Essays on Microeconomic Theory and Practice

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1. INTRODUCTION

Economic theory and the empirically observed behaviour of agents are often challenging to match because of the richness of aspects that influence the acting of economic agents. Theory, on the other hand requires a limited number of clearly defined dimensions to be able to derive stringent arguments and conclusions. This work attempts to contribute to economic research by attempting both to retrace the real-life behaviour of agents, to validate and match findings against existing theory as well as to contribute to new theory.

Following a long standing tradition among researchers in industrial organization, as e.g. put forward by Tirole (2003), Chapter 2 presents results from detailed case study interviews in procurement in the automotive industry, thus exploiting the broad array of aspects that any complex empirical problem has. Chapter 3 then presents a narrowly focussed econometric analysis of one particular aspect that has been identified in the previous case study interviews, based on a second survey data set. Chapter 4 discusses a theoretical work that is technically closely related to a well established model in industrial organization, Hotelling, and applies this to the international trade context. All chapters are self-contained research papers, and every chapter is followed by its bibliography and appendix.

In Chapter 2, my co-authors, Florian Müller and Konrad Stahl, and I report on the results of a series of case study interviews with senior managers of suppliers as well as input procurers in the German automotive industry. With this research we attempt to fill the gap between theory building and empirical observation and testing, by introducing a case study approach in which the discussed questions are based on theory, and the context in which they are raised is specified to an extent that allows the reexamination of existent theory, and new theory building. Hypotheses to explain and to evaluate the observed interactions or to identify the need for further theoretical and empirical studies are derived. Among others, we find that the hold-up by suppliers is washed out by contractual interdependence, and in particular by repetition. On the other hand, we assess upstream innovative efforts to be inefficiently small because complementarity effects as well as effort results are not fully internalized. Further theoretical investigation related to inducing innovation and the allocation of risks in the value chain we consider especially interesting. A more detailed empirical analysis would be justified, among others, concerning the differences in contracting between varying types of procured parts and the organization of manufacturing along the value chain.

Chapter 3 succeeds the case study interviews discussed in Chapter 2 and concentrates on a single aspect in automotive procurement, delegation versus centralization, based on a different, larger, and more focused set of data that was generated in a survey of the German automotive industry. This industry is characterized by several stages or tiers of production. Automotive manufacturers (OEMs) in some instances directly negotiate with sub-suppliers of their direct or tier 1 suppliers. This strategy is generally referred to as directed business in the industry. I provide evidence on the use of directed business and match the empirical evidence to the theory of delegation versus centralization. Directed business, or centralization of contracting, decreases the informational rents of the tier 1 supplier as predicted by theory. In addition, I show that directed business includes higher development effort by the OEM and (weakly) reduces incentives of the tier 1 supplier to produce sufficient quality.

Chapter 4 presents a model with differentiated goods applied to the context of international trade and is a joint work with Andrey V. Ivanov. The literature related to the "innocent bystander problem" (Krugman, 1991) predicts that when a subset of countries enters into a free trade agreement (FTA), the rest of the world suffers in welfare. We present a trade model with horizontally differentiated goods, in which in contrast to the literature, under some conditions the non-FTA-participating countries can also *gain* in welfare. The main drivers behind this positive result are the size asymmetry of the countries and the inability of firms to perfectly price-discriminate across countries.

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2. UPSTREAM RELATIONSHIPS IN THE AUTOMOTIVE INDUSTRY: A CONTRACTUAL PERSPECTIVE

2.1 Introduction

Game and contract theories with their extensions to the design of allocation mechanisms, and their applications to the theories of the firm and industry are arguably amongst the most interesting and influential microeconomic theories that have emerged during the last thirty-five years. Bringing these theories to statistical data, however, suffers from the problem that many assumptions essential in driving the results are well beyond the detail captured in the data. Hence many theories remain unchecked empirically.

An additional important facet is brought in by the fact that efficient contracts or other mechanisms proposed by theory are often never implemented in practice, because sophisticated mechanisms may be unnecessary, infeasible, or too costly to implement. In view of this, it seems important to see which mechanisms are actually used, to seek the reasons for apparent inefficiencies, and possibly to improve on them. In other words, the development of new theory in this realm should rest on assumptions that are based on empirically founded generic statements, rather than on assumptions that are, while plausible, often rather ad hoc.

With the present research we attempt to fill the gap between theory building and empirical observation and testing, by introducing a case study approach in which the case questions discussed are based on theory, and the context in which they are raised is hopefully specified to an extent that allows the reexamination of extant theory, and new theory building. The case data are generated from in-depth interviews of the management personnel of German automotive producers' procurement divisions, as well as of the personnel of upstream suppliers' R&D and sales divisions.

The automotive industry exhibits properties that rather ideally serve the purpose. No other mass market consumer product is more complex, and consists of more individual product specific parts, than a modern vehicle. The number of parties engaged in producing and collating these parts is large, and the interfaces between the parts are of a complexity that necessitates particularly detailed coordination. Modern vehicles contain an enormous amount of innovative features in many technological dimensions. Vehicle parts are idiosyncratic to an extent that extremely few parts are used in any two different vehicle models, even if supplied by one automotive manufacturer (henceforth called OEM, Original Equipment Manufacturer). All these properties lead to contractual relationships, in particular between OEMs and their direct suppliers, that span between very personal relational contracts and impersonal arms length relationships.

The automotive industry has changed significantly during the recent 15 years. Two features dominate. Firstly, the typical OEM's product portfolio has broadened significantly, to the extent that product portfolios have become more similar. This, amongst other features, has substantially increased the intensity of competition between similar vehicles.[1]

Secondly, the OEMs have outsourced significantly. Yet at the same time they also have reduced the number of suppliers they are directly dealing with. New supplier types, called system or module suppliers, have emerged. While a system supplier is characterized by integrating several components into a functioning system, module suppliers are merging neighboring components that functionally do not necessarily interact with each other. Examples for a system are the vehicle electronics, or the brake system integrating products from the brake pedal to the brake disks; and for a module the front end, combining the bumper, headlights, radiator and other smaller parts.

Many features of automotive production processes have already been discussed in the literature. In particular, the striking difference between the Japanese and the U.S. way of organizing upstream supply has been discussed in detail. Also the question of in- vs. outsourcing has been subject of research, as discussed, for instance, in the classic example of General Motors and Fisher Body.[2]

Yet a large number of open questions remains related to positive and normative aspects of organizing the upstream sector in the industry as a paradigm example. Some of them are derived from the case study evidence in the sequel of the paper. They largely relate to the mode of upstream innovation, and series supply procurement and compensation schemes.

Our research is geared by two interests. Firstly the methodological one introduced before. We wish to bring data closer to the theory and vice versa, in the hope of mutual cross fertilization. In particular, we attempt to show where theory in its current state helps us interpreting what we observe. By bringing data closer to theory, we also hope to filter out the pertinent models from the overwhelmingly rich set of variants offered to date. Complementarily, we hope to suggest aspects where additional theory is needed to explain the empirical observations.

Secondly, we wish to contribute specifically to an understanding of the players' actions in the automotive industry by analyzing and evaluating the consequences of their actions, towards recommendations for a more efficient upstream interaction, and industrial structure in this important sector.

The sequel of the paper evolves as follows. In section 2.2 we outline our case study interview approach. In section 2.3 we survey key findings from

[1] In the sequel we will only *passim* touch upon this interesting observation. The reasons for this do merit further analysis.

[2] See Klein, Crawford, and Alchian (1978) among others.

in-depth case interviews with senior management sales officials of upstream suppliers and procurement officials of OEMs in Germany, and structure them by microeconomic principles. In section 2.4 we derive research questions and hypotheses, that upon further analysis are geared to answer these questions. We summarize in the concluding section 2.5.

2.2 Case study interviews: Approach

The focus of our case study was on the incentive structures involved in upstream procurement and their change, primarily with respect to research and development, production planning and execution, and also quality management and logistics. All these dimensions can be addressed within formal contracts between the parties, as well as within informal arrangements.

Due to the complexity as well as sensitivity of the issues addressed, we chose an open, personal interview format. Interviews of on average about two hours were conducted at the supplier level with senior management personnel responsible for research and development, production and sales; and at the OEM level with management personnel responsible for parts procurement. The interviews were organized around eight thematic blocks, with a total of some 70 general questions. These covered the product discussed, its buyer and supplier market, the contracting process for research and development, as well as series and spare part production, and finally the resulting after sales market activities.[3] The sequencing of topics pursued in the interviews was flexible. The questions served to control for completeness rather than to prescribe a strict schedule. The Appendix contains questionnaire versions for the upstream suppliers and the OEMs that mirror procurement from the two player categories' point of view. The questions discussing the same subject matter have the same number. The interviews were conducted between November 2005 and May 2006.

Overall 45 upstream suppliers and 7 OEMs were approached towards an interview. The companies were collected from the member list of the Verband Deutscher Automobilunternehmen (VDA). All OEMs producing motorcars were considered. Upstream suppliers were selected to generate a representative sample of the industry, where product complexity, customer specificity and strength of market position are the key characteristics that differentiate suppliers. Interviews were conducted with 17 companies. Each interview of an upstream supplier focused on a representative product range for that

[3] After sales market activities involve selling parts of vehicles that are no longer produced and sold anew, for which the OEM extends an implicit guarantee that these parts are made available for about 15 years after end of production.

company. One of the suppliers was available for interviews in two divisions, that are acting in economically as well as technically different markets.

In all, we consider a total of 15 supplier and 3 OEM interviews in the ensuing analysis. Of the OEMs interviewed, one is a high-volume vehicle producer and one is a pure premium vehicle producer. The third offers a mixed product portfolio. Amongst the 15 suppliers, one was characterized by simple products with a low customer specificity and a weak market position, seven were characterized by complex products with a low customer specificity and a medium market share, six by complex products with a high customer specificity and a medium market share and one by complex products with a high customer specificity and a large market share.[4]

Overall the interviewed companies had sales well in excess of EUR 100 billion, and employed more than 350.000 staff in 2004. The diversity of the interviewed suppliers is also illustrated by their highly varying size, ranging from sales of 200 million up until several billion Euros, and employment figures between 2000 and well over 10.000. Average sales of all interviewed companies were 6.8 billion and the median was at 1.9 billion Euros. The average number of employees was 21.000, and the median number was 9.000.

Before we report on the results of our interview study, we should emphasize that the interview results may be subject to bias. Naturally we observe only the firms surviving in the market. Firms unsuccessful in the past are likely to have exited. Since the typical OEM is too big to fail, this self-selection bias is relatively more pronounced at the upstream supplier level. In addition, of the companies still active in the automotive industry, managers of more successful companies might be inclined to talk more openly about their business, than managers of less successful ones. Our interviewees may also tend to overemphasize current business developments relative to long-term changes. For example, while we observe a long run increase in outsourcing activity, the interview partners emphasized the recent slight backswing. Many answers given in the interviews include very sensitive information. In addition, supplier markets for certain parts are thin, sometimes with only two or three players in Europe or even world wide. Also the number of OEMs worldwide is very limited. We have taken utmost care to anonymize all statements.

[4] The characterization of suppliers was performed outside in via a cluster analysis, based on annual reports and auxiliary information available on their web sites.

2.3 Procurement structures in the automotive industry: Evidence

2.3.1 Overview on interaction structures

As emphasized before, there are very few standardized commodities involved in the upstream procurement for automobile parts. Most parts, even O-rings or screws in a vehicle are produced specifically for one vehicle model, in specific size, material, or machining. Thus there are very few products taken off the shelves to be sold to different car producers, or even to one car producer as carry-over parts, towards use in different models.[5]

The various parts are highly complementary in development, production and delivery. The production process is very sensitive to supply delays, as most parts are no longer held in stock. Often the parts are characterized by very complex interfaces to each other, a feature that affects research and development, production, and part functioning, including part failure and its consequences. In consequence the activities of all parts suppliers are strongly complementary to each other when concentrating on one car model.

All of this calls for complex models of vertical restraints, with several competing principals (the OEMs) and multiple competing agents (the first tier upstream suppliers). Theoretical models on vertical restraints are for example covered in the survey by Katz (1989). Note that externalities abound in this structure. The actions of one party affect the profits of many, if not all others, but the party typically takes its decision based only on the effects of its own profits or utility.

The interaction is complicated by the fact that endogenous fixed and endogenous variable costs interact in a very intricate way. R&D efforts constitute a major part of fixed costs. When conceptualizing a vehicle model, the OEM typically thinks of so called unique selling properties (USP) in which the model should provide innovative advantage over similar models offered by competing OEMs.[6] Research and development for a particular part could in principle be performed by the OEM, by his supplier, or by a joint effort.

However, the OEM typically directly contacts particularly innovative suppliers, and adopts one of the gadgets developed by them, or initiates tenders between a preselected small group of potential suppliers, towards the development of a concept for these innovative parts along the desired specifications.

[5] In the automotive industry's jargon, all parts are called *commodities* that are similar in all vehicle models and produced without major R&D effort. This involves a large share of parts but a small share of the total value procured.

[6] These properties sometimes extend into the larger share of the OEM's portfolio of models.

If several suppliers participate, the concept competition phase for that part ends with each supplier submitting a proposal for the construction of that part, including a price quote for development and production.

Supplier efforts during this phase are most often not directly compensated by the OEM. The supplier undertakes basic R&D efforts (about 10 per cent of his total R&D outlay) at his own expense and risk, often in close contact to universities and other research facilities, and presents the results to one or several OEMs. In the ensuing pre-development phase the supplier engages, sometimes in cooperation with a particular OEM, in the development of a prototype not geared towards a particular vehicle model, with the cost again borne by the supplier or shared with the OEM. In most instances, the development of the model specific part is also conducted by the supplier, but under the OEM's close supervision. Sometimes this supervision is extended into a joint development effort with the OEM.

Variable costs primarily arise per piece supplied. The OEM selects one or possibly several suppliers to develop the part to production maturity. Then often another tender is held, and the winner is awarded the series production contract or portions thereof; for instance, the initial year of series production. In most cases parts are procured from one supplier only at a time. Dual sourcing, with the second firm assigned a smaller share of production volume, is rarely used amongst German OEMs. Finally, second sourcing, with a second source nominated, but no production share availed unless the first source drops out, was not observed at all.

For many reasons including capacity utilization in development and production as well as brand marketing, the typical OEM launches individual vehicle models in different years. The observed pattern exhibits an overlapping generations (OLG) structure. This is reflected in an OLG structure of supply contracts, often with the same supplier. When contracting parts for a new vehicle model, the OEM frequently uses the occasion to renegotiate procurement contracts; in particular prices, for parts built into running models.

