$ $0.92\ ;\ .395$ 0.08
	Excl. telecom ind.	N: 273 F: 21 Bal.	$-.142\ ;\ .045$ $-3.14\ ;\ .002$ 0.33	$-.061\ ;\ .043$ $-1.43\ ;\ .153$ 0.65	$-.142\ ;\ .069$ $-2.05\ ;\ .054$ 0.33	$-.053\ ;\ .180$ $-0.29\ ;\ .774$ 0.32	$.053\ ;\ .009$ $0.46\ ;\ .651$ 0.29	$-.721\ ;\ 1.28$ $-3.25\ ;\ .004$ 0.30
	Excl. forest ind.	N: 260 F: 20 Bal.	$-.192\ ;\ .046$ $-4.21\ ;\ .000$ 0.39	$-.127\ ;\ .042$ $-3.02\ ;\ .003$ 0.63	$-.192\ ;\ .093$ $-2.06\ ;\ .053$ 0.40	$-.392\ ;\ .301$ $-1.30\ ;\ .209$ 0.29	$-.074\ ;\ .011$ $-0.48\ ;\ .635$ 0.31	$-1.13\ ;\ 2.03$ $-2.89\ ;\ .009$ 0.34
	Excl. chem. ind.	N: 286 F: 22 Bal.	$-.184\ ;\ .048$ $-3.83\ ;\ .000$ 0.27	$-.120\ ;\ .047$ $-2.54\ ;\ .011$ 0.58	$-.184\ ;\ .088$ $-2.09\ ;\ .049$ 0.27	$-.298\ ;\ .311$ $-0.96\ ;\ .349$ 0.24	$-.045\ ;\ .012$ $-0.29\ ;\ .771$ 0.25	$-1.00\ ;\ 1.97$ $-2.72\ ;\ .013$ 0.24
	Rnd. samp. odd firm ids	N: 156 F: 12 Bal.	$-.205\ ;\ .058$ $-3.56\ ;\ .001$ 0.50	$-.108\ ;\ .055$ $-1.97\ ;\ .049$ 0.74	$-.205\ ;\ .099$ $-2.07\ ;\ .062$ 0.50	$-.221\ ;\ .194$ $-1.14\ ;\ .280$ 0.39	$-.128\ ;\ .011$ $-0.82\ ;\ .431$ 0.45	$-1.06\ ;\ 1.55$ $-3.86\ ;\ .003$ 0.38
	Rnd. samp. even firm ids	N: 143 F: 11 Bal.	$-.302\ ;\ .095$ $-3.20\ ;\ .002$ 0.18	$-.296\ ;\ .092$ $-3.24\ ;\ .001$ 0.49	$-.302\ ;\ .210$ $-1.44\ ;\ .180$ 0.18	$-.900\ ;\ .753$ $-1.20\ ;\ .260$ 0.27	$-.275\ ;\ .030$ $-0.81\ ;\ .437$ 0.15	$-1.53\ ;\ 4.58$ $-1.72\ ;\ .116$ 0.28
	Excl. neg. vars.	N: 269 F: 23 Unb.	$.086\ ;\ .050$ $1.72\ ;\ .087$ 0.28	$.080\ ;\ .049$ $1.62\ ;\ .105$ 0.62	$.086\ ;\ .060$ $1.44\ ;\ .164$ 0.28	$.004\ ;\ .119$ $0.03\ ;\ .972$ 0.13	$.083\ ;\ .008$ $0.92\ ;\ .370$ 0.19	$-.026\ ;\ .910$ $-0.17\ ;\ .869$ 0.18

A.2.7 Check for Robustness in different Polynomial Regression models

Since the function of the theoretical which I am trying to estimate with a regression, may be non-homogeneous of any degree, I need to analyze the homogeneity properties of the theoretical function and analyze the empirical implications of such homogeneity.

I am estimating the effect of change in transports on profit

$$\frac{\partial \pi}{\partial q} = -\frac{(q\omega^2 - 2q\omega - c + a)L}{2\beta}$$

A function is homogeneous of degree, k, if multiplication of the input variables by a factor, z, will multiply the function by a factor z^k

$$f(zq, z\omega, zc, za, zL, z\beta) = z^k f(q, \omega, c, a, L, \beta)$$

Such homogeneous function can be used to determine the value of a function, given homogeneous change in the input variables. However, I wish to keep some variables constant and thereby I wish to check if the function is homogeneous in any degree in q, c, a, L, β for each ω, fixed (Sydsæter 2006, p.440). The condition I wish to check is

$$f(zq, \omega, zc, za, zL, z\beta) = z^k f(q)$$

By multiplying the term z to t, c and a in the function

$$f(zq, \omega, zc, za, zL, z\beta) = -\frac{(zq\omega^2 - 2zq\omega - zc + za)zL}{2z\beta}$$

$$= -\frac{z(q\omega^2 - 2q\omega - c + a)zL}{2z\beta}$$

$$= -z^1 \frac{(q\omega^2 - 2q\omega - c + a)zL}{2z\beta}$$

The function is homogeneous of degree, $k = 1$, if the visibility, ω, is held fixed. However, if the visibility, ω, is not fixed, the function is no longer homogeneous, since the terms $z\omega$ and $z\omega^2$ would make it impossible to isolate z^k as a product of the original function. If the visibility would not be constant, which I think may be true, and since I cannot keep visibility constant in the regression since I cannot measure visibility, I may have a polynomial effect in the estimation of the effect of transportation, q, on profit, π. However, if specialization in transportation costs is extremely costly compared to the revenue gained from specializing, there may be no specialization within the group and thereby low and constant visibility. Also one can ask the question why visibility in transportation costs would change. Perhaps experience would change visibility for the individual, but then again if it would be

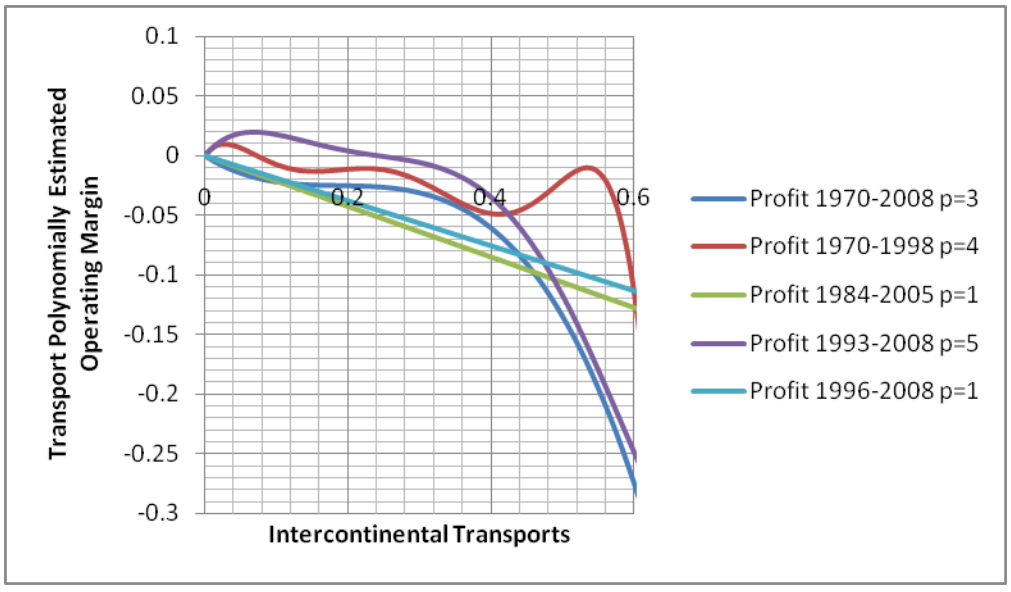
extremely costly it would still be constant for the individual. Also, even if visibility would change for the individual, it would be most probably be constant for the firm.