Schemes to reimburse the supplier's development efforts towards model specific parts vary between coverage of a fixed share by the OEM, and coverage by a mark up on production costs, rarely with a volume guarantee by the OEM. Almost all production contracts account for learning cost savings varying between 3 and 5 per cent p.a. The aforementioned renegotiations are often geared towards the OEM's increased participation in such cost savings.

In the following subsections we structure upstream-downstream interactions, and our case study evidence. This should help the development of research questions and hypotheses on upstream procurement behavior and its economic effects pursued in the ensuing section 2.4.

2.3.2 Contractual incompleteness

Upstream supply contracts in the industry exhibit a variety that ranges from very specific, to general framework contracts that outline a general understanding between the supplier and the OEM on the procurement of a part during the life cycle of a model. The shell for all contract forms is typically provided by the OEM within *General Terms and Conditions*. A development, or supply contract typically contains the following specifics: Contract duration; dates and terms of supply; parts specifications and changes of those; quantity, logistics (order flow); quality and warranty management; payment terms; cancellation payments, and intellectual property rights on newly developed components.

There are very few, if any, contracts that can be called complete.[7] Incompleteness arises with respect to elements that are technically not verifiable (see below) or are too costly to specify in a contract. They also do not cover all eventualities (possible states of nature). Court cases are rare and thus verifiability is rarely an issue, for an obvious reason: Most interactions are repeated, and thus it is not in the interest of at least one contracting party to draw the opposing party into costly court rulings.[8]

More specifically, our case study interviews suggest incompleteness primarily in the following dimensions.

Attributes of the part are inherently specified incompletely at the moment the development contract is written. Conversely the supplier's development effort intensity is both not specified and not verifiable.

Quantities procured by the OEM are specified typically via the OEMs' target vehicle output quantities over the model's entire life time. Yet the effective quantities demanded are dependent on the final demand for the model. That is realized only in the short-run, and effectuated in the OEM's release orders weeks or days before delivery. The contracts specify the release order procedure. The supplier determines his capacity largely at his own risk. The OEM very rarely grants volume guarantees.

[7] Interview results: Contracts used are widely incomplete and augmented with (partially not verifiable) side agreements (Yes=7, N/A=9, No=2), such that the value of contracts for the relationship is limited.

[8] Results from the interviews for the use of court procedures showed 6 'No', 12 'N/A' and no 'Yes'. Amongst the 6 'No', 2 suppliers explicitly stated they would not engage into court procedures on patent infringements, 2 would not engage in procedures against the OEM, if he disclosed research results to competitor suppliers, 3 stated that they would not engage in procedures against OEM in general (also general disregard of contracts was mentioned).

Reliability is typically exercised within contractual terms, in form of maximal failure rates (parts per million) required by the OEM, and so are payment flows when responsibilities for failed parts are clearly identifiable. Contracts typically remain unclear with respect to failures involving externalities discussed below, in the section on reliability risk.

Prices at which the part is delivered to the OEM are always precisely specified for the initial delivery period, e.g. one year. Framework contracts, however, include further delivery periods up to over the model lifetime. If such a contract is written, then prices for ensuing periods are either pre-specified, with stepwise price reduction schedules to account for learning effects on the supplier side; or prices are renegotiated annually. In either case, price specifications are likely not to be binding. The OEM may enforce renegotiations under breach of contract, which contributes to contractual incompleteness.

Switching suppliers: While the discontinuation of a supply contract appears to be a rare event, the conditions for a discontinuation apparently are almost never completely specified. One of the few provisions from the procurer's point of view is the property right over model specific tools typically also financed by him. While in theory the tool can be transferred between suppliers, the switching cost involved in the transfer is very high, as stated by both OEMs and suppliers.

There are other components of the supplier-buyer-relationship that seem to be not specified in contracts at all. For example, there was no report on provisions that account for a supplier's potential financial distress. In view of the complementarity between the parts, the OEM's interest in an uninterrupted flow of supply, and the high switching cost involved in changing a supplier, it is in the OEM's short run interest to bail-out a current supplier in distress.[9] Also, the OEM may want to enhance competition between suppliers of similar parts by rescuing his present supplier. However, this obviously distorts incentives at the supplier level. Alternatively, under dual sourcing, the second supplier may be asked by the OEM to also produce the distressed supplier's share, towards a gain in reputation against the OEM.[10]

[9] Six suppliers stated explicitly that they observed situations in which the OEM would provide ex post bail-out for suppliers in distress. One supplier declined this. 11 suppliers did not provide an answer.

[10] We have found one instance in which a competitor of the bankrupt supplier was asked by the OEM to provide bailout—thus rescuing the competitor—in exchange for favorable supply conditions on another contract.

Further aspects resulting in contractual incompleteness are borne out in the sequel.

2.3.3 Complexity of parts exchanged

Led by increasing demands on vehicle features such as engine power, energy efficiency, active and passive security, or operating noise reduction, the engineering complexity of vehicles has increased enormously in recent years. This has given rise to the question of delegating development and production of a part rather than producing it in-house. When procuring a part, problems arise from the delegation of control over development and production processes. We have identified three components:

Development complexity arises from the fact that the delegation of development tasks may lead to local rather than global optimization in the development process. This problem is more relevant for parts that are essential for the functionality of, and very much integrated into the structure of the vehicle such as the power train; rather than those that are inessential but with functions that contribute to the vehicle's overall quality, such as the car interior.
The main drivers of development complexity are the essential part's interfaces to other parts and the intensity of required development interactions. One attempt to cope with this complexity problem is to have the supplier's engineers take residence at the OEM's development site. We have found this being common practice during the development phase of essential parts.[11] However, this only partially resolves the problem, since innovation in systems or modules may be driven by suppliers further upstream. In case of the development of a system or module, the system or module supplier has to orchestrate these development efforts.

Logistics complexity is the complexity incurred in the assembly of the system or module, and the scheduling of the assembled parts supply in the specification that is in immediate demand. The logistics complexity is driven by the number of sub- suppliers involved and the complexity of the interfaces between the parts procured by the supplier. For essential parts this interface tends to be very complex. Some of the scheduling problems are accounted for by the establishment of Just-In-Time (JIT) production facilities by the supplier close to the location where the vehicle is assembled.

[11] Out of our interviewees, resident engineer schemes are reported to be used by 7, no interviewee rejected the use of residence engineers, 11 did not respond in this respect.

Contract complexity is the complexity incurred by contractual agreements between the business partners, that arises from the outsourcing of more complex parts. It contains the cost of administering business contacts with potential suppliers (including quality certification, etc.) and the actual cost of designing and executing the contract between the OEM and actual suppliers (including the cost of quality control, administration, lawyers, etc.)

Overall the OEMs have reacted to these different forms of complexity by the bundling of parts otherwise procured separately into systems or modules. This should reduce total complexity problems between the OEM and the so-called first-tier supplier. However, the reduction of complexity by increased procurement of systems and modules and systems at the level of the OEM leads to longer supply chains, involving delegated monitoring.

We found two distinct types of system or module suppliers: A first type procures and assembles all parts contained in the system or module independently of the OEM, and delivers it as one part to the OEM. While in this case the OEM enjoys minimum complexity at least for logistics and contracts, he loses the direct contact to the parts suppliers further upstream. The main consequence is a loss of control over the development of the part.

A second type only assembles all the parts, which are procured by the OEM. Whilst only the assembled part is shipped to the OEM such that the logistics complexity for the OEM remains the same as with the first type system supplier, the OEM, by procuring himself, keeps contact to parts suppliers further upstream, at the expense of a higher contract complexity. Hybrids of the two models are common.

2.3.4 Risk and incomplete information

For each part of a vehicle in development, incomplete information of all parties involved creates three major classes of risk that need to be borne by the OEM and its suppliers, namely innovation risk, volume risk, and reliability risk. Portions of all risks are exogenous to the supply hierarchy. For instance, volume risk is to some extent induced by random demand shocks in the downstream car market. However, there are also important endogenous portions. For instance, volume risk is to some extent influenced by the OEM's marketing efforts. In particular, the reliability of the vehicle depends on the effort by many parties in the supply chain that goes into the development (including testing) and the production of all the parts. In view of this the risks need to be allocated between the participants of the supply chain so as to create efficient effort incentives towards controlling these risks. To be more specific, we consider the following components:

Innovation risk is the risk that either an innovation effort fails to achieve an ex-ante stated objective, or the innovation is not achieved at the ex-ante expected cost. Innovation risk differs between model unspecific basic research and model specific adaptation development. Our case study evidence suggests that independent basic research by the supplier constitutes only a small share (about 10 per cent) of his R&D effort. However, the innovation risk involved in this remains fully with him. The larger share of basic research is ordered by the OEM, and sometimes jointly pursued with him in a research joint venture, which reduces the supplier's risk. The remaining share of the supplier's R&D effort constitutes the model specific adaptation of innovation results. While project success is almost sure, the remuneration of project costs is the major risk resting with the developing supplier, if the development costs are reimbursed via a mark up on risky volume. Another kind of innovation risk arises from the fact that final consumers' willingness to pay for a particular innovation embedded in a part may be too low, relative to the cost of producing the innovative part. This risk especially arises when suppliers perform independent basic research, and post development, for the reason given, are faced with the problem that OEMs are not willing to absorb the innovation.

Volume risk is the risk that the realized vehicle sales volume is at variance with the capacity determined on the basis of expected volume. To the upstream supplier the downside risk that volume is below expectations and thus production capacity remains idle carries more financial weight. This risk is exogenous to some extent. However, the OEM's marketing efforts are influential. As car parts are perfect complements to each other, the risk carries over into the supply chain. Supply contracts almost never specify exact quantities. Even minimum quantities to be absorbed by the OEM are rarely specified. However, if specified and the actual numbers fall short of these, the OEM may agree to compensation payments that cap suppliers' risk.[12]

Reliability risk is the risk that parts are subject to a higher than expected failure rate. Additional complexity in the risk involved is due to an important externality. The failure of one part can induce the failure of other parts. An extreme example is the failure of an O-ring that may

[12] That OEMs guarantee minimum quantities is stated by 2 interviewees, 7 reject the use of minimum quantities. Out of the latter, 4 state the possibility of renegotiations when quantities fall short of expectations, but with a strongly varying success rate. 9 interviewees did not respond on this topic.

destroy a car's entire engine. The risk of individual part failure is to a large extent endogenous and varies with the supplier's development and production effort decision. The source of reliability risk cannot always be identified. It is the OEM, however, who is exposed to the quality risk vis à vis the final consumer, typically by a formal warranty commitment, and via reputational effects that may involve indirect costs outweighing by orders of magnitude the direct costs of resolving a warranty problem. Our case study evidence suggests that in the majority of cases failure can be attributed to the faulty part and the supplier is billed the direct cost. Reputational risk, however, remains with the OEM.

2.3.5 Asymmetric information

In upstream markets for buyer-specific parts such as the one considered here, informational asymmetries between OEMs and upstream suppliers take particular forms. By definition, the OEM should know best what suits his business, because that is determined by the final consumer's willingness to pay for the entire vehicle, composed of many complementary parts. By contrast, the supplier knows best the cost of developing and producing the good. More specifically,

R&D effort exerted by the supplier can only be incompletely monitored by the procurer, which invites moral hazard on the supplier side. Joint development efforts, in particular resident engineer schemes, reduce the informational asymmetry. Moral hazard is also contained by the ex post observability of the supplier's R&D success embodied in a vehicle model, that may or may not invite repeated procurement from the same supplier by the same OEM.

Cost information on development and production costs is a key private information of the supplier. During the initial procurement process for a new vehicle model, the OEM can elicit cost information from the competing suppliers; in the extreme form by asking them to reveal their accounting numbers. Since products are idiosyncratic, their production is idiosyncratic, so it requires a specific effort on the OEM's side to uphold, or develop, skills towards evaluating cost structures.[13]
The continued production of parts is subject to substantive learning

[13] One OEM stated that—while fostering outsourcing—he was losing this judging ability due to the loss of technical expertise. Currently he is engaging in measures to stop this drain of expertise.

effects. Towards reducing informational asymmetries in continued procurement phases, the OEMs generate cost estimates first from the internal production of similar parts, as well as with the help of re-engineered parts and a thorough cost analysis. When prices are renegotiated annually under a framework contract, some OEMs organize inverse auctions, often by passing on construction blueprints to competing firms, towards obtaining independent cost estimates. These are often used to press on the incumbent supplier for cost reductions. Recently the OEMs have acquired sufficient market power so that they can require to an increasing extent open book accounting, forcing the supplier to disclose his cost accounting scheme. This can only be profitable for the supplier if either he pursues "creative accounting" in order to hide profits,[14] or if the OEM guarantees him an acceptable profit.[15]
Cost monitoring by the OEM seems more concentrated on more valuable parts.[16] Also, the suppliers feel more squeezed when dealing with a module supplier than with an OEM. Indeed, system and module suppliers also may be forced to disclose their upstream contractual relationships. The OEM may prescribe the upstream partners and impose a particular contractual relationship, via directed business.

Willingness to pay (WTP) by the OEM for a certain procured part is derived, in principle, from the final consumers' willingness to pay for the entire car in the downstream market. Anticipating, and decomposing that willingness to pay into the components supplied is one of the more difficult tasks in the design phase of a car.
The OEM implicitly performs a hedonic price decomposition,[17] and derives his expected benefits by mirroring this with target cost accounting. This cost accounting scheme serves to derive the OEM's WTP for the part.
If a supplier has developed a novel gadget or feature on the basis of his own R&D efforts, he can exploit monopoly power against the OEM buyers. We found that when faced with the alternative to offer the

[14] One supplier, who produces parts as well as the part specific tools, stated that the cost accounting for the tools is much less transparent than for the parts and that tools show significantly higher margins.

[15] Apparently the open accounting scheme was adopted from Toyota, today considered the world's most efficient and profitably vehicle producer. However, Toyota seems to guarantee an acceptable profit (or even profit sharing) in return, whilst this appears not to be done by the German automotive producers.

[16] Statement by one supplier: "Best way to earn money is without attracting attention".

[17] In all cases observed, this is done implicitly by asking the question of how much more the consumer would be willing to pay for the car if the gadget in question were included.

gadget to one OEM towards its monopolistic exploitation in the final market, vs. to offer it more or less simultaneously to several OEMs, he never prefers to offer it to one, but always to several OEMs - possibly after the short term exploitation of monopoly under a short term (six months to one year) exclusivity contract with one OEM. The rationales given are twofold. Most gadgets are produced subject to substantive learning cost reductions, and due to limited enforceability of intellectual property rights, competing suppliers could flood the market with close (improved) product variants.

Expected production volume is an important prerequisite specification for the upstream supplier when determining his production capacity and his unit cost; the latter especially if both the fixed development and the fixed production costs are financed via mark-ups on unit prices. The OEM has an incentive to overstate the expected production volume when negotiating a new contract. Upstream excess capacity would induce a more favorable ex post bargaining situation for him than a capacity shortage, as the supplier's initially quoted per unit mark-ups would be reduced. By our observations, all suppliers anticipate this and determine their capacity by discounting the numbers quoted by the OEM by up to 30 percent.

Generally, by their own statements the players do not consider very important informational asymmetries between first tier suppliers and OEMs. This should lead to relatively low information rents for all players. The OEMs seem to be better informed about the suppliers than the suppliers about OEMs. The OEMs clearly engage actively in measures to reduce the suppliers' private information. Premium and volume OEMs assign differing importance to the individual measures. Premium OEMs are more reluctant in the use of external measures to gain information such as procurement auctions, in order to not curtail suppliers' innovation incentives. Instead, learning from past joint development activities and from procurement with the same supplier seems to be dominant. By contrast, a volume OEM stressed the importance of frequent pseudo-auctions, as well as of re-engineering of parts, as information gathering devices.

2.3.6 Mutual hold-up

Hold-up of the other party could in principle occur in various ways. The OEM faces hold-up risk by the supplier, as by delaying or discontinuing delivery that supplier can bring the entire assembly process to an expensive halt. Additionally, during an ongoing development or production contract, the OEM faces the problem to incentivise the supplier towards exerting effort on improving quality and/or reducing cost.

The supplier in turn faces the problem of potential leakage by the OEM of the intellectual property incorporated into his product, and the risk of not being ordered the volume for which he had designed capacity at a fixed cost. This problem is magnified when the supplier is not fully compensated upfront for his development and production fixed costs. He then is uncertain about the compensation of these fixed costs in the face of uncertain quantities delivered.

Although the OEM very often faces potential hold-up situations with his suppliers we rarely see a supplier actually engaging in hold-up.[18] We found it only in the rare situation in which a supplier not originally under contract for series production was asked to step in, because the original supplier was confronted with quality problems. Conversely the hold up of suppliers by OEMs seems to figure more prominently in two contexts: Some OEMs tend to pass on intellectual property to competitors, or tend to delay payments for delivered parts.

While contractual penalties could remedy the problem, they seem not to play a major role in supply contracts. They also were never mentioned as a strategic option.

2.3.7 Switching cost and lock-in

The production of buyer-, and beyond those, of model-specific parts by a supplier induces switching costs to both the supplier and the OEM. More specifically, switching cost may arise from the following sources:

Product specific intellectual property rights often reside with the upstream supplier. Often there is a generic conflict of interest between the upstream supplier and the OEM. Whilst the OEM would like to exploit such rights by exclusively using the part in his model (or models), the upstream supplier is interested in selling variants of such a part to competing OEMs. No matter the resolution of this conflict, the property right increases the OEM's cost of switching to another supplier of that part. While sometimes the OEM exerts his market power to enforce the licensing of the property right to the supplier's competitors, such an enforcement is invariably related to a loss in the OEM's reputation as a reliable trading partner.

[18] A famous exception is the hold up of Ford by Kiekert, a one time monopolist in the production of car locks, in Wachtler (2002).

Production tools are the product specific elements of a machine to produce a part. For example, the production of a body part necessitates a welding press that can be used to press many different body parts, and a tool that shapes the particular body part. While the welding press is owned by the supplier, the tool is owned by the OEM in all cases we have observed, but only operated by the supplier. In principle, this enables OEM to withdraw the tool and to set it up with a competing supplier.[19] Yet the cost of reorganizing the supply stream appears so high that this incident arises extremely rarely.

Process know-how complements the use of the tools to produce the car part. It is the capability to manage a particular technology. In most cases this knowledge is technically difficult to transfer, and such a transfer is not enforceable. Together with the tools, the complementing process know-how is idiosyncratic and creates sizeable switching cost to the OEM.

Internal supplier certification on process and product quality as well as on logistics processes by the OEM is costly. Indeed, internal supplier certification costs by the OEM exceed the external process quality certification costs that are the prerequisite for a supplier to participate in a tender at all. When switching suppliers the OEM duplicates these costs. The case study evidence suggests that this is one of the main elements constituting switching cost in a supply relationship.

Capacity that has been built up to supply the parts ordered for one vehicle model typically represents a substantive component of a supplier's total order book. Within a Just-In-Time (JIT) manufacturing scheme the capacity may have been built close to the OEM's manufacturing outlet. This capacity can not be easily relocated or adjusted to the production of other parts, which constitutes the most important switching cost to the supplier.

Production downtime connected with a switch of supplier is also a sizable element of switching cost. Even the transfer of one tool to another supplier inflicts a sizeable loss on the production volume of a vehicle, if, as usual at current production logistics, the OEM does not hold a buffer stock of the part in question.

In all, since the procured parts are complementary to each other, and decreasing cost technologies in development and production invite procurement

[19] It also allows the OEM to indirectly control the markets for spare parts produced with the tool.

from one supplier only, that supplier has, largely due to the switching costs arising for the OEM, an ex post monopoly in the supply of any part that is essential for the production of that vehicle. However, the supplier also faces high short run costs of switching to another buyer.

Both, OEMs and suppliers can strategically influence the level of switching costs. Within limits, the OEM can try to avoid product idiosyncrasies and the associated jeopardy of being held-up. He can engage in industry-wide standardization (e.g. halogen headlights, tires), but this is clearly limited by his interest in specifying unique selling propositions for his vehicle models in the market.

Keiretsu-like structures as used by the Japanese OEM's can also resolve the hold-up problem.[20] The OEM may also employ dual sourcing as a safeguard against lock-in by the first supplier. Yet this option must be weighed against an increase in overall production costs (i.e. double the fixed cost and thus lower economies of scale).

The typical supplier has fewer means to decrease the switching cost for him. By contrast, he can increase the typical OEM's switching costs by increasing the level of intellectual property embodied in the part supplied, so that circumventing the innovation is inefficient and costly for the OEM.

Despite the high switching cost and lock-in potential we rarely see hold-up strategies being played.

2.3.8 Contractual interdependencies

In the automotive market, OEMs produce many models. The suppliers supply parts for many models of many OEMs. This inevitably leads to multi-market-contact between upstream suppliers and OEMs. From our case study, we observe that at any time supply contracts are interdependent, mainly in the following variants:

Supply contracts for innovative and standard products: Many upstream suppliers provide both innovative components and standard commodities to the same OEM. We found evidence that such an upstream supplier appears limited in exploiting monopolistic advantage in the provision of the innovative product. This, he feels, would induce the OEM to withdraw from the supply relationship for more competitive products.

Supply contracts for high and low volume products: Contracts, so the suppliers, differ by volume in their attractiveness to the typical supplier. Large volume contracts appear to be more profitable to the typical

[20] See McMillan (1990) for a description of Keiretsu structures.

supplier than small volume contracts - an indirect indication for the possibility that (portions of) information about decreasing costs remains proprietary to the supplier.
OEMs also offer niche models in small volumes, either because they are profitable themselves, or because there are positive branding spillovers. At any rate, according to our evidence, the OEM demands the supply of small volumes for niche products when contracting with the supplier for large volume products.

There is a third most important variant of contractual interdependence singled out below, namely an intertemporal contractual interdependence.

Contractual interdependencies are virtually always induced by the OEM. Only one premium OEM explicitly stated that he avoids bundling, while focusing on the optimal contract for each part.[21]

2.3.9 Repeated interactions

A particular form of contractual interdependence arises when interactions between the same buyer and seller are repeated many times. Repetitions may arise in the following form:

Repetition within a vehicle model lifetime: There may be sequential contracts on the same vehicle part. Two basic contract types have emerged. One extends over one year, and can be (and in most cases is) extended on an annual basis. The second one, a framework contract, extends over half or the entire model lifetime. However, prices are renegotiated every year, with the option left to either party to discontinue the contract without penalties.[22]

Repetition across several vehicle models: Owing to the OLG structure of model supply, the OEM has to contract anew for structurally the same parts when introducing a new model. The supplier of such a part often remains the same even when the part specification has changed. Our evidence suggests that bargaining about parts supply for a new model is frequently—if not always—used towards renegotiating prices for parts supplied for the production of an established model. The OEM often conditions the award of a new contract to the supplier on an extra price reduction on the old contract. In an exceptional case the supplier

[21] Result from the interviews: Bundling of contracts is common practice (Yes=13, N/A=4, No=1).
[22] Confirmed in 12 interviews.

would demand price increases on old contracts in order to agree to a new contract.[23]

2.4 Effects of procurement behavior on the automotive industry: Research questions and hypotheses

In this section we specify research questions derived from the evidence obtained, check them against existing theory, and develop hypotheses to be analyzed further theoretically as well as empirically. We distinguish between two types of hypotheses: those related to the efficiency of contracting between the participating (two) parties, and those related to the efficiency of the upstream industry structure that results from the observed contracting structures. In all of this we take as given the OEMs' outsourcing decision.

What is then primarily at stake is the interplay between market pressure and profit incentives exercised on upstream firms to innovate and/or to reduce production costs. These forces exercise impact on magnitudes invariant in the quantity produced (innovation efforts, fixed production costs) and on quantity dependent magnitudes (marginal production costs, that are in turn dependent on fixed costs).

2.4.1 Why does the typical OEM exercise dominant market power in the design and execution (enforcement) of upstream contractual relationships?

One of the most intriguing observations we extract from our case study is that in the relationship between OEMs and first tier suppliers, the larger market power rests with the OEMs, and this in spite of the fact that some of the tier 1 firms are sizeable, and some of the supplier-industries' sectors (defined by product range) at this level are much more concentrated than the automotive producing sector itself. A key example is the automotive electronics subsector, with Bosch, the world's largest automotive supplier and up to recently, Siemens VDO and now Conti being the leading firms. Apparently, the automotive producers largely dictate the contracts with the tier 1 upstream suppliers.

This leads us to

Hypothesis 1: The OEM has larger relative market power because he serves - and thus is more knowledgeable about - the final market. In particular,

[23] Result from the interviews: Consecutive contracts are bundled in an OLG structure occurs (Yes=10, N/A=6, No=2).

the incorporation of gadgets (developed and) provided by upstream suppliers is up to the discretion of the OEM, which gives him additional market power.

2.4.2 Is upstream R&D efficiently organized?

Efficient (joint profit maximizing) R&D incentives require that the returns to R&D are fully appropriated by the agent engaging in it.

R&D efforts are reduced if

- they are not fully compensated for
- their beneficiary is not sure about their full value, which induces moral hazard on the seller side
- they act complementarily and are conducted by independent agents, since complementarity induces (uncompensated) positive externalities in increased effort provision.

Hypothesis 2: Upstream innovative efforts are inefficiently small since they are complementary to each other and produced by independent agents, and even smaller

- if the OEM induces competition between innovators and does not compensate their competitive efforts
- if the OEM offers compensation of innovative effort only within a production contract to one of the innovators, and compensation is subject to volume risk.

Hypothesis 3: Incentives to upstream suppliers to invest in both model unspecific R&D and into model specific adaptation are efficient only if effort results are fully internalized, and in particular contractual provisions are such that the use of R&D results can be appropriately licensed out.

A natural conflict arises between the innovative upstream supplier and the OEM with whom he has developed the first application of the innovation. While the latter has an incentive to monopolistically exploit the innovation, the upstream supplier is interested in its multiple application, as multiple applications induce downstream competition and lead to a reallocation of rents to the upstream firm.

Hypothesis 4: Overall efficiency necessitates that R&D results are implemented first in premium models.

Buyers of premium models typically exercise relatively selective tastes for particular vehicle features, and thus exhibit a relatively price inelastic demand. This allows the innovator to recoup his R&D costs with higher probability in a shorter time window, even in a regime where learning cost effects cannot be exploited (as yet).

In order to reduce the complexity of organizing the supply of all parts of a vehicle, the OEMs started in the 90ies of the last century to procure the supply of so called systems and modules. There are two types of system/module suppliers: Systems consist of multiple parts that are functionally connected, modules of physically connected parts. A typical example for a system is the electronics system. A typical example for a module is a car front end. While system suppliers tend to be highly innovative, module suppliers compile and assemble parts from other suppliers often without central innovative features. The latter suppliers thus constitute just another level in the supply hierarchy.

The delegation of system/module development and production implies delegation of responsibilities on

- monitoring innovation in components that form parts of the system/ module in question
- coordination of interfaces between the components
- monitoring the production costs of these components
- administering reliability problems, and absorbing warranty payments.

Hypothesis 5: The vertical flow of innovation is inhibited by the delegation of module or system development and production.

Past work on supply networks, e.g. by Baron and Besanko (1984, 1992, 1994), shows that the existence of asymmetric information could, especially in steeper hierarchies, lead to higher cost for the procurer compared to flatter hierarchies. At best the cost of the organizational form stays constant with the increase of a steeper hierarchy.

In the theoretical literature the profitability of hierarchies is typically assumed. Yet Baron and Besanko (1992, 1994, 1984); Mookherjee and Reichelstein (1997, 2001); Mookherjee and Tsumagari (2004); Melumad, Mookherjee, and Reichelstein (1995) look at the potential cost of hierarchies, which is in the focus of the above discussion on asymmetric information, lock-in, or loss of contact to innovative suppliers in the production chain. Radner (1993); Gruener and Schulte (2004a,b) cover the optimal organization of hierarchies under constrained processing power of the participating units, which can also be related to complexity cost.

2.4.3 *Are parts efficiently priced?*

By a standard argument, the prices of complementary goods are too high relatively to joint profit maximizing prices if determined independently, since complementarity induces negative externalities from higher prices.

Hypothesis 6: At given levels of innovation, asymmetric information allows upstream producers to set inefficiently high parts prices, especially if upstream markets are concentrated and the OEM is incompletely informed about upstream (innovation and) production costs.

2.4.4 *Do contractual interdependences increase the efficiency of supply contracts?*

In the world of first-tier supply contracts, contractual interdependences are apparently generated and enforced by the OEMs. A primary driver appears to be the OEM's interest to use his agenda setting power in substituting for informational asymmetry. In the sequel, we consider hypotheses under the assumption that contractual efficiency is defined by the sum of surpluses generated by the two bargaining parties.