Because the theoretical model, which I am estimating with a regression, may be a non-homogeneous function of any degree and thereby I may have a polynomial effect on the transportation variable, I estimate a regression with different degrees of polynomials of the transportation variable depending on the significances of different polynomials.

Table A.2.7.a – Most efficient number of polynomials for every time series

Operating Margin	1970-2008 polyn=3	1970-1998 polyn=4	1984-2005 polyn=1	1993-2008 polyn=5	1996-2008 polyn=1
Transports, q	-0.386***	0.817*	-0.213***	0.837	-0.189***
q^2	2.000***	-19.613**		-9.007*	
q^3	-3.534***	159.05***		37.957*	
q^4		-580.85***		-69.319*	
q^5		968.77***		42.573**	
q^6		-598.59**			
intercept	0.438***	0.341***	0.076	0.236**	0.190

I also plot the estimated operating margin given polynomial transportation



Observations with more transportation than 0.4 are pretty rare and therefore the estimation beyond $q > 0.4$ may not be representative. A common trend originating from origo as a cone suggests a homothetic function, $f(z\pi) = f(zq)$, which is a requirement for a function to be homogeneous. Even though there is significance of

the polynomials, the common trend suggests that the visibility is not fixed, but also not so variable and that the estimated model can be considered to be homogeneous of degree $k > 1$ (increasingly negative profits to trade) with fixed visibility and thereby the linear OLS can be estimated.

APPENDIX B.1 – TABLES AND FIGURES

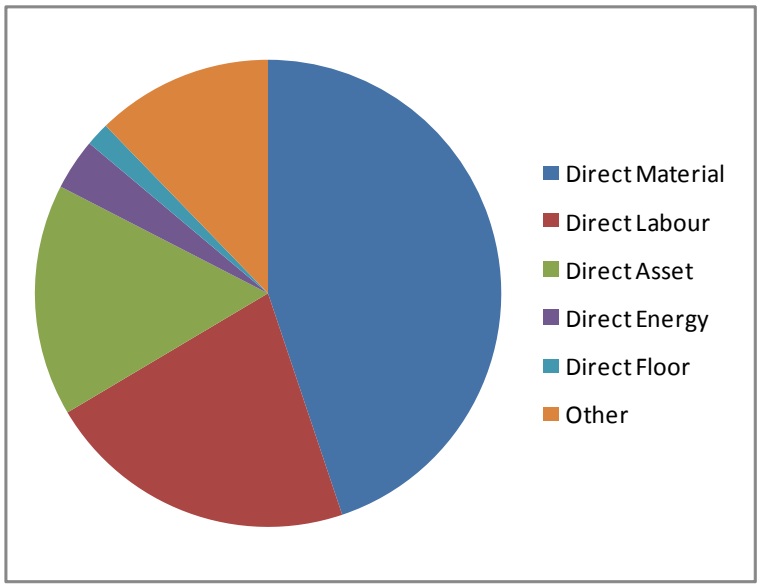
Table B.1.a – Activity Based Cost, sample of 23 articles produced in EU

	Direct Material	Direct Labour	Direct Asset	Direct Energy	Direct Floor	Other
Plastic Assembly	43%	26%	18%	3%	2%	7%
Plastic	68%	14%	6%	2%	0%	10%
Plastic	44%	17%	14%	3%	4%	12%
Plastic	33%	13%	30%	6%	2%	16%
Plastic	55%	14%	10%	4%	1%	15%
Steel Sheet Metal	58%	8%	17%	4%	2%	11%
Plastic	62%	9%	11%	5%	1%	14%
Steel Forging Machining	38%	25%	21%	1%	1%	14%
Steel Machining	45%	19%	6%	2%	1%	13%
Plastic Assembly	61%	9%	10%	4%	0%	15%
Steel Machining	23%	24%	37%	2%	1%	11%
Steel Sheet Metal	61%	20%	3%	1%	0%	14%
Steel Machining	18%	30%	22%	3%	1%	7%
Steel Machining	28%	26%	20%	12%	3%	11%
Steel Machining	49%	15%	16%	2%	0%	0%
Plastic	41%	20%	19%	3%	3%	13%
Steel Machining	23%	36%	17%	2%	1%	12%
Plastic	30%	20%	22%	11%	2%	15%
Sheet Metal	68%	12%	5%	1%	2%	11%
Plastic	57%	8%	21%	3%	1%	10%
Plastic Assembly	26%	37%	16%	3%	4%	15%
Metal	27%	49%	6%	2%	1%	13%
Steel	42%	32%	10%	0%	1%	15%

Source: Anonymous firm (2010)

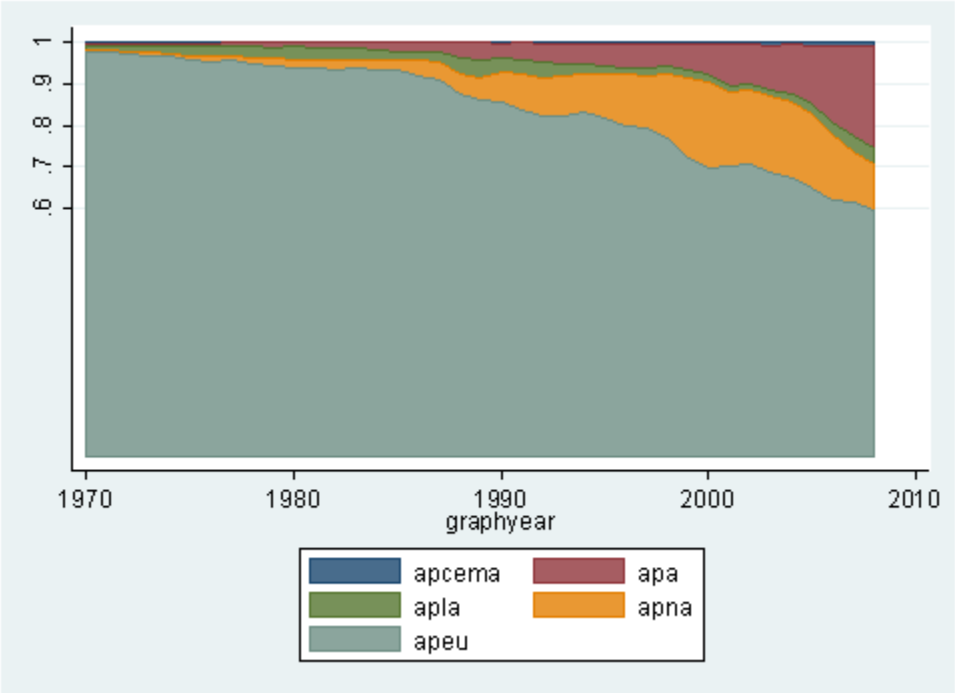
Figure B.1.b – Activity Based Cost, share of 23 articles produced in EU