Hypothesis 7: The construction of contractual interdependence between supply contracts for innovative and standard parts is efficiency decreasing.

Hypothesis 8: The construction of contractual interdependence between high volume and low volume products is efficiency decreasing.

Hypothesis 9: The construction of contractual interdependence between new and running contracts via price renegotiation in current contracts decreases long run efficiency.

Contracts are incomplete and thus, by now standard arguments (Hart and Moore, 1999; Grossman and Hart, 1986) cannot fully discipline the partners because they give rise to ex post opportunism. Contractual solutions to ex-post opportunism are treated e.g. by Che and Chung (1999), who find that the supplier chooses an efficient investment level only if arrangements are made such that he can at least recoup the initial investment from later payments even after renegotiations. Repeated interactions (eventually infinitely often, or by Kreps, Milgrom, Roberts, and Wilson (1982) discontinuation with low enough probability) can serve as a disciplining mechanism once they involve trigger strategies by the players, thus balancing the incentives for a partner to defect from the agreed contract by offering a high chance of repetition once each contract is honored, and discontinuation otherwise. See also Blonski and Spagnolo (2002).

The upstream supplier's incentives to reduce unit costs are dependent on his ability to absorb the benefits of his cost reducing effort. His preference of a high volume over a low volume contract suggests that the supply of high volumes is more profitable. This must imply that when designing the price decline clauses within a long term contract, the OEM cannot fully anticipate the cost reduction effects due to learning.

If the continued engagement with the same supplier in both R&D and in parts procurement would open channels by which information about cost reduction enjoyed by the supplier were revealed to the OEM as time goes by, then it would be profitable for the OEM, and possibly joint profit increasing, to renegotiate prices.[24] It so far has not become clear whether the price renegotiation frequently enforced by the OEMs is ever due to improved information, or more due to the short term opportunistic use of market power. At any rate, intertemporal contractual interdependencies increase switching costs and, in consequence lead to restricted entry into upstream market.

2.4.5 How do the players cope with mutual hold-up?

Here we assume that hold-up exercised by an agent is observable to the agent subject to.

Hypothesis 10: Hold-up by a supplier is washed out by contractual interdependence, and in particular by repetition.

Hypothesis 11: Hold-up by the OEM via forced price renegotiations is sustainable by pure market power, but inefficient even if suppliers ex ante incorporate it in their calculus.

2.4.6 Does increasing downstream competition reduce upstream innovation and product reliability?

Downstream competition for any particular vehicle type (specified by size and quality) can be thought of as taking place in three major dimensions: Innovativeness, reliability, and price of the vehicle. For any given R&D outlay, there

[24] Meyer and Zwiebel (2006) treat this problem in a theoretical model.

is a trade off between innovativeness and reliability: the more innovations embedded in a new vehicle model, the less these innovations can be exposed to (expensive) test routines. Increasing downstream competition leads to increasing pressure on the downstream sales price for the vehicle, as well as to pressure on time-to-market, the time elapsing between the conception of a new model and its presentation in the market.

The Japanese automotive industry tends to produce competitively priced, reliable vehicles with a lower level of innovation.[25] This allows in particular to use second mover advantages by introducing innovations that are already tested by other players in the market, which also reduces the time-to-market.

One possibility to differentiate that is adopted by European vehicle producers, is to introduce more innovative but, given the limitations on the time-to-market induced by competitive pressure, less reliable vehicles. In view of the pressure on returns and time-to-market, upstream suppliers are simply left with the problem of producing at a given level of innovativeness and a given time-to-market, less reliable parts.

Additional pressure in this direction may be generated by suppliers' opportunism. Innovativeness signals can be profitably exploited in the very short run by the supplier within the upstream competitive context, and by the OEM upon the introduction of a model, whilst reliability problems tend to arise later in the model life cycle, and are largely absorbed by the OEM.

Hypothesis 12: Increasing downstream price competition may lead to reduced product reliability.

2.4.7 Are development, volume, and reliability risks allocated efficiently?

Economic theory suggests that if a certain risk is exogenous, it should be allocated such that the risk neutral party absorbs this risk. By contrast, if a risk is endogenous, the player able to influence this risk according to theory should absorb the payoffs, such that the incentives to manage the risk are optimally set; see, for instance, Tirole (2003).

Let, in line with by now standard reasoning, the degree of risk aversion of the firms in the value chain be directly related to their size, with the OEM as the biggest player being risk neutral.

From a theoretical point of view, the suppliers seem to be allocated an inefficiently high share of volume risk while on the other hand their share of reliability risk seems to be below the efficient level.

Hypothesis 13: If innovative effort primarily rests with the supplier, then he should absorb the associated risk. If the OEM absorbs a share of

[25] The only exception to this general rule is the hybrid engine car.

it, then it should be made dependent on the supplier's degree of risk aversion.

We observe that the OEMs take over a share of the fixed production costs of suppliers through financing the OEM specific tools. Yet the larger share of the fixed costs, especially innovation adaptation costs and capacity costs are typically not compensated directly but spread across parts purchased by the OEM. As the OEM rarely provides volume guarantees, this allocates a share of volume risk to the supplier. The OEM typically overstates expected volumes during negotiations, that if used in the supplier's calculation would decrease his expected average cost and make him lenient to a low price offer. However, suppliers anticipate this and typically calculate their offer prices up to 30 percent deflated volume estimates.

From a theoretical point of view, both the exogenous as well as the endogenous proportion of demand uncertainty suggest that it is efficient to have the OEM bear the associated volume risk.

Hypothesis 14: The OEM should bear a larger share of the volume risk than the supplier.

As discussed above there exists a substantial reputation risk, from which the OEM suffers most. This risk can not be transferred to the suppliers, even if the size of the risk stays largely under the influence of the suppliers, for example if the suppliers' effort for quality of specific parts determines the reliability of the whole car.

Hypothesis 15: Reliability risks, including collateral damage, should be allocated to the source as far as possible. Reliability risks involving unobservable sources should be pooled.

2.4.8 Is cost monitoring performed efficiently?

In order to keep production cost down, the OEM might engage into monitoring activities of all parts procured. Cost monitoring involves a large fixed cost component. Hence the OEM has an incentive to allocate more monitoring effort to the production of more valuable, rather than less valuable parts. This incentivizes the supplier to achieve higher cost savings and thus higher margins with lower valued parts. In passing, this has implications on upstream suppliers' relative incentives to supply directly to the OEM vs. to supply to a module or system supplier. He prefers to supply to the former, as the relative value of the same part supplied is the smaller, the more valuable the end product.

Hypothesis 16: Independent of risk premia, supplier margins are inversely related to the relative value of the part. This induces allocative inefficiency.

Suppliers face the risk of bankruptcy, which is partly exogenous, e.g. due to unexpected rises in raw material prices. The allocation of this risk should be corrected in view of the strict ex post complementarities between the upstream supply flows for current production, and in view of the fact that while maintaining a more competitive upstream supply structure is helpful for all OEMs, the individual OEM can internalize only part of this externality. Exogeneity of the causes of financial distress implies that gambling behavior by the upstream supplier is not invited.

Hypothesis 17: OEMs should orchestrate efforts to bail out suppliers if distress is exogenously caused.[26]

2.4.9 Does OEM behavior induce an efficient upstream industry structure?

In a purely price driven competitive situation, an OEM should be interested in more competition at each level in the upstream value chain. This result can be derived from standard auction theory or Cournot oligopoly theory (cf. e.g. Tirole, 2003; Krishna, 2003), where typically the revenue of one side of the market increases with the level of competition on the other side of the market. In this respect the case material apparently confirms the theory. OEMs as well as suppliers stated that a very concentrated upstream market does not allow for a full extraction of profits from the suppliers. One participant stated that two suppliers were not enough to effectively build up price pressure on the supply market.

However, revealed preference suggests that it is at least in some OEMs' interest to restrain competition. Especially premium car manufacturers engage into the practice of assigning core suppliers, to whom they award most of the contacts, thus hoping for a higher degree of innovation and reliability. Yet one premium OEM stated explicitly that together with other OEMs he subsidizes the entry of an additional supplier in a very concentrated market. This strategy was also mentioned by several upstream suppliers. In all, it is unclear whether the optimal level of upstream competition from the OEM's point of view corresponds to an optimal level concerning industry incentives for innovation and reliability.

Hypothesis 18: The assignment of core suppliers by OEMs creates entry barriers and thus an inefficiently concentrated upstream market structure.

[26] One volume OEM explicitly suggested this strategy.

2.5 Concluding remarks

Our case study interviews focused on a broad range of phenomena in the supply chain of the automotive industry we consider worth further theoretical investigation. We consider interesting in particular questions related to financing innovation including allocative consequences and the allocation of risks in the value chain.

Several aspects may also be worth a more detailed empirical analysis. Among others, this concerns the pursuit of innovative activities by suppliers, initiated by or connected to particular OEMs. Why is there barely no vehicle model independent research activity of the suppliers? Also, is there a relationship between part type and contract length? In particular, are more complex parts supplied within longer term contracts? And why does module or system outsourcing not emerge as predominant manufacturing organization, given that it apparently leads to tighter cost control?

A question not discussed here relates to the driving forces behind increasing competition in the automotive industry that was assumed in the specification of our hypotheses. One clear sign is that automotive producers' product portfolios have become much more similar during the last ten years. Unless the typical consumer's choice of brand dominates her choice of car size and style, this move observed in the entire industry is bound to lead to increasing competition.

We found systematic excess capacity at the OEM level in need of explanation, less so at the supplier level. Also, changes in the technology of producing automotive vehicles are all towards higher shares of fixed to variable costs. A typical example are ever increasing shares of software in the car. This intensifies questions as to appropriate linear or better, nonlinear pricing schemes.

On a broader scale, one might ask for the OEMs' role model in the automotive industry in the future, given recent and ongoing changes in innovation activities, technology proliferation, and competition intensity. Which activities remain in their generic competence, which ones will, or should be outsourced?

We hope that further work will be able to solve some of the open questions and thus further contribute to bringing together economic theory and empirical findings in one of the major industries in the world.

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2.6 Appendix: Questionnaire

2.6.1 Supplier version

1. Produkteigenschaften
   - 1.1. Teilebeschreibung
     - 1.1.1. Was sind Ihre strategischen Ziele für den betrachteten Produktbereich für die Zukunft? (System- oder Teilelieferant, Know-how Fokussierung)
     - 1.1.2. Welche Produkte (Systeme, Module oder Teile) werden von Ihnen außerdem produziert bzw. eingekauft?
     - 1.1.3. Ist hierbei Ihre Rolle als System- oder Teilelieferant von Beginn an festgelegt oder entscheidet sich dies im Laufe der Entwicklung? Wann entscheidet sich dies im letztern Fall typischerweise?
   - 1.2. Wertschöpfung
     - 1.2.1. Welchen Wertanteil hat das betrachtete Produkt an einem Fahrzeug? Was sind die durchschnittlichen Einkaufskosten und Verkaufspreise für dieses Produkt? Was ist die typische Umsatzmarge?
     - 1.2.2. Welcher Anteil der Wertschöpfung wird vom Systemlieferanten, welcher von dem (den) Teilelieferanten geschaffen?
     - 1.2.3. Inwieweit unterscheiden sich Module/Systeme von Einzelteilen in Produktion und Einkauf hinsichtlich Lernkurven-Effekten (Kosteneinsparung über Zeit; x Prozent pro Jahr) und Economies of Scale (Kosteneinsparungen über größere Mengen; x Prozent bei doppelter Menge)?
   - 1.3. Technologie und Innovation
     - 1.3.1. Wie komplex ist das betrachtete Produkt? Kann es leicht imitiert werden, weil alle Technologien zur Herstellung des Produkts allgemein bekannt sind? Bestehen Patentrechte auf Systeme, Module oder einzelne Teile?
     - 1.3.2. Wie beurteilen Sie die technologische Entwicklung der letzten 5 Jahre im Umfeld Ihres Produktes (insbesondere vor dem Hintergrund einer stärkeren Fokussierung auf Fahrzeugelektronik und Soft- gegenüber Hardware)?
     - 1.3.3. Wie spezifisch für ein bestimmtes Fahrzeugmodell oder einen OEM ist das Produkt in der Entwicklung und in der Produktion?

1.3.4. Wie komplex sind die Schnittstellen (Entwicklung und Einbau) zum restlichen Fahrzeug (Umfang des Lastenhefts, Interaktion mit anderen Bauteilen/Systemen)?
1.3.5. Wie hoch sind die Innovationszyklen im betrachteten Produkt? Wie lange dauert es erfahrungsgemäß, bis eine Innovation auf dem Markt erscheint?
1.3.6. Beschleunigt oder bremst die Vergabe von Modulen/Systemen an Systemlieferanten die Zeit zwischen Entwicklung und Markteinführung eines Fahrzeugs im Vergleich zur Eigenentwicklung durch den OEM?

2. Kunden

2.1.1. Mit welchen Unternehmen unterhalten Sie zu diesem Produkt Lieferbeziehungen?
2.1.2. Welche anderen Produkte liefern Sie außerdem an diese Unternehmen? In wiefern wird die Lieferung verschiedener Produkte (z.B. über Baureihen) oder Projektbündel gemeinsam verhandelt oder bestehen Rahmenverträge?
2.1.3. Welche strategischen Implikationen ergeben sich aus Ihrer Sicht aus der Verbreiterung der Produktpalette durch Fahrzeughersteller, z.B. durch die BMW 1er- und X-Serie, den Porsche Cayenne oder die Mercedes A-Klasse bzw. den Maybach? Wie denken Sie wird dies von den Konsumenten beurteilt?
2.1.4. Wie beurteilen Sie die Bedeutung der Produkteinführungszeiten? Läßt sich eine Tendenz zu kürzeren Produkteinführungszeiten oder -lebenszyklen feststellen und wie wirkt sich diese aus?
2.1.5. Hat sich aus Ihrer Sicht der Wettbewerb zwischen den OEMs erhöht? Was sind Ursachen hierfür (z.B. stagnierende Absatzzahlen, Überkapazitäten, etc.)? Wie hat sich dies gegebenenfalls auf Sie ausgewirkt?

3. Anbieter (im gleichen Produktmarkt)

3.1. Marktstruktur

3.1.1. Wie groß ist der Markt für das betrachtete Produkt in Deutschland, Europa, weltweit (Umsatz, Stückzahlen)?
3.1.2. Wie viele Wettbewerber existieren für das betrachtete Produkt in Deutschland, in Europa, weltweit? In welcher

zeitlichen Reihenfolge erfolgte der Markteintritt Ihres Unternehmens und der Ihrer Wettbewerber?

3.1.3. Wie verteilen sich die Marktanteile unter den angesprochenen Wettbewerbern?

3.1.4. In welchem Umfang hängt die Anzahl der Stufen in der Lieferantenhierarchie ab von der Innovationsfrequenz im betrachteten Markt, der Komplexität des betrachteten Produkts, der Volatilität der Nachfrage nach dem Produkt, dem Wettbewerb im entsprechenden Produktmarkt oder im Fahrzeugmarkt allgemein?

3.2. Anbietereigenschaften

3.2.1. Gibt es technologische Unterschiede zwischen den Wettbewerbern?

3.2.2. Welche Informationen haben Sie über Technologie und Kostenstrukturen Ihrer Wettbewerber?

3.2.3. Was ist Ihre Eigentümerstruktur? Welche Eigentümerstruktur haben Ihre Wettbewerber, Zulieferer und Kunden?

3.2.4. In wieweit hat aus Ihrer Sicht die Entwicklung und Stärkung einer eigenen Zulieferer-Marke, z.B. durch Bosch, Einfluss auf den Wettbewerb unter Zulieferern?

3.3. Globalisierung

3.3.1. Welchen Einfluß hat aus Ihrer Sicht die Globalisierung der Industrie (OEM und Zulieferer) auf den Wettbewerb?

3.3.2. In welcher Form und weshalb verfolgen Sie heute und in der Zukunft eine Globalisierungsstrategie (Zentrale Produktion (High Tech vs. Low cost) und weltweiter Vertrieb vs. Lokale/OEM-nahe Produktion und Vertrieb)?

3.3.3. In wieweit erfolgt eine Produktionsverlagerung gemeinsam mit anderen System- oder Teilelieferanten oder OEMs? Wer führt die Initiative an? In wieweit erfolgt eine (finanzielle) Unterstützung durch andere Unternehmen, insb. den OEM?

3.3.4. In welchem Umfang führt eine Globalisierung der Produktion zu einem verstärkten Wettbewerbsdruck auf Seiten der System- oder Teilelieferanten, z.B. über Second Sourcing?

4. Anbieterauswahl

4.1.1. Wie beurteilen Sie die Auslagerung der Herstellung von ganzen Systemen oder Modulen vom Fahrzeughersteller zu sog. System- oder Modullieferanten und damit die Entwicklung von mehrstufigen Zulieferhierarchien? Worin sehen Sie Vor- und Nachteile einer solchen Entwicklung?

4.1.2. Was sind die wichtigsten Schritte in der Lieferantenauswahl durch Ihre Kunden? Findet eine Auktion (Entwicklung und Produktion) zwischen verschiedenen potentiellen Anbietern statt und wenn ja zu welchem Zeitpunkt in der Lieferantenauswahl?

4.1.3. Wie viele (potentielle) Anbieter stehen dem OEM zu folgenden Zeitpunkten in der Lieferantenauswahl zur Verfügung: in der Konzeptphase (vor Entwicklung, Entwicklungswettbewerb), während Entwicklung (Parallel Engineering), bei Ausschreibung der Produktion, während der Produktion (Second oder Dual Sourcing)? Wie verteilen sich Aufgaben und Volumina bei mehreren Anbietern gleichzeitig?

4.1.4. Baut der OEM alternative Lieferanten (wenn nicht schon bei einer einzigen Modellreihe) über verschiedene Modellreihen auf?

4.1.5. In wieweit gibt es Vorteile aus wiederholter Zusammenarbeit über verschiedene Projekte hinweg zwischen OEM und Lieferanten? Wie werden diese bei der Vergabe neuer Projekte berücksichtigt?

4.1.6. In welcher Reihenfolge werden Verhandlungen geführt (und ggf. Verträge geschlossen)? Zuerst zwischen OEM und den Systemlieferanten oder zuerst zwischen Systemlieferanten und indirekten Teilelieferanten?. Welche Verträge werden zuletzt geschlossen? Wer hat Ausstiegsmöglichkeiten, wann und zu welchen Kosten? Wer bestimmt de Reihenfolge der Verhandlungen?

4.1.7. In welchem Umfang hat der OEM Einfluß auf die Wahl der indirekten Teilelieferanten durch die Systemlieferanten?

5. Entwicklung

5.1. Modellunspezifische Entwicklungen

5.1.1. Können Sie eine Verschiebung der Entwicklungsleistung vom OEM zu System- oder Teilelieferanten feststellen? Wie beurteilen Sie eine solche Entwicklung, wo sehen Sie Vor- und Nachteile?

5.1.2. In wieweit schließen sich Lieferanten untereinander oder mit OEMs bzw. Systemlieferanten für über fahrzeugmodellspezifische Entwicklungsleistungen hinausgehende Forschung zusammen?

5.1.3. Was sind die wichtigsten Vor- und Nachteile solcher Kooperationen?

5.1.4. Wie wirkt sich dies auf die Lieferantenauswahl und damit ggf. auf Preise aus?

5.2. Modellspezifische Entwicklungen (Adaptionsentwicklungen)

5.2.1. Wie viel Entwicklungsaufwand (Zeit, Mann-Tage, EUR) entsteht durch eine modellspezifische Anpassung (Entwicklung einer bereits prinzipiell bestehenden Technik in ein neues Fahrzeugmodell)?

5.2.2. Welcher Anteil am Entwicklungsaufwand wird vom Teilelieferanten, Systemlieferanten und dem OEM jeweils übernommen (Wer entwickelt und wer trägt die anfallenden Kosten)?

5.2.3. Wer erhält typischerweise Patente an Entwicklungsleistungen?

5.2.4. Wie werden die Aktivitäten der Beteiligten untereinander koordiniert? Wer überwacht die Aktivitäten und definiert Schnittstellen? Wer ist für den Erfolg verantwortlich?

5.2.5. Wie findet bei Entwicklungen durch System- oder (direkten oder indirekten) Teilelieferanten eine Koordination mit Entwicklern anderer Bauteile statt?

5.2.6. In wieweit lassen sich Entwicklungserkenntnisse übertragen und so eine Trennung von Entwicklung und Produktion erreichen? Welchen Anteil am gesamten Entwicklungsaufwand (in Zeit, EUR) müsste bei einer Nach-Entwicklung neu aufgebracht werden, wenn der Erstentwickler den Nachentwickler mit allen vorhandenen Informationen unterstützt oder wenn nur eine Übergabe von Zeichnungen und Prototypen erfolgt?

5.2.7. In wieweit kooperieren Sie auch mit direkten Wettbewerbern bei der Entwicklung von Bauteilen, z.B. um Gleichteileffekte bei verschiedenen Fahrzeugen über Baureihen oder sogar Marken hinweg zu nutzen?

5.2.8. Gibt es neben einer Entwicklung durch OEM oder Lieferanten auch eine Entwicklung durch spezielle Entwicklungsfirmen? Wenn ja, wer nutzt solche Firmen vor allem (OEM, Systemlieferant oder Teilelieferanten)? Was sind die Gründe für eine solche Auslagerung von Entwicklungsleistung? Welcher Anteil an Entwicklungsleistungen wird dabei ausgelagert? Wie verteilen sich dabei die Risiken, z.B. falls sich eine Entwicklung als fehlerhaft herausstellt?

6. Produktion

   6.1. Produktionsentscheidungen

      6.1.1. Auf welcher Ebene der Zulieferhierarchie werden welche Entscheidungen getroffen? (z.B. bezüglich Kapazitäten, Produktionsmengen und Losgrößen)

      6.1.2. Nutzt der Lieferant auch Produktionsmittel (Maschinen, Werkzeuge oder auch Patente) des OEM bei der Produktion?

      6.1.3. Rechnen die OEM mit (oder unternehmen die OEM etwas gegen) drohende Insolvenzen der Systemlieferanten oder (direkten und indirekten) Teilelieferanten? Wie hoch ist das jeweils zu erwartende Risiko?

   6.2. Vertragsabweichungen und -strafen

      6.2.1. Wie wollen Lieferanten und OEMs in Zukunft Qualitätssicherung betreiben, um kostspielige Rückrufaktionen zu vermeiden, insb. vor dem Hintergrund einer Verschiebung der Entwicklungsleistung vom OEM zu den System- oder Teilelieferanten?

      6.2.2. Wie und von wem werden Abweichungen von zuvor in Verträgen spezifizierten Kosten, Mengen oder Qualitäten festgestellt? Wie sind entsprechende Strafen vertraglich ausgestaltet? Gibt es außervertragliche Absprachen in dieser Hinsicht?

      6.2.3. Ist es möglich, Fehler im fertigen Produkt System- oder Teilelieferanten zuzuweisen und gegebenenfalls entstehende Zusatzkosten verursachungsgerecht aufzuteilen? Ist es möglich, Fehler des Systemlieferanten im Zusammenbau (im Gegensatz zu den Fehlern der verbauten Einzelteile) des Systems/Moduls zu erkennen?

      6.2.4. Wie häufig sind im Nachhinein zu Tage tretende Missverständnisse in Bezug auf Inhalt und Interpretation von Verträgen?

7. Vertragsgestaltung

   7.1. Vertragsinhalte

- 7.1.1. Was wird in den Verträgen typischerweise wann spezifiziert? Werden Mengen bereits beim ersten Angebot festgelegt (insbesondere vor der letzten Möglichkeit der Parteien, aus dem Vertrag ohne Vertragsstrafen auszusteigen)?
- 7.1.2. Wie lange ist die typische Vertragsdauer und wer legt sie fest?
- 7.1.3. Gibt es selbst noch während der Vertragslaufzeit Nachverhandlungen? Unter welchen Bedingungen finden Nachverhandlungen statt und wer veranlasst diese?
- 7.1.4. In wieweit wird die Weitergabe von F&E Ergebnissen der Zulieferer an Konkurrenten des OEM vertraglich eingeschränkt?
- 7.1.5. Welche Absprachen werden neben den vertraglichen Regelungen zwischen OEM und Systemlieferanten bzw. zwischen System- und indirekten Teilelieferanten typischerweise noch getroffen (nicht justitiable Absprachen)?

7.2. Anreizstrukturen und Kostenteilung

- 7.2.1. In welcher Form und Höhe sind Lieferverträge Performance-abhängig (Zielerfüllung hinsichtlich Qualität und Menge)? Gibt es Unterschiede zwischen den verschiedenen Lieferantenebenen?
- 7.2.2. In wieweit werden die Kosten für Investitionen des Lieferanten vom OEM (bzw. bei indirekten Teilelieferanten vom Systemlieferanten) übernommen, z.B. für Entwicklungen oder für Maschinen und Werkzeuge?
- 7.2.3. Wie erfolgt in diesem Fall eine Übernahme der Kosten (direkte Bezahlung, Umschlag auf eine festgelegte Produktionsmenge, etc.)?
- 7.2.4. Wie wirkt sich eine Kostenübernahme auf die Eigentumsrechte, z.B. an Patenten oder Maschinen und Werkzeugen, aus?

8. Informationen

- 8.1.1. Welche Informationen hat ein Geschäftspartner (besonders der OEM) über die Produktionskosten der anderen Partner (System- und Teilelieferanten)? In wieweit geben Unterschiede zwischen alten und neuen Produktmodellen oder Baureihen Anhaltspunkte hierfür?
- 8.1.2. Hat der Systemlieferant bessere Informationen über die Kostenstruktur der indirekten Teilelieferanten als der OEM?

8.1.3. Kann der OEM Informationen oder Vermutungen über die Kosten des Systemlieferanten aus den Verhandlungen mit dem indirekten Teilelieferanten ableiten (falls solche stattfinden)?

8.1.4. Wie flexibel sind Ihre eigenen Informations- und Kostenrechnungssysteme, um verschiedene Vertragskonstellationen abzubilden?

8.1.5. Sind die Verträge zwischen System- und indirekten Teilelieferanten dem OEM bekannt? Wenn ja, welche Elemente (z.B. Preis, Menge, Qualität, Zusammenarbeit in der Forschung)? Kann der OEM Verträge, die er selbst schließt, daran knüpfen?

8.1.6. Sind die Verträge zwischen dem OEM und Systemlieferanten dem indirekten Teilelieferanten bekannt? Kann es z.B. sein, dass der OEM direkt mit dem Teilelieferanten verhandelt und Daten aus dem Vertrag mit dem Systemlieferanten weitergibt?

2.6.2 OEM version

1. Produkteigenschaften
   - 1.1. Teilebeschreibung
     - 1.1.1. Was sind Ihre strategischen Ziele im Einkauf für die Zukunft? (z.B. verstärktes Outsourcing, Know-how Fokussierung, mehr oder weniger Zusammenarbeit mit Systemlieferanten)
     - 1.1.2. Welche Produkte (Systeme, Module oder Teile) bzw. Produktgruppen werden von Ihnen von welchen Lieferanten eingekauft? Wie ist Ihre Einkaufsorganisation aufgebaut? (Weitere Details vgl. Kap. 3)
     - 1.1.3. Ist hierbei der Einkauf von einem System- oder Teilelieferanten von Beginn an festgelegt oder entscheidet sich dies im Laufe der Entwicklung? Wann entscheidet sich dies im letztern Fall typischerweise?
   - 1.2. Wertschöpfung
     - 1.2.1. Welchen Wertanteil am Fahrzeug haben die eingekauften Produkte? Was ist der durchschnittliche Materialkostenanteil, Ihre Wertschöpfung und die Marge je Fahrzeug?
     - 1.2.2. Welcher Anteil der Wertschöpfung wird vom Systemlieferanten, welcher von dem (den) Teilelieferanten geschaffen?
     - 1.2.3. Erfahren Sie für Module/Systeme höhere oder niedrigere Economies of Scale relativ zu Einzelbauteilen? In welcher Größenordnung bewegen sich diese (Verdopplung der Einkaufmenge führt zu x Prozent Einsparungen)? In wieweit beziehen diese sich auf die Produktion (Lernkurveneffekte) oder auf Einkaufserfolge (Einkaufs-Economies of Scale)?
   - 1.3. Technologie und Innovation
     - 1.3.1. Wie komplex sind die betrachteten, von Ihnen eingekauften Produkte (System, Modul oder Teil)? Sind alle Technologien zur Herstellung dieser Produkte allgemein bekannt? Bestehen Patentrechte auf Systeme, Module oder einzelne Teile?
     - 1.3.2. Wie beurteilen Sie die technologische Entwicklung der letzten 5 Jahre im Umfeld der von Ihnen eingekauften Produkte (insbesondere vor dem Hintergrund einer stärkeren Fokussierung auf Fahrzeugelektronik und Soft- gegenüber Hardware)?
     - 1.3.3. Wie spezifisch für ein bestimmtes Fahrzeugmodell oder einen OEM sind die Produkte, in der Entwicklung und in der Produktion?