	Mean	Standard deviation	p-value	Confidence Interval Lower	Confidence Interval Upper
Direct Material	43,5%	15,5%	0,99%	37,1%	49,8%
Direct Labour	21,0%	10,7%	6,11%	16,6%	25,3%
Direct Asset	15,6%	8,2%	6,94%	12,2%	18,9%
Direct Energy	3,4%	3,0%	25,94%	2,2%	4,7%
Direct Floor	1,6%	1,0%	12,71%	1,2%	2,0%
Other	11,9%	3,5%	0,25%	10,4%	13,3%
alpha	0,05				



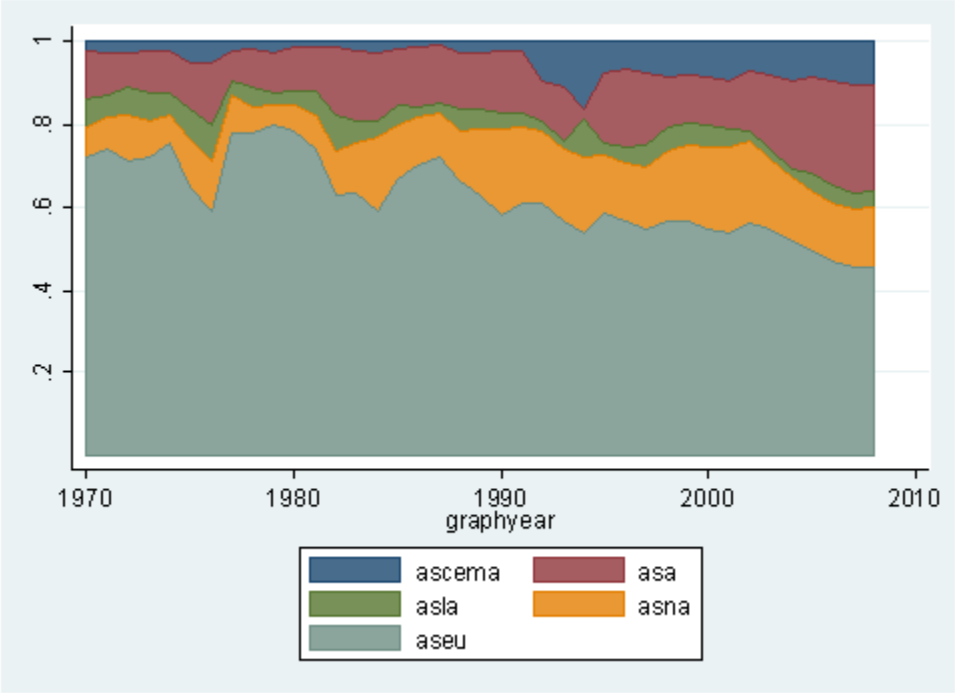
Source: Anonymous firm (2010)

Figures B.1.c – Average production per continent of 26 firms over time



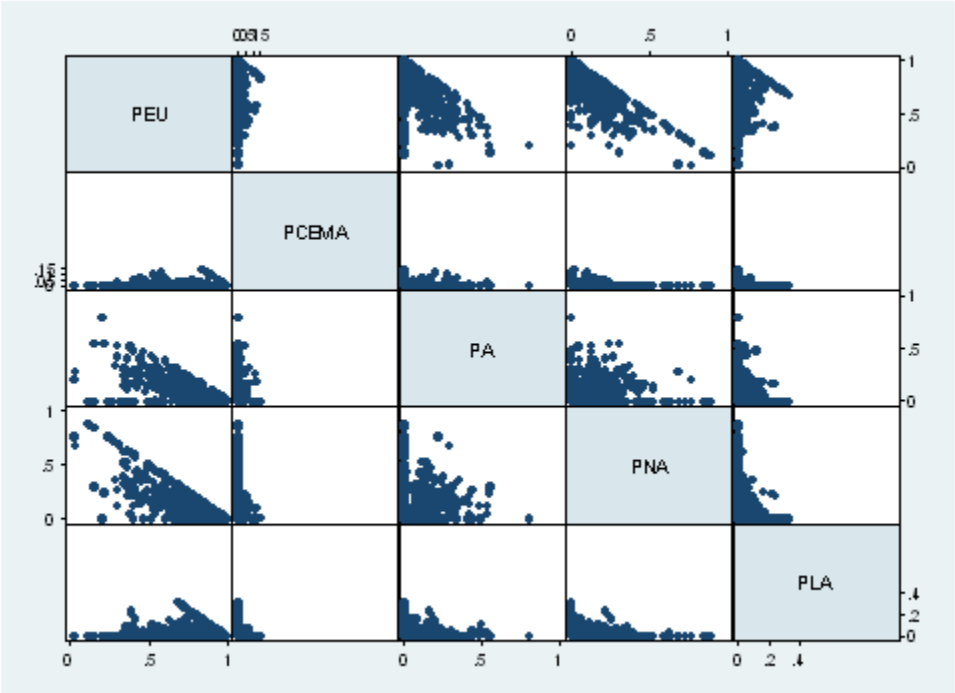
Source: Annual reports (1970-2008)

Figures B.1.d – Average sales per continent of 26 firms over time



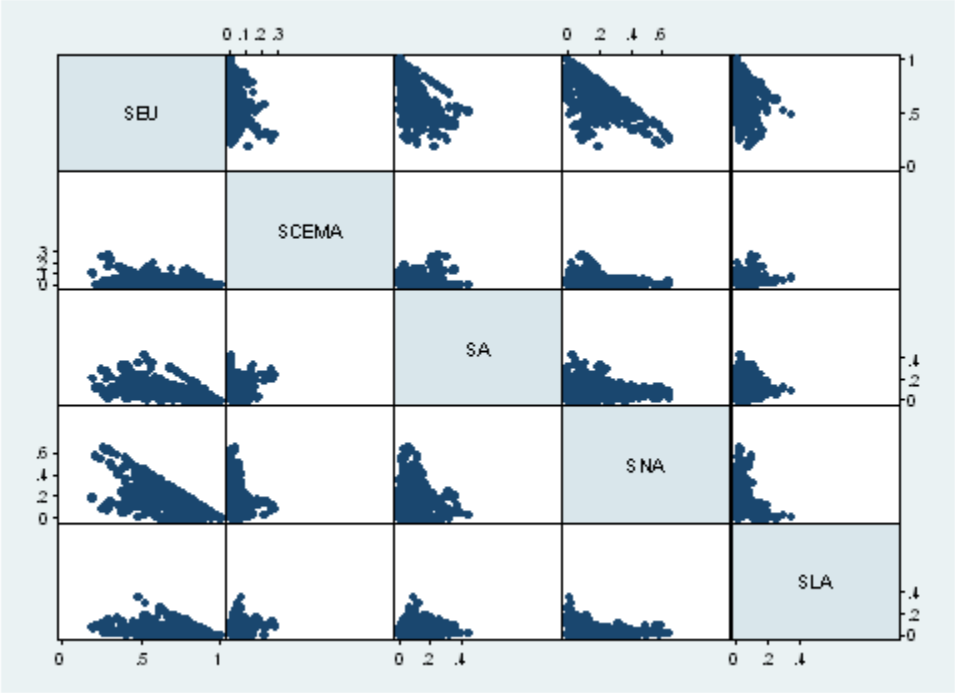
Source: Annual reports (1970-2008)