1.3.4. Wie komplex sind die Schnittstellen (Entwicklung und Einbau) zum restlichen Fahrzeug (Umfang des Lastenhefts, Interaktion mit anderen Bauteilen/Systemen)?

1.3.5. Wie lang sind die Innovationszyklen in den von Ihnen eingekauften Produkten? Wie lange dauert es erfahrungsgemäß, bis eine Innovation auf dem Markt erscheint?

1.3.6. Beschleunigt oder bremst die Vergabe von Modulen/Systemen an Systemlieferanten die Zeit zwischen Entwicklung und Markteinführung eines Fahrzeugs im Vergleich zur Eigenentwicklung (durch den OEM)?

2. Kunden

2.1.1. Welche anderen Unternehmen (OEM) werden vom selben Lieferanten mit dem betrachteten oder einem vergleichbaren Produkt beliefert? Welche OEM kaufen bei anderen Lieferanten ein oder stellen das betrachtete Produkt selbst her?

2.1.2. Welche anderen Produkte beziehen Sie noch vom selben Lieferanten? In wiefern wird die Lieferung verschiedener Produkte (z.B. über Baureihen) oder Projektbündel gemeinsam verhandelt oder bestehen Rahmenverträge?

2.1.3. Welche strategischen Implikationen ergeben sich aus Ihrer Sicht aus der Verbreiterung der Produktpalette durch Fahrzeughersteller, z.B. durch die BMW 1er- und X-Serie, den Porsche Cayenne oder die Mercedes A-Klasse bzw. den Maybach? Wie denken Sie wird dies von den Konsumenten beurteilt?

2.1.4. Wie beurteilen Sie die Bedeutung der Produkteinführungszeiten? Läßt sich eine Tendenz zu kürzeren Produkteinführungszeiten oder -lebenszyklen feststellen und wie wirkt sich diese aus?

2.1.5. Hat sich aus Ihrer Sicht der Wettbewerb zwischen den OEMs erhöht? Was sind Ursachen hierfür (z.B. stagnierende Absatzzahlen, Überkapazitäten, etc.)? Wie hat sich dies gegebenenfalls auf Sie ausgewirkt?

3. Anbieter (im gleichen Produktmarkt)

3.1. Marktstruktur

3.1.1. Wie groß ist der Markt für die von Ihnen eingekauften Produkte in Deutschland, Europa, weltweit: Wie viel Umsatz wird mit diesen Produkten p.a. erzielt? Wie viel Stück werden umgesetzt?

3.1.2. Wie viele potentielle Lieferanten stehen Ihnen für die von Ihnen eingekauften Produkte zur Verfügung? Mit welchen unterhalten Sie Lieferbeziehungen?

3.1.3. Wie verteilen sich die Marktanteile unter den angesprochenen Wettbewerbern?

3.1.4. In welchem Umfang hängt die Anzahl der Stufen in der Lieferantenhierarchie ab von der Innovationsfrequenz im betrachteten Markt, der Komplexität des betrachteten Produkts, der Volatilität der Nachfrage nach dem Produkt, dem Wettbewerb im entsprechenden Produktmarkt oder im Fahrzeugmarkt allgemein?

3.2. Anbietereigenschaften

3.2.1. Gibt es technologische Unterschiede zwischen den verschiedenen System - oder Teilelieferanten im Markt der von Ihnen eingekauften Produkte?

3.2.2. Welche Informationen haben Sie über Technologie und Kostenstrukturen der Lieferanten?

3.2.3. Was ist die typische Eigentümerstruktur eines System- und eines Teilelieferanten: Welche Eigentümer und Gesellschaftsform existiert, in wieweit sind Tochterunternehmen und Beteiligungen vorhanden?

3.2.4. In wieweit hat aus Ihrer Sicht die Entwicklung und Stärkung einer eigenen Zulieferer-Marke, z.B. durch Bosch, Einfluss auf den Wettbewerb unter Zulieferern? Wie beurteilen Sie als OEM den Aufbau einer Zulieferer-Marke?

3.3. Globalisierung

3.3.1. Welchen Einfluss hat aus Ihrer Sicht die Globalisierung der Industrie (sowohl der OEM als auch der Zulieferer) auf den Wettbewerb?

3.3.2. In welcher Form und weshalb verfolgen Sie heute und in der Zukunft eine Globalisierungsstrategie (Zentrale Produktion (High Tech vs. Low cost) und weltweiter Vertrieb vs. lokale Produktion und Vertrieb)?

3.3.3. In wieweit erfolgt eine Produktionsverlagerung gemeinsam mit System- oder Teilelieferanten oder OEMs? Wer führt die Initiative an? In wieweit unterstützen Sie Ihre Lieferanten, z.B. finanziell? In wieweit unterstützen Lieferanten ihre Unterlieferanten bei einer Produktionsverlagerung?

3.3.4. In welchem Umfang führt eine Globalisierung der Produktion zu einem verstärkten Wettbewerbsdruck auf Seiten der System- oder Teilelieferanten, z.B. über Second Sourcing?

4. Anbieterauswahl

4.1.1. Wie beurteilen Sie die Auslagerung der Herstellung von ganzen Systemen oder Modulen zu sog. System- oder Modullieferanten und damit die Entwicklung von mehrstufigen Zulieferhierarchien? Worin sehen Sie Vor- und Nachteile einer solchen Entwicklung?

4.1.2. Was sind die wichtigsten Schritte in der Lieferantenauswahl? Findet eine Auktion (Entwicklung und Produktion) zwischen verschiedenen potentiellen Anbietern statt und wenn ja zu welchem Zeitpunkt in der Lieferantenauswahl?

4.1.3. Wie viele potentielle Geschäftspartner im Systemlieferanten- und (direkten oder indirekten) Teilelieferantenlevel stehen Ihnen typischerweise während der folgenden Phasen zur Verfügung: in der Konzeptphase (vor Entwicklung, Entwicklungswettbewerb), während Entwicklung (Parallel Engineering), bei Ausschreibung der Produktion, während der Produktion (Second oder Dual Sourcing)? Wie verteilen sich Aufgaben und Volumina bei mehreren Anbietern gleichzeitig?

4.1.4. Bauen Sie alternative Lieferanten (wenn nicht schon bei einer einzigen Modellreihe) über verschiedene Modellreihen auf?

4.1.5. In wieweit gibt es Vorteile aus wiederholter Zusammenarbeit mit einem bestimmten Lieferanten über verschiedene Projekte hinweg? Wie werden diese bei der Vergabe neuer Projekte berücksichtigt?

4.1.6. In welcher Reihenfolge werden Verhandlungen geführt (und ggf. Verträge geschlossen)? Zuerst zwischen Ihnen und den Systemlieferanten oder zuerst zwischen Systemlieferanten und indirekten Teilelieferanten? Welche Verträge werden zuletzt geschlossen? Wer hat Ausstiegsmöglichkeiten, wann und zu welchen Kosten? Wer bestimmt de Reihenfolge der Verhandlungen?

4.1.7. In welchem Umfang haben Sie Einfluß auf die Wahl der indirekten Teilelieferanten durch einen Systemlieferanten (sog. Directed Business)?

5. Entwicklung

   5.1. Modellunspezifische Entwicklungen

      5.1.1. Können Sie eine Verschiebung der Entwicklungsleistung (vom OEM) zu System- oder Teilelieferanten feststellen? Wie beurteilen Sie eine solche Entwicklung, wo sehen Sie Vor- und Nachteile?

      5.1.2. In wieweit schließen sich Lieferanten untereinander oder mit Systemlieferanten oder Ihnen als OEM für über fahrzeugmodellspezifische Entwicklungsleistungen hinausgehende Forschung zusammen?

      5.1.3. Was sind die wichtigsten Vor- und Nachteile solcher Kooperationen?

      5.1.4. Wie wirkt sich dies auf die Lieferantenauswahl und damit ggf. auf Preise aus?

   5.2. Modellspezifische Entwicklungen (Adaptionsentwicklungen)

      5.2.1. Wie viel Entwicklungsaufwand (Zeit, Mann-Tage, EUR) fällt für ein neues Fahrzeugmodell insgesamt an? Wie teilt sich dieser Aufwand zwischen Grundlagen- und Adaptionsentwicklungen auf? Wie verhält sich dies für einzelne exemplarische (eingekaufte) Teile?

      5.2.2. Welcher Anteil am Entwicklungsaufwand wird vom Teilelieferanten, Systemlieferanten und Ihnen als OEM jeweils übernommen (Wer entwickelt und wer trägt die anfallenden Kosten)?

      5.2.3. Wer erhält typischerweise Patente an Entwicklungsleistungen?

      5.2.4. Wie werden die Aktivitäten der Beteiligten untereinander koordiniert? Wer überwacht die Aktivitäten und definiert Schnittstellen? Wer ist für den Erfolg verantwortlich?

      5.2.5. Wie findet bei Entwicklungen durch System- oder (direkten oder indirekten) Teilelieferanten eine Koordination mit Entwicklern anderer Bauteile statt?

      5.2.6. In wieweit lassen sich Entwicklungserkenntnisse übertragen und so eine Trennung von Entwicklung und Produktion erreichen? Welchen Anteil am gesamten Entwicklungsaufwand (in Zeit, EUR) müsste bei einer Nach-Entwicklung neu aufgebracht werden wenn der Erstentwickler den Nachentwickler mit allen vorhandenen Informationen unterstützt oder wenn nur eine Übergabe von Zeichnungen und Prototypen erfolgt?

5.2.7. In wieweit kooperieren Sie auch mit Wettbewerbern oder Lieferanten von Wettbewerbern bei der Entwicklung von Bauteilen, z.B. um Gleichteileffekte bei verschiedenen Fahrzeugen über Baureihen oder sogar Marken hinweg zu nutzen?

5.2.8. Gibt es neben einer Entwicklung durch OEM oder Lieferanten auch eine Entwicklung durch spezielle Entwicklungsfirmen? Wenn ja, wer nutzt solche Firmen vor Allem (OEM, Systemlieferant oder Teilelieferanten)? Was sind die Gründe für eine solche Auslagerung von Entwicklungsleistung? Welcher Anteil an Entwicklungsleistungen wird dabei ausgelagert? Wie verteilen sich dabei die Risiken, z.B. falls sich eine Entwicklung als fehlerhaft herausstellt?

6. Produktion

6.1. Produktionsentscheidungen

6.1.1. Auf welcher Ebene (OEM, Systemlieferant, Teilelieferant) werden welche Entscheidungen getroffen? (z.B. bezüglich Kapazitäten, Produktionsmengen und Losgrößen)

6.1.2. Nutzen Lieferanten auch Ihre Produktionsmittel (Maschinen, Werkzeuge oder auch Patente) oder die von Systemlieferanten?

6.1.3. Rechnen Sie mit (oder unternehmen Sie etwas gegen) drohende Insolvenzen der Systemlieferanten oder (direkten und indirekten) Teilelieferanten? Wie hoch ist das jeweils zu erwartende Risiko?

6.2. Vertragsabweichungen und -strafen

6.2.1. Wie wollen Sie und Ihre Lieferanten in Zukunft Qualitätssicherung betreiben, um kostspielige Rückrufaktionen zu vermeiden, insb. vor dem Hintergrund einer Verschiebung der Entwicklungsleistung vom OEM zu den System- oder Teilelieferanten?

6.2.2. Wie und von wem werden Abweichungen von zuvor in Verträgen spezifizierten Kosten, Mengen oder Qualitäten festgestellt? Wie sind entsprechende Strafen vertraglich ausgestaltet? Gibt es außervertragliche Absprachen in dieser Hinsicht?

6.2.3. Ist es möglich, Fehler im fertigen Produkt System- oder Teilelieferanten zuzuweisen und gegebenenfalls entstehende Zusatzkosten verursachungsgerecht aufzuteilen? Ist es möglich, Fehler des Systemlieferanten im Zusammenbau (im Gegensatz zu den Fehlern der verbauten Einzelteile) des Systems/Moduls zu erkennen?

6.2.4. Wie häufig sind im Nachhinein zu Tage tretende Missverständnisse in Bezug auf Inhalt und Interpretation von Verträgen?

7. Vertragsgestaltung

7.1. Vertragsinhalte

7.1.1. Was wird in den Verträgen typischerweise wann spezifiziert? Werden Mengen bereits beim ersten Angebot festgelegt (insbesondere vor der letzten Möglichkeit der Parteien, aus dem Vertrag ohne Vertragsstrafen auszusteigen)?

7.1.2. Wie lange ist die typische Vertragsdauer und wer legt sie fest?

7.1.3. Gibt es selbst noch während der Vertragslaufzeit Nachverhandlungen? Unter welchen Bedingungen finden Nachverhandlungen statt und wer veranlasst diese?

7.1.4. In wieweit wird die Weitergabe von F&E Ergebnissen der System- oder Teilelieferanten an andere OEM vertraglich eingeschränkt?

7.1.5. Welche Absprachen werden neben den vertraglichen Regelungen zwischen Ihnen und Systemlieferanten bzw. zwischen System- und indirekten Teilelieferanten typischerweise noch getroffen (nicht justitiable Absprachen)?

7.2. Anreizstrukturen und Kostenteilung

7.2.1. Hängen die Gewinne der Firmen, die direkt an Sie liefern, stärker von ihrer Performance (Zielerfüllung hinsichtlich Qualität und Menge) ab? Beinhalten z.B. die Verträge zwischen Ihnen und Systemlieferanten einen höheren pauschalen Anteil und die Verträge zwischen System- und indirekten Teilelieferanten einen höheren produktionsmengenabhängigen Anteil?

7.2.2. In wieweit werden die Kosten für Investitionen der Systemlieferanten oder Teilelieferanten von Ihnen übernommen, z.B. für Entwicklungen oder für Maschinen und

Werkzeuge? Übernehmen Systemlieferanten solche Kosten bei den Teilelieferanten?

7.2.3. Wie erfolgt in diesem Fall eine Übernahme der Kosten (direkte Bezahlung, Umschlag auf eine festgelegte Produktionsmenge, etc.)?

7.2.4. Wie wirkt sich eine Kostenübernahme auf die Eigentumsrechte, z.B. an Patenten oder Maschinen und Werkzeugen, aus?

8. Informationen

8.1.1. Welche Informationen haben Sie über die Produktionskosten und Gewinne Ihrer Geschäftspartner (System- und indirekten Teilelieferanten)? In wieweit geben Unterschiede zwischen alten und neuen Produktmodellen oder Baureihen Anhaltspunkte hierfür?