Figure B.1.e – Correlation of production between continents



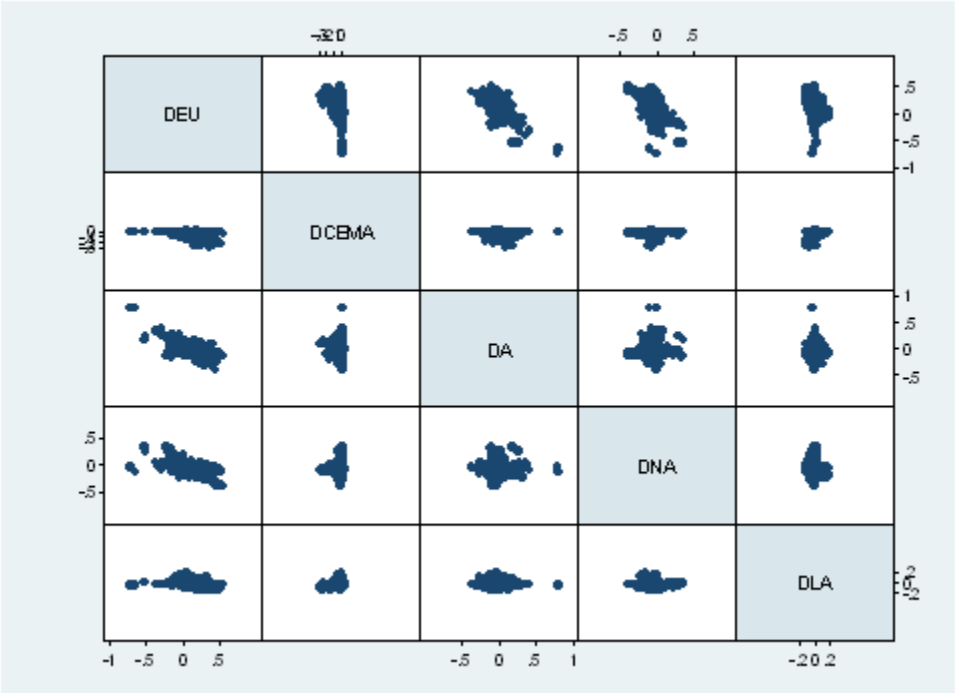
Source: Annual reports (1970-2008)

Figure B.1.f – Correlation of sales between continents



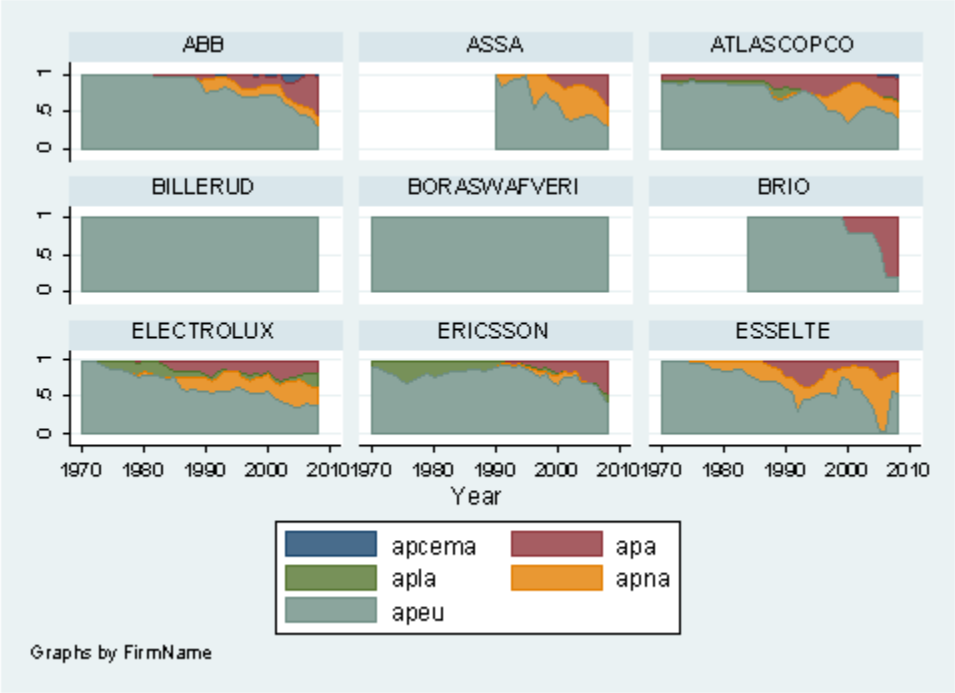
Source: Annual reports (1970-2008)

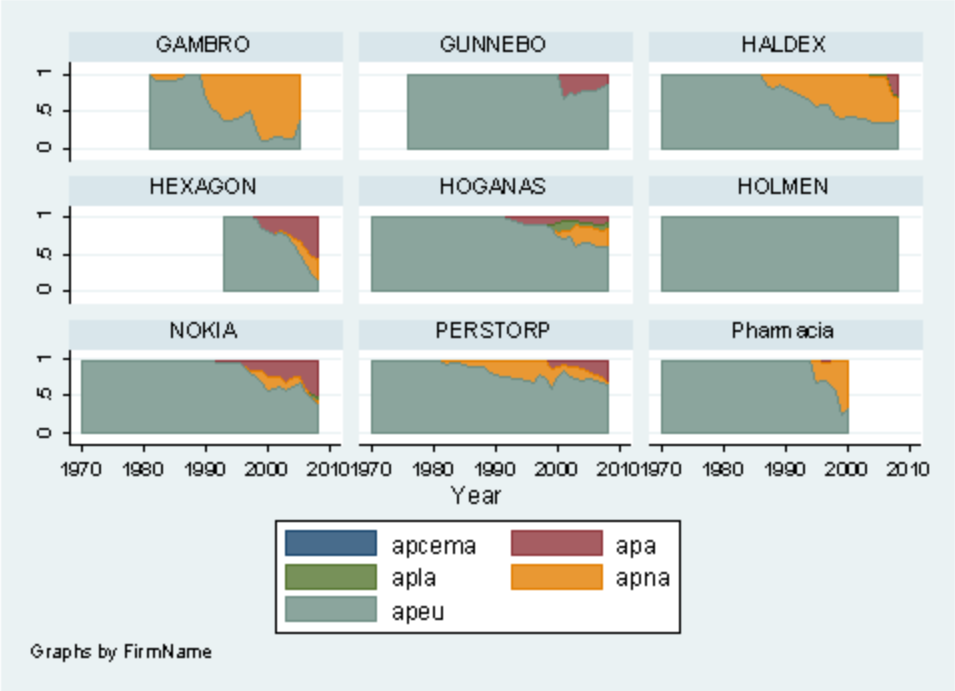
Figure B.1.g – Correlation of trade between continents

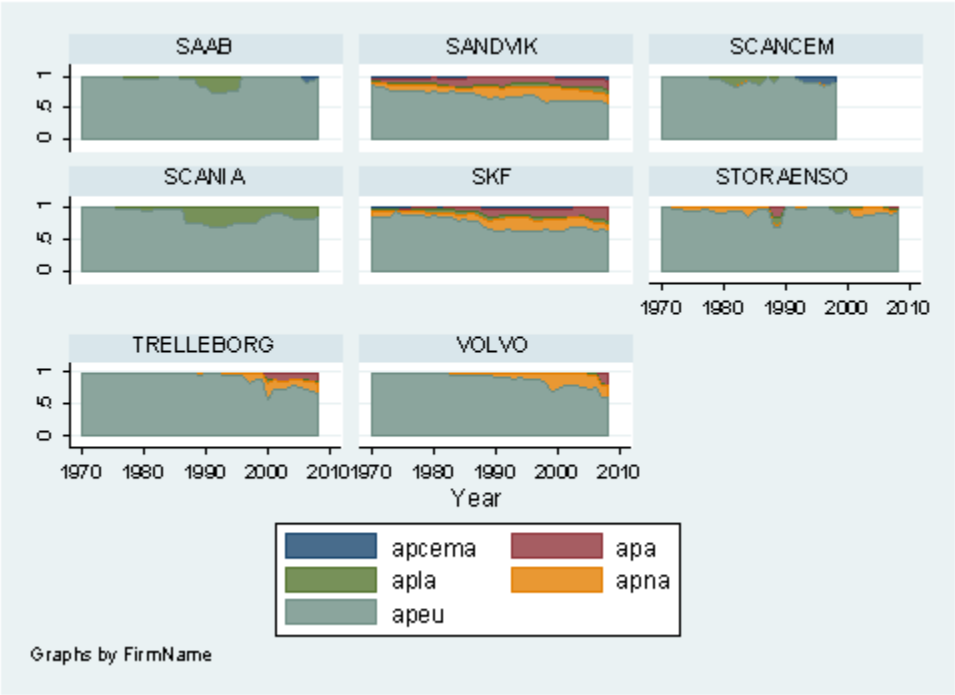


Source: Annual reports (1970-2008)