8.1.2. Hat der Systemlieferant bessere Informationen über die Kostenstruktur der indirekten Teilelieferanten als Sie?

8.1.3. Können Sie Informationen/Vermutungen über die Kosten des Systemlieferanten aus den Verhandlungen mit dem indirekten Teilelieferanten ableiten (falls solche stattfinden)?

8.1.4. Werden von System- oder Teilelieferanten Preismenüs (z.B. verschiedene Möglichkeiten der Kompensation von Entwicklungskosten) angeboten? Wie transparent sind diese Kalkulationen?

8.1.5. Sind Ihnen die Verträge zwischen System- und indirekten Teilelieferanten bekannt? Wenn ja, welche Elemente (z.B. Preis, Menge, Qualität, Zusammenarbeit in der Forschung)? Können Sie Verträge, die Sie selbst schließen, daran knüpfen?

8.1.6. Sind die Verträge zwischen Ihnen und dem Systemlieferanten den indirekten Teilelieferanten bekannt? Kann es z.B. sein, dass Sie direkt mit dem Teilelieferanten verhandeln und Daten aus dem Vertrag mit dem Systemlieferanten weitergeben?

3. DELEGATION AND HIERARCHIES IN AUTOMOTIVE PROCUREMENT: MANAGING SUB-SUPPLIERS THROUGH DIRECTED BUSINESS

3.1 Motivation

In recent years procurement of automotive manufacturers, henceforth OEMs, has changed with fewer suppliers developing and producing a wider range of vehicle parts. This has, among others, given rise to so-called module or system suppliers who combine vehicle parts either spatially (modules) or functionally (systems). Thus both assembly, as mainly in the case of modules, as well as research and development, notably when technically advanced and innovative systems are concerned, are outsourced from the OEM to suppliers. On first sight, this strategy may have reduced procurement complexity as OEMs can procure bigger packages from fewer suppliers. But it also contains a greater loss of control of the value creating process. When procuring a package of several parts together, the OEM loses information and control of these individual parts, especially if they are originally produced by different suppliers. To regain control of the supply chain, automotive OEMs have been increasingly active in the management of sub-suppliers, often referred to as directed business in the industry. Directed business implies that the procurer directly negotiates with sub-suppliers of his direct or tier 1 supplier, concludes supply contracts and prescribes the sub-suppliers to the tier 1 supplier. Yet the management of the development and later production process remains with the tier 1 supplier.

Directed business is a relatively recent phenomenon and has received little attention both in business management and in the economic literature. Nevertheless it is an important strategy in the automotive industry. One of the few works on directed business, Girschik (2002), states that in the case of bumper modules, 70 Percent of all parts are procured via directed business[1]. In addition, Müller, Stahl, and Wachtler (2007) conducted interviews with senior managers in the automotive industry and discussed, among others, the efficient organization of the supply chain.

Directed business in the automotive industry provides an excellent opportunity to test the theory of delegation and hierarchies. Centralization in its strict empirical interpretation refers to the procurement of all individual parts of the OEM himself. This would also entail the management of the development and production process including assembly. Delegation refers to delegation of research and development, production and also sub-supplier negotiations to a tier 1 supplier. Thus comparing centralization with delegation may be largely driven by differences in assembly costs or economies of scale in production or research and development. On the other hand, directed business represents an intermediary case where sub-supplier negotiations are

[1] See page 4 in Girschik (2002).

centralized, but all other aspects remain delegated. Thus the decision to engage in directed business will be solely driven by problems in asymmetric information and moral hazard as they are discussed in the literature on delegation and hierarchies as e.g. in Baron and Besanko (1992), Mookherjee and Tsumagari (2004), Baliga and Sjöström (1998) or Radner (1993). The pivotal goal of this article is thus to test, based on existing theoretical research, the hypotheses on the OEM's decision whether to engage in directed business or to allow the tier 1 supplier to independently source its upstream products. Policy implications for automotive OEMs can then be derived.

We find that directed business, or centralization of contracting, leads to more cost transparency and more frequent renegotiations with the tier 1 supplier. This indicates a decrease of informational rents of the supplier as predicted by theory. In addition, we show that directed business includes higher development effort by the OEM and (weakly) reduces incentives of the tier 1 supplier to produce sufficient quality. Surprisingly, no significant difference between premium and volume OEMs regarding directed business is found, which may indicate that in procurement OEMs do not differentiate themselves as much as theory would suggest.

The article is organized as follows. Section 3.2 presents the existing literature on delegation and hierarchies as well as existing empirical findings regarding the automotive industry in this respect. In Section 3.3 we describe the data set analyzed and afterwards derive hypothesis for directed business in Section 3.4, based on theoretical predictions. Section 3.5 presents the empirical evidence and Section 3.6 concludes.

3.2 Literature

Several strands of theory could be relevant to explain the phenomenon of directed business in the automotive industry. Most closely related is the literature on hierarchies and delegation, which applies both to problems within a firm or to procurement, as e.g. Mookherjee (2006) points out. This literature can be divided into two main areas. One strand focuses on information asymmetries or moral hazard but assumes no transaction and information processing costs. The second strand of literature ignores the latter and explicitly analyzes costly information processing. Directed business may also be interpreted from the perspective of the theory of the firm and the question of in- vs. outsourcing of activities. The property rights theory as developed by Grossman and Hart (1986) and Hart and Moore (1988) with its empirical implications especially to the automotive industry has been widely discussed, e.g. in Klein (1988). Its application to the case of directed business is less obvious, because all property rights stay with the same party, the tier 1 or the sub-supplier, irrespective of independent sourcing or directed business.[2] Thus we will not concentrate on this strand of literature.

3.2.1 Hierarchies and asymmetric information

A large number of articles analyzes hierarchies in a setting with a principal and two productive agents where the agents have private information about their costs.[3] Centralization in this context refers to the principal directly contracting with both agents, while under delegation he contracts with one agent only and this agent concludes a contract with the second agent. Delegation then refers to independent sourcing in the automotive industry and directed business corresponds to centralization.

The key results of this literature, as e.g. Baron and Besanko (1992), Gilbert and Riordan (1995) or Melumad, Mookherjee, and Reichelstein (1995), is that centralization is at least as good as delegation because the latter may induce a double marginalization of rents and thus production misallocation and inefficiencies. The disadvantages of delegation may nevertheless be eliminated under observability of sub-contracting costs or production allocation by the principal, top down contracting and risk neutrality and no limited liability of agents.[4]

Collusion among agents and the existence of a third, better informed agent, the middleman, may change the results obtained. Introducing an informed middleman should intuitively make delegation more attractive. Yet the principal could always extract the middleman's information through direct centralized contracting with all parties, thus avoiding the disadvantages of delegation. If the middleman and the agents can collude, this prevents costless information acquisition from the middleman, such that delegation will dominate centralization.[5]

[2] Nevertheless, if one takes outsourcing by the automotive OEM as given, one may argue that the more specific investments are, the more will both parties, the procuring OEM and the supplier, prefer to contract with each other directly and not through a middleman, i.e. the tier 1 supplier. However, this hierarchical issue is not specifically addressed in the property rights theory.

[3] The article by Mookherjee (2006) provides an extensive survey of the recent theoretical literature on this area of research.

[4] Note that the authors in all these articles also assume that there are no costs of communication, contracting or information processing.

[5] On the other hand, collusion will be harder to enforce under centralization, because agents will always be able to opt out of the collusive agreement and directly contract with the principal. With collusion, enforceability is a main concern and most literature assumes either long-term contracts or restricts to self-enforcing behavior. Furthermore, it is assumed that agents can reallocate payment and production between themselves without

Two articles discuss a setting with one productive agent and one middleman where the production costs of the agent are private information. In Faure-Grimaud, Laffont, and David (2003), the authors find that delegation is equivalent to centralization. The key driver of this result is that collusion among agents also under centralization leads to the same distortions as delegation.[6] Also the article finds that it is welfare maximizing if the middleman does not have full but only some information about agents.[7] In Celik (2007), delegation is dominated by centralization because the middleman distorts the allocation of production. In some cases, it is even better to not involve the informed middleman at all. The informational asymmetries though are limited as there can only be three different cost levels for the agent, out of which one is always known by the middleman.[8]

The article by Mookherjee and Tsumagari (2004) analyzes decentralization versus centralization in a setting with two agents, with or without an informed middleman. Without an informed middleman, centralization always dominates decentralization because of a double marginalization of rents.[9] With an informed middleman, decentralization dominates, assumed that the double marginalization of rents through delegation is small enough.[10] This result holds also given collusion between the agents and the middleman. The benefits of delegation rely on the superior information of the middleman[11], the intuition being that the procurer will prefer to contract with a more "internally efficient" coalition. While Mookherjee and Tsumagari (2004) only consider the two polar cases where the middleman has either perfect information or the same information as the procurer, they hypothesize that the value of delegation monotonically increases in the middleman's degree of information relative to the procurer.

The work of Laffont and Martimort (1998) is closely related to Mookherjee and Tsumagari (2004) but includes limits on communication. The agents then can not reveal all information to the principal in the centralized mechanism, which renders delegation superior.[12]

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the principal's knowledge. Whether this holds in the automotive industry is questionable.

[6] The question whether and how collusive agreements between agents can be enforced drives the results, obviously.

[7] Thus the degree of information is interior, in the sense that it is larger than zero but not complete, see pages 254 and 255.

[8] See page 3.

[9] This result holds irrespective of collusion among the agents.

[10] And given the agents produce complements, the reverse holds in the case of substitutes.

[11] See page 1181.

[12] Note also that in Laffont and Martimort (1998), it is assumed that the tier 1 supplier has all bargaining power under delegation while under centralization a third party designs the side contract for the agents.

3.2.2 Hierarchies and moral hazard

The article by Baliga and Sjöström (1998) discusses moral hazard and delegation in a setting with one principal and two agents who provide effort that jointly determines the probability of success of the project. The agents are also limited liable and can collude. The principal can either directly contract with two agents or contract with agent two only, who then contracts with agent one. Neither effort is ex post observed by the procurer, only the success of the project. But agent two observes the effort of agent one before deciding his own effort level. The authors then find that delegation dominates centralization. Only when collusion is not fully possible[13], centralization is superior. The intuition for the superiority of delegation may be interpreted in parallel to the adverse selection literature as in Mookherjee and Tsumagari (2004). Given collusion among agents and complementarities, it is superior to delegate to a better informed middleman, where in Mookherjee and Tsumagari (2004) the middleman has better information about the costs of the agent and in Baliga and Sjöström (1998) agent two observes the effort level of agent one.

Another article on delegation and moral hazard is Macho-Stadler and Pérez-Castrillo (1998). As in Baliga and Sjöström (1998), two agents' effort determines the outcome of a project and the principal can either delegate to one agent or contract centrally. The authors apply their theoretical work to franchising. The result is similar. If collusion can not be avoided[14], delegation is superior. This result also depends on contracts being signed sequentially. If contracts with agents can be concluded simultaneously and agents can not collude, centralization is superior in Macho-Stadler and Pérez-Castrillo (1998).

The article by Vafai (2005) analyzes moral hazard in monitoring under delegation to a middleman or centralization. The middleman does not have a superior monitoring technology and just serves to prevent the principal from concealing positive information, i.e. a high output of the agent. On the other hand, when involving a middleman, collusion may occur either between the agent and the middleman or the middleman and the principal. The respective costs of both sourcing systems determine their superiority. The article by Vafai (2005) differs in analyzing monitoring, not effort that determines success, and does not have an informational advantage of the

[13] In Baliga and Sjöström (1998) collusion is not possible when the procurer introduces randomized wages. Then the agents can not be sure to pay bribes because they are limited liable and the required bribe may exceed the wage they receive. Another way to have collusion break down are secret messages.

[14] The principal could forbid or monitor collusion between the agents.

middleman. Thus it only limitedly applies to the situation in the automotive industry.

3.2.3 Hierarchies and costly information processing

Pioneered by Radner (1992) and Radner (1993), this strand of literature discusses the design of efficient hierarchies given that agents have only a limited information processing ability in a given time. Thus the organizational form that can process a given number of tasks in the minimum time given a certain number of processors or agents is being sought. An organization, in the definition of Radner (1993), is efficient if for a given number of tasks the number of processors can not be decreased without increasing the decision time or vice versa. The optimal solution to this problem is a "reduced tree" which corresponds to an intermediate hierarchical organization where some decisions are delegated to intermediary managers and others centrally decided by the principal. The articles by Schulte and Grüner (2007) and Grüner and Schulte (2005) add the quality of decisions to this setup, assuming that agents can only imperfectly process information. In Schulte and Grüner (2007) the information processing technology is exogenously given and the "reduced tree" is again shown to outperform centralization as well as full delegation, both in the dimensions of decision speed, costs, and quality. In Grüner and Schulte (2005), it is assumed that agents can endogenously provide effort to better process information. In general, the authors find that decentralization per se has a positive effect because it reduces the decisions and thus costs per agent. As before, the "reduced tree" outperforms all other organizational forms. Other articles with similar results are Van Zandt and Radner (2001) or Van Zandt (1999).

A limited ability of information processing in its strict definition as in Radner (1993) should be less relevant to the automotive industry as we can safely assume that the OEM will always be able to employ more staff in procurement and development to be able to process all information, if desired.[15] The article Melumad, Mookherjee, and Reichelstein (1992) takes another approach and assumes that the messages that agents can exchange are limited. Thus centralization can not collect all information from agents. Delegation then outperforms centralization if the principal can monitor production assignments or payments between the agents ex post. Another aspect may be that not agents' messages are limited but that contingencies in contracts are constrained, i.e. there is a limited contract complexity. This is discussed in Melumad, Mookherjee, and Reichelstein (1997) and leads to delegation as the

[15] Potentially though at increasing marginal costs.

preferred outcome if the gain through better information processing under delegation outweighs the controll loss through asymmetric information.

3.2.4 Empirical research on directed business

The earliest work on directed business in the automotive industry is Girschik (2002). The author finds that under opportunistic behavior of the tier 1 supplier, either the OEM or the sub-supplier may initiate directed business. Directed business is also claimed to lead to efficiency losses, but these are not quantified. The findings are based on case study interviews in a very narrowly defined range of vehicle parts as well as experimental results, not on a broad set of data.