Figures B.1.h (i-iii) – Production per continent over time

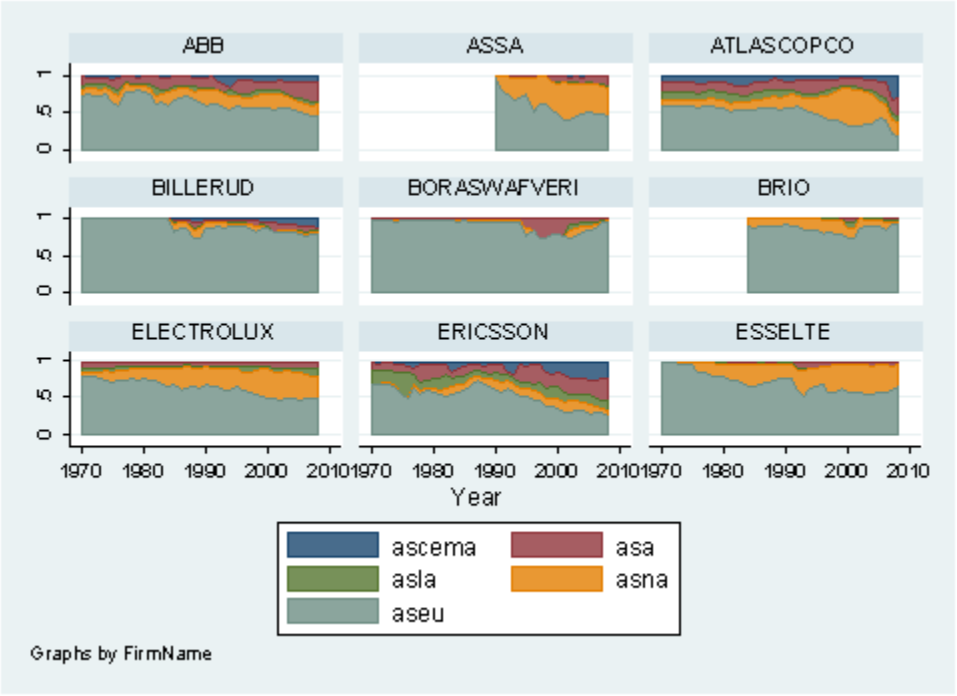


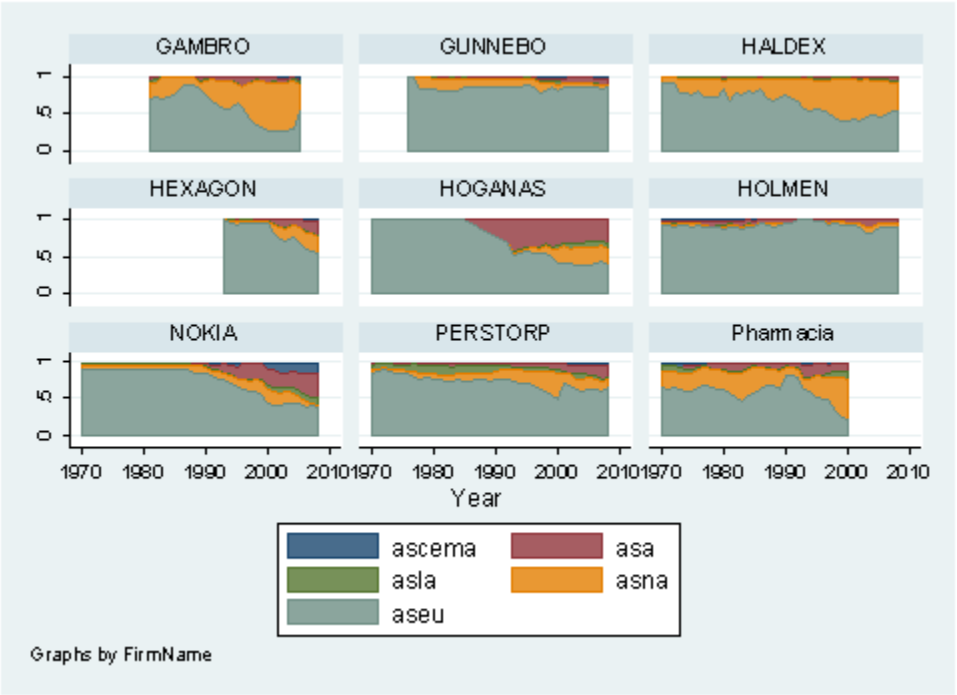


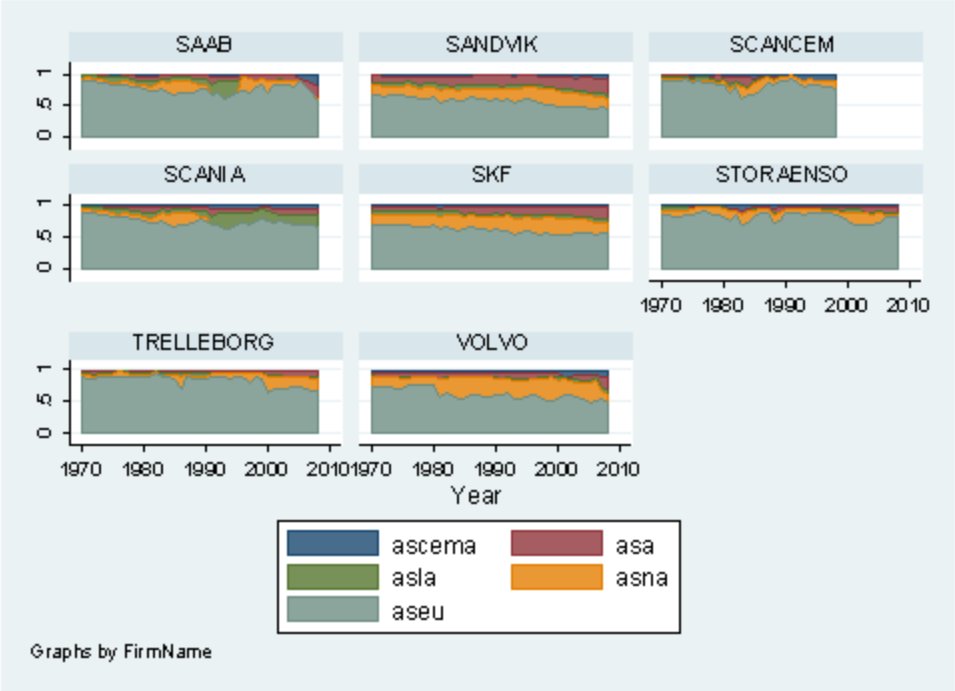


Source: Annual reports (1970-2008)

Figures B.1.i (i-iii) – Sales per continent over time

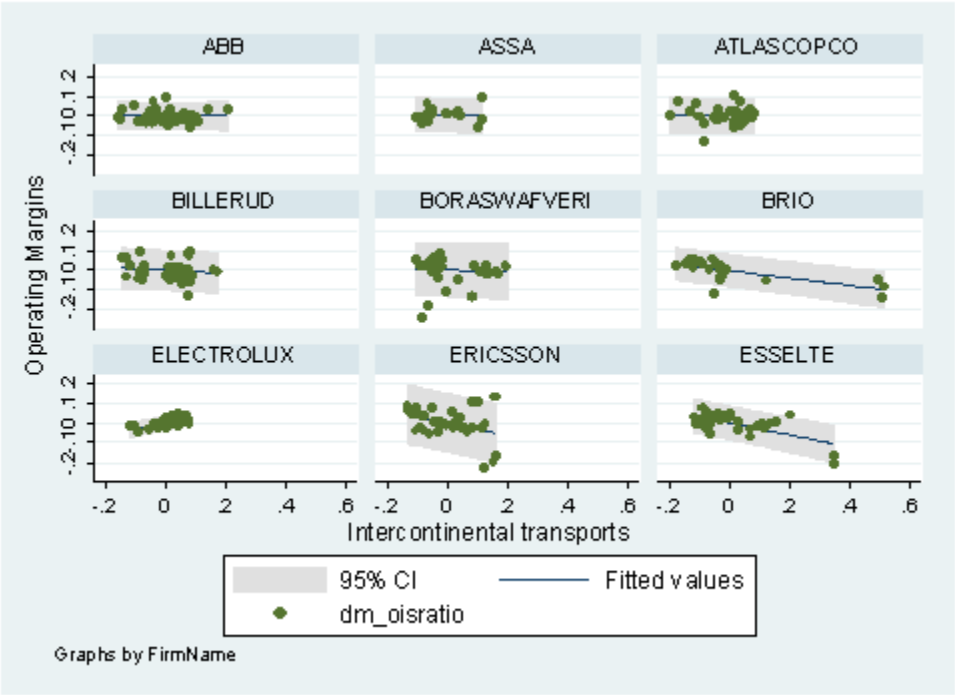


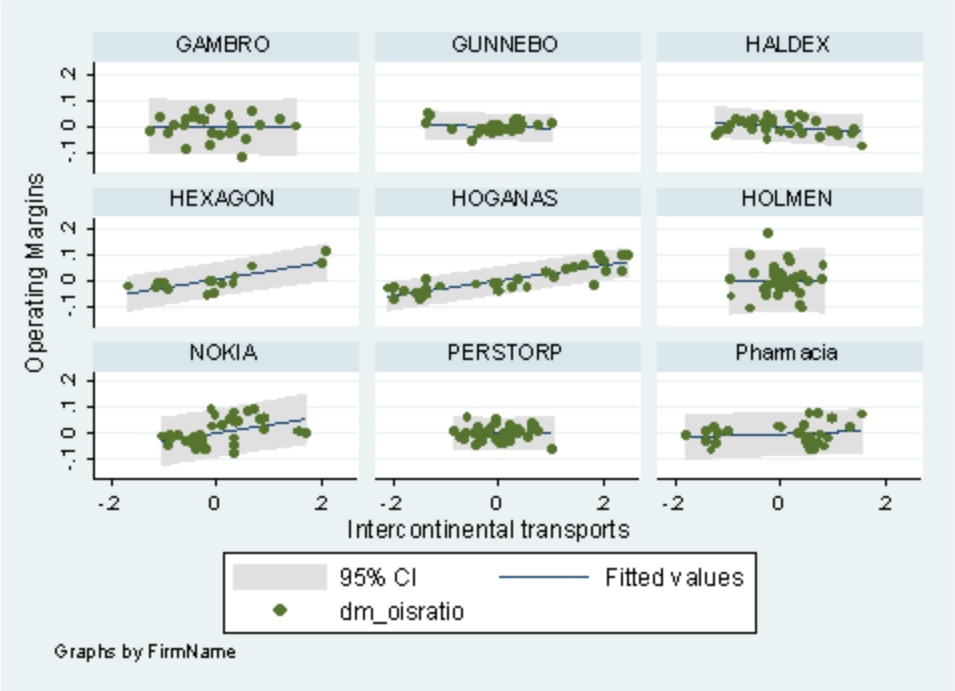


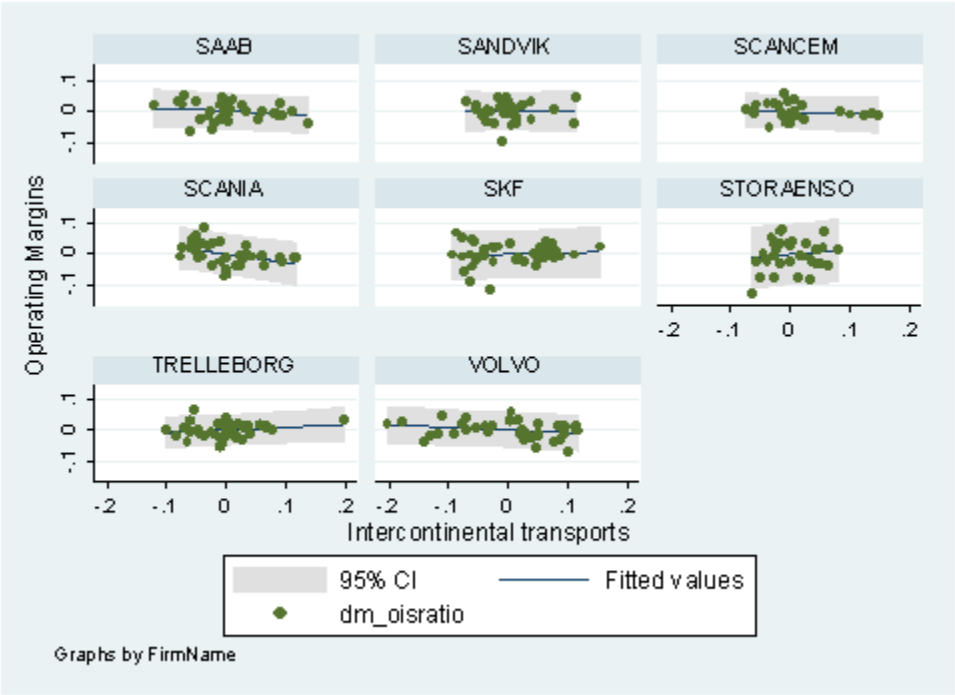


Source: Annual reports (1970-2008)

Figures B.1.j (i-iii) – Operating margins and intercontinental transport







Source: Annual reports (1970-2008)

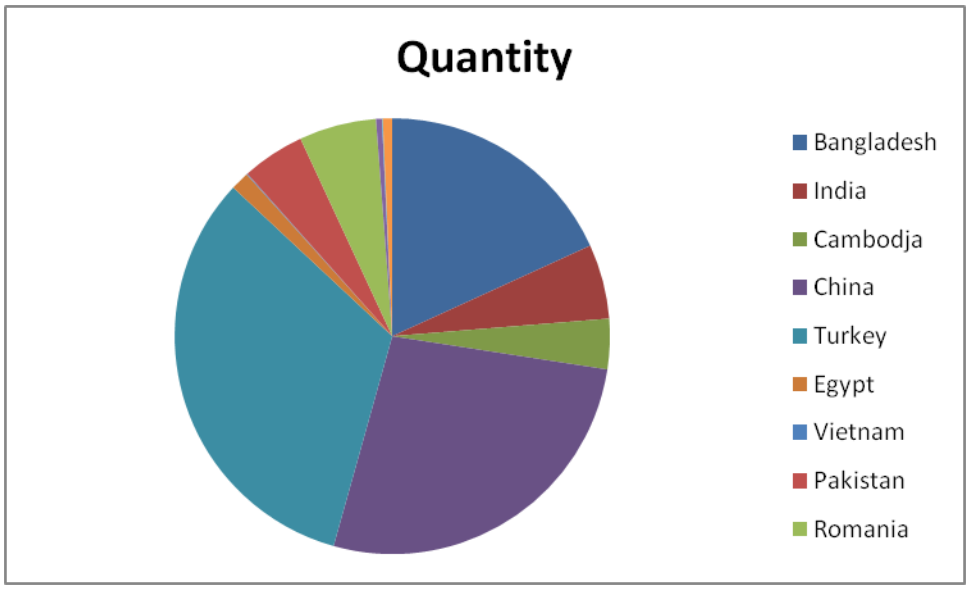
Note: Operating margins and intercontinental transports have been demeaned. However, I do not control for differences in continental production and sales margins in these graphs. Also the slope does not give information due to firm idiosyncratic measurement errors. Only a systemic slope in a panel data system will be of explanatory value.

Table B.1.k – Firms, Estimation Time Periods, Green=included Red=excluded

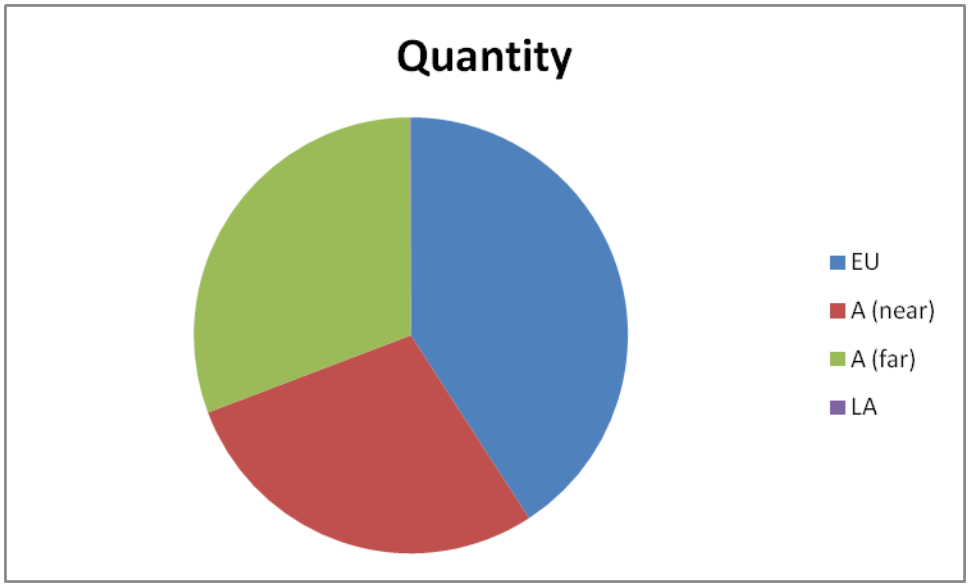
Firm	Industry	1970-2008	1970-1998	1984-2005	1993-2008	1996-2008
ABB	*Power Equipment Manufacturer*					
ASSA	*Lock Manufacturer*					
Atlas Copco	*Industrial Production Equipment Manufacturer*					
Billerud	*Wood and Paper Producer*					
Borås Wäfveri	*Textile Products Producer*					
Brio	*Toy Manufacturer*					
Electrolux	*Appliance Manufacturer*					
Ericsson	*Telecom Equipment Manufacturer*					
Esselte	*Office Supplies Manufacturer*					
Gambro	*Medical Technology Manufacturer*					
Gunnebo	*Security Product Manufacturer*					
Haldex	*Vehicle Components Manufacturer*					
Hexagon	*Measuremen Equipment Manufacturer*					
Holmen	*Wood and Paper Producer*					
Höganäs	*Metal Powder Producer*					
Nokia	*Telecom Equipment Manufacturer*					
Perstorp	*Chemical Producer*					
Pharmacia	*Medicine Manufacturer*					
Saab	*Vehicle/Aircraft Producer*					
Sandvik	*Tools and Equipment for mining and cutting*					
Scancem	*Cement Producer*					
Scania	*Vehicle Producer*					
SKF	*Ball Bearing Manufacturer*					
Stora Enso	*Wood and Paper Producer*					
Trelleborg	*Polymer Producer*					
Volvo	*Vehicle Producer*					
Number of observations		**741**	**609**	**462**	**352**	**276**

Table B.1.1 (i-ii)– Regional sources for clothes in H&M stores in Stockholm, Sweden

Region	Quantity	Store Weighted Total	Store Weighted <200sek	Store Weighted >200sek	Value Weighted Total
Bangladesh	111	21.3%	38.8%	12.0%	18.2%
India	44	8.2%	15.8%	2.5%	5.5%
Cambodia	13	2.7%	1.6%	4.4%	3.7%
China	116	24.4%	23.2%	28.0%	26.9%
Turkey	138	31.5%	17.0%	37.3%	32.6%
Egypt	8	1.5%	1.0%	1.5%	1.4%
Vietnam	2	0.2%	0.3%	0.0%	0.1%
Pakistan	13	3.1%	0.0%	6.1%	4.7%
Romania	23	5.4%	0.7%	7.3%	5.7%
Bulgaria	3	0.7%	0.5%	0.4%	0.4%
Colombia	1	0.2%	0.3%	0.0%	0.1%
Ukraine	3	0.9%	0.9%	0.6%	0.7%
Total	*475*	*100.0%*	*100.0%*	*100.0%*	*100.0%*



Region	Quantity	Store Weighted Total	Store Weighted <200sek	Store Weighted >=200sek	Value Weighted Total
EU	175	40.0%	20.1%	47.1%	40.9%
A (near)	168	32.6%	54.5%	20.5%	28.4%
A (far)	131	27.3%	25.1%	32.4%	30.7%
LA	1	0.2%	0.3%	0.0%	0.1%
Total	*475*	*100.0%*	*100.0%*	*100.0%*	*100.0%*



APPENDIX B.2 – INTERVIEW WITH A COST ENGINEER

In order to understand the cost structure of a good I interviewed a professional cost engineer in a multinational enterprise. My choice of firm was a firm which purchases and calculates costs of all typical goods, except advanced electronics.

The anonymous firm is a well functioning firm which has performed with good operating profit.

The interview questions with answers follows below:

Q1: What does a cost-engineer at your firms purchasing department work with?

A1: A cost engineer is working primarily with calculating product costs of articles, purchased and thereafter used as parts of the final product, on the purchasers' commission. The purchasers use these calculations in negotiations with the supplier. The purchasers also use these calculations to evaluate quoted prices from the suppliers. The calculations, which are of activity based cost type (ABC-type), are primarily founded upon information received from; machine manufacturers, information databases, cost-engineer visiting suppliers.

Q2: What is the reason, seen from an ABC-perspective, to manufacture in a low-cost-country.?

A2: What do you mean with ABC-perspective? Our purchasing department is mainly looking at the purchase price, i.e. excluded transports and hidden costs. There suppliers in low cost countries sometimes can quote lower prices. How often I do not know. My perception is that our firm started with the low cost country thinking (LCC), to move on with best cost country thinking (BCC) and now these concepts are not in our strategic plan anymore. I believe that today we are more open in localizing production where it is more cost effective over the whole value chain, regardless if it is in Gnosjö (Swedish countryside) or China.

Q3: I was thinking which part of the cost is less in low cost countries, which makes the price relatively low. I assume that direct salary is smaller, and possibly direct machine, since some things that machines does in Europe, can be made by hand.

A3: Correct! Primarily the direct salary is becomes much smaller, about 12 percent of Swedish salary (UBC 2007). Lower direct labor gives lower costs, but also that it becomes more profitable to use a lower degree of automation when the machine cost is relatively high compared to the salary.

Q4: Are you including costs of transportation in the calculations you deliver to the purchaser?

A4: No

Q5: Does the purchasers calculate the costs of transportation himself?

A5: Within Europe probably not, but for transports from Asia we have our own logistics function NBF (North Bound Flow). NBF quotes logistics prices which are included in decisions regarding sourcing from Asia.

Q6: So the prices that are offered are thereby visible costs of transportation, like the carriers price tag, as well as the cost of logistics personnel at our firm.

A6: Yes, the whole cost of logistics from the handover at supplier all the way to the factory at our firm, or if it will go to store.

Q7: Who decides directly and indirectly from which supplier your firm is purchasing from?

A7: Directly it is the purchaser, but depending on the extent, the group manager or the department manager must consent.

Q8: Who decides directly or indirectly from which part of the world your firm is sourcing from?

A8: See above

Q9: Is the investment cost of a machine identical all over the world?

A9: This is a complex question. If the comparison is made between Europe and China, a machine in China is probably cheaper, probably because of the lower labor costs and development cost. The Chinese machine has probably a lower lifespan, productivity and is not the top-notch regarding technological development. Now there are European machine manufacturers who are expanding its business by manufacturing their machines also in China, and they are probably similar to those produced in Europe. How they set their prices and which markets they supply I do not know. The question is also connected to what type of machines that are sold. Nowadays there are smaller machines built in line production and supplied in higher quantities. There are also larger machines built one by one in projects.

Q10: Assume that one invests in two machines, a simpler Chinese and a more advanced European. They price of them differ so that the simpler one is cheaper than the advanced one. The machines are both run at full capacity in 3 shifts until the simpler one is completely worn out. At that time the simpler one is scrapped and the more advanced one is sold to another firm. Both have sufficient maintenance in order to be able to run at 80 percent OEE (operating equipment efficiency; an efficiency measure of how much of the machine time is producing goods). Disregard the floor cost and labor cost. Have the machines at that time cost approximately the same per hour?

A10: This is difficult to answer! I still believe that the European has a higher hourly cost, but is producing with considerably shorter cycle time (a measure of how long time, often in seconds, between the goods leaving the machines), otherwise it would be of no use buying a more expensive machine. And as you write, the efficiency does not necessarily have to be lower. Sometimes it can be easier to hold a higher capacity with simpler machines because they are not so complicated. This way we have reasoned at our firm during the last years, where robots have been replaced by humans because of higher flexibility and reliability. Maybe one can relate the question to the Chinese car industry, where the quality of cars is lower than the European because of the technical advantage. If the Chinese would catch up on that advantage, they would in theory produce for a lower cost despite that the products are alike.

Q10: Does machines have similar machine-hour cost all over the world?

A10: If you mean the actual cost, it is not similar. But it is always differing, due to how the users of the machines are taking care of them, the age of the machine, depreciation time, electricity, floor costs and of course labor costs.

One thing seems to be general all over the world is that some firms are competing with old and simple equipment and others with new "top of the line" machines, even in LCCs like China.

Q11: What happens if an article is missing at the moment it is supposed to be used in production?

A11: If it is a less important article, the final product is manufactured until near completion and thereafter complemented with the missing article, which of course induce extra costs and delayed time of delivery. If it is a less important article, which cannot be complemented at later moment, the production stops, which can cause all production to stop.

Q12: Is it common that an article is damaged during transports?

A12: I do not know.

Q13: Is there hidden costs of transportation which are difficult to calculate?

A13: Yes, this is an area we need to learn more from. I am convinced of that it is possible to analyze afterwards by using regression analysis.

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