In Klibanoff and Novak (2003), the authors provide an empirical analysis of directed business based on interviews and data on parts sourced for luxury vehicles. The authors find that more complex products and directed business individually increase the prices of the sourced parts. However, when observed together, procurement prices decrease. This result is driven by the assumption that the OEM chooses a lower acceptable quality under directed business. Yet quality itself is not observed in the authors' data. Klibanoff and Novak (2003) also note that the responsibility for failures is shifted from the tier 1 supplier to the procuring OEM in the case of directed business. Thus the incentives to provide effort for quality are reduced on the tier 1 level.

3.2.5 Summary

In an asymmetric information setting, delegation in general leads to a double marginalization of rents as discussed for example in Mookherjee and Tsumagari (2004) and therefore is dominated by centralized procurement. This disadvantage may be outweighed if delegation occurs to a sufficiently better informed middleman or if processing of information is limited as in Melumad, Mookherjee, and Reichelstein (1997). Under complementarity of effort, delegation is equally superior, provided there is a better informed middleman as shown in Baliga and Sjöström (1998). Whether complementarity of effort without a better informed middleman leads to delegation is not specifically discussed.

A theoretical model that incorporates asymmetric information as well as moral hazard with or without limited information processing still remains to be developed. Especially interesting in this respect may be to evaluate a potential trade-off between double marginalization of information rents, which favors centralization, and complementarity of effort, which may induce delegation. The informational advantage of the potential middleman, i.e. the ability to observe costs or effort of the agents may then interact both effects and thus influence the trade-off. Such a model will represent more closely the situation that we consider in the automotive industry. Procurers will in general be faced both with imperfect information of their suppliers' costs and unobservable effort.

Our analysis will contribute empirical evidence to the development of such a unified model. In addition, we test the existing theory against our findings. We also differ from the existing empirical works in several aspects. First of all, our data set is larger and broader compared to both Girschik (2002) and Klibanoff and Novak (2003). In addition, our theoretical predictions differ. While Klibanoff and Novak (2003), as well as partially Girschik (2002), predict an increase of the procurement price in directed business, the theoretical literature on hierarchies and delegation, as well as our own findings, indicates the opposite. Also we will include a much wider array of factors that may influence directed business into our analysis.

3.3 Data description

We analyze a cross-section data set generated during a survey of the German automotive industry association, the Verband Deutscher Automobilunternehmen e.V. (VDA), that was undertaken in 2007. In the survey, suppliers were asked to characterize the procurement behavior of their different OEM customers for a representative sample of parts in their product portfolio. The survey covered eleven automotive manufacturers, which are all major players in the worldwide automotive market. These OEMs also represent nearly all production capacity of passenger vehicles as well as trucks in Germany. Nine suppliers, all members of the VDA, participated in the survey and were selected to provide a broad picture of the parts produced in the supplier industry. The survey involved all relevant departments in these firms, sales, research and development, production, quality management, logistics and aftersales. Within the supplier departments, 376 employees participated in the survey.

Table 3.1 presents a list and definition of the variables that will be used in the following discussion. These include characteristica of the supplier parts ($Compet$, $Complex$, $VolFluct$), the frequency of quality problems ($QualProb$) and their associated costs ($QualCost$), the frequency of price renegotiations during the production lifecycle ($Renegot$), the size of price reduction ($PriceRed$) as well as the frequency of directed business ($DirectBus$). Also the sharing of development effort between the OEM and suppliers is covered (*DevShareSS*, *DevShareT*1, *DevShareOEM*). These characteristica are all given on the level of the tier 1 product. Unfortunately, information about the products of sub-suppliers that go into the specific tier 1 product is lacking. The only observation that we have in this respect is the share of development effort that the sub-supplier undertakes.

Table 3.2 presents the summary statistics of the variables. The data set contains 214 parts that were supplied directly to the OEMs. On average, we observe that directed business (*DirectBus*) occurred in more than 20 percent of all cases. Average price reductions (*PriceRed*) are on the upper limit on the interval of $5 - 10$ percent.[16] Renegotiations because of efficiency gains (*Renegot*) occurred in almost half of the cases.

In table 3.2 the number of observations per variable varies considerably. Consequently, the data set contains a significant share of missing responses. This will be important to remember in the econometric analysis of the data set.

Unavoidably, the data are subject to a selection bias. None of the suppliers was exposed to bankruptcy risk or is expected to be so in the close future. The respondent firms are all major market participants with a long standing in the market. Irrespectively of producing low-value, simple or high-value, advanced parts, the suppliers may have considerably more bargaining power towards an OEM than the average supplier in the industry. Also, the data set contains missing values. Certain questions may not have been filled out by respondents on purpose. For example, it is open to debate whether suppliers would truthfully report if there were grave quality problems that may also have caused disruptions in their relationship with the OEM.

Before proceeding to the following section, we would also like to highlight a number of important characteristics of the automotive industry. Sourcing decisions in the automotive industry are always made by the OEM who manages the overall project, i.e., the development and production of a new vehicle model. After a preliminary concept phase, the OEM decides which parts of the vehicle will be procured from outside and how outsourcing will be organized. All parts of a vehicle are perfect complements and may be interacting with each other spatially and also functionally. Vehicle parts are also specific to a certain vehicle model or platform. Developing and producing them involves high specific investments that create the potential for hold-up. The market participants though interact with each other repeatedly and also potentially in several markets at the same time. In general, a supplier

[16] Please note that responses about price reductions were given in intervals with the highest interval, corresponding to price reductions above 20 percent, is open. Thus an average price reduction in the sample can not be accurately calculated. The average response is measured at 2.958.

Tab. 3.1: Variable description

Variable	**Scale**	**Description**
DirectBus	Never - very frequently (6 - scale)	Frequency that the OEM has directly negotiated with sub-suppliers of the tier 1 supplier during the last five years
QualProb	Very rarely - very frequently (5 - scale)	Frequency of quality problems during production
QualCost	Very low - very high (5 - scale)	Size of the cost that occured in the case of quality problems
CostTransp	Very rarely - very frequently (5 - scale)	Frequency that the tier 1 supplier's costs were made transparent to the OEM
Renegot	Never - very frequently (6 - scale)	Frequency of renegotiations during the product lifecycle because of efficiency gains of the supplier
PriceRed	<5% - >20% (6 - scale)	Average price reduction over the product lifecycle
DevShareSS	<20% - >80% (5 - scale)	Share of development effort by the sub-supplier
DevShareT1	<20% - >80% (5 - scale)	Share of development effort by the tier 1 supplier
DevShareOEM	<20% - >80% (5 - scale)	Share of the OEM's development effort
Testing	1 - 5 (5 - scale)	Responsibility for testing, 1 = tier 1 supplier, 5 = OEM
QualResp	Never - very frequently (6 - scale)	Frequency that the tier 1 supplier was held responsible for quality problems, given testing by the OEM
RDstaff	<2% - >8% (5 - scale)	Share of employees in research and development
Compet	Very low - very high (5 - scale)	Intensity of competition in the tier 1 market
Complex	Very low - very high (5 - scale)	Complexity of the part's interfaces to the vehicle
VolFluct	<+/-10% - > +/-70% (5 - scale)	Possible fluctuations of production volume specified in supply contracts
DUMMYPREM	-	Dummy variable if a premium OEM is supplied

Tab. 3.2: Summary statistics of variables

Variable	Mean	Std. Dev.	Min.	Max.	N
DirectBus	0.215	0.248	0	0.9	214
QualProb	0.211	0.136	0.1	0.9	123
QualCost	3.008	1.255	1	5	121
CostTransp	0.426	0.27	0.1	0.9	157
Renegot	0.471	0.306	0	0.9	153
PriceRed	2.958	1.142	1	5	142
DevShareSS	0.203	0.189	0.1	0.9	185
DevShareT1	0.602	0.257	0.1	0.9	185
DevShareOEM	0.338	0.21	0.1	0.9	141
Testing	2.833	0.989	1	5	168
QualResp	0.568	0.261	0	0.9	154
RDstaff	0.043	0.031	0.01	0.09	131
Compet	1.601	0.789	1	5	148
Complex	3.372	1.077	1	5	148
VolFluct	0.175	0.093	0.05	0.8	146
DUMMYPREM	0.486	0.501	0	1	214

produces different parts for different vehicles of the same OEM, repeatedly. In Müller, Stahl, and Wachtler (2007) a more detailed discussion of these economically interesting aspects is provided.

3.4 Hypotheses on the use of directed business

Based on the previously discussed literature, hypotheses to explain directed business in automotive procurement can be derived. In this context, automotive OEMs are facing problems of asymmetric information, moral hazard as well as incomplete contracts and costly information processing. Asymmetric information largely concerns the production costs of the suppliers, which also change considerable during the vehicle model lifetime due to learning curve effects. The supplier's effort to provide a sufficient quality of the parts is the largest driver of moral hazard. Contracts are incomplete, especially regarding expected production volumes or the design of parts prior to the development stage.[17] The decision to engage in directed business will be based on the combination of all these aspects. Below, we will refer to the situation without directed business as delegated sourcing.

[17] Please refer to Müller, Stahl, and Wachtler (2007) for a more detailed discussion of these aspects in automotive procurement.

3.4.1 Supplier effort for quality

Vehicle reliability is a major concern for consumers and thus automotive manufacturers. Ensuring that only flawless parts are built into a vehicle and that these parts will also not fail when interacting with other parts of the vehicle is one of the key determinant of success. Having to recall and repair vehicles is not only costly but can lead to a significant reputational loss for the OEM and potentially the supplier. Suppliers' effort for higher reliability can thus be interpreted along the lines of Baliga and Sjöström (1998). Thus we predict that under delegated sourcing, incentives to provide effort for quality are higher and thus parts failure rates lower, especially for the tier 1 supplier. The superiority of delegation in Baliga and Sjöström (1998) is among others based on the fact that the agent that is delegated to observes the quality of the sub-supplier's product. We consider this not to hold for a wide range of parts for two reasons. First of all, quality will never be perfectly observable before a part is built into a vehicle and finally used by the customer. Monitoring quality at some stage will have prohibitively increasing marginal cost. Also, in many instances, the OEM himself may be able to observe the sub-supplier's quality equally well as the tier 1 supplier, thus there is no informational advantage.

Nevertheless, quality incentives will be higher under independent souring when we consider complementarity effects between parts. Under delegated sourcing, the tier 1 supplier will be responsible for the quality of the whole set of parts that he supplies to the OEM. On the other hand, under directed business, the tier 1 supplier will usually refuse to be held responsible for all quality issues related to the sub-supplier. The tier 1 supplier will always claim that the OEM's selection of the wrong sub-supplier was the cause of quality problems and that if he had only been able to choose his own, better supplier, these issues would not have occurred. This shift of responsibility is observed in Klibanoff and Novak (2003) and was also mentioned in the interviews that have been conducted by Müller, Stahl, and Wachtler (2007). The impact of the shift in responsibility is more pronounced the more the failure of one part induces failure of another part and the cause of failure is not perfectly identifiable ex post. Under delegated sourcing, the tier 1 supplier will nevertheless be liable for failure. Under directed business, he will not be liable, at least as long as his part can not be clearly identified as responsible. Therefore his incentives to engage in effort that increases quality will be higher under delegated sourcing. A simple model that formally illustrates this effect is presented in the Appendix 3.7.

Hypothesis 1 (Quality incentives)**.** *An increased degree of directed business* *in a certain tier 1 part will lead to higher failure rates of this tier 1 part*

$$\frac{\partial QualProb}{\partial DirectBus} > 0. \tag{3.1}$$

Besides the impact on quality incentives, limited liability may also be a significant driver for delegated sourcing. As discussed before, under directed business the tier 1 supplier will not take over responsibility for failure of parts of the sub-supplier. Under delegated sourcing, he takes over responsibility for failures across the whole set of parts, independently from the identification of the cause of failure. If the sub-supplier is identified responsible, the tier 1 supplier recoups the failure costs from the sub-supplier.[18] In a situation with limited liability, delegated sourcing thus leads to two suppliers being liable, in the first stage the tier 1 supplier and secondly the sub-supplier. Even if the sub-supplier is insolvent, the tier 1 supplier will still have to compensate the OEM for failure. Thus the negative effect of suppliers' limited liability on the OEM is reduced under delegated sourcing. In addition, tier 1 suppliers tend to be larger than sub-suppliers. They have larger sales volumes and larger balance sheets, thus the risk of their insolvency is lower. The article by Mookherjee (2006) hints at this aspect by mentioning that delegation may be a second best solution when "the prime contractor is a large firm with deep pockets".[19] Also Müller, Stahl, and Wachtler (2007) identify limited liability to be potentially important with parts that have a low price but induce high costs if they fail. To test the impact of limited liability empirically, we require data where either tier 1 suppliers significantly vary in balance sheet strength or where we can differentiate between sub-supplier products that vary according to the financial strength of the supplier and the ratio of price versus failure costs. As our data set does not contain this information, we abstain from analyzing the aspect further.

3.4.2 Informational rents of the tier 1 supplier

As stressed in the literature on hierarchies under asymmetric information, delegation will lead to a double marginalization of rents.[20] In the automotive industry, the OEM will equally not know the production costs of his suppliers, neither before contracting nor afterwards. Also costs change considerably

[18] This is due to the hierarchical contracting structure. Under delegated sourcing, the OEM only contracts with the tier 1 supplier and the tier 1 subsequently with the sub-supplier. All payments flow accordingly. Details of this aspect may also be found in Müller, Stahl, and Wachtler (2007).

[19] See pg. 378.

[20] See among others Baron and Besanko (1992), Gilbert and Riordan (1995) or Melumad, Mookherjee, and Reichelstein (1995).

over the production cycle due to learning curve effects. Directed business allows the OEM to learn the price of the parts of the sub-supplier. Thus the cost structure of the tier 1 supplier will become more transparent to the OEM. This will reduce the double marginalization rent of the tier 1 supplier as discussed in Baron and Besanko (1992), Gilbert and Riordan (1995) or Melumad, Mookherjee, and Reichelstein (1995).

In the data, we can not directly observe the size of rents of the tier 1 supplier, yet there are second order effects that indicate their size or respectively their reduction under directed business. In the automotive industry, learning curve effects lead to renegotiations between suppliers and OEMs, as Müller, Stahl, and Wachtler (2007) find.[21] Better information about sub-supplier costs through directed business will induce the OEM to more frequently renegotiate prices with the tier 1 supplier. Thus we expect more frequent renegotiations under directed business.

Hypothesis 2 (Cost transparency)**.** *Directed business will increase the transparency of the tier 1 supplier's costs for the OEM*

$$\frac{\partial CostTransp}{\partial DirectBus} > 0. \tag{3.2}$$

Hypothesis 3 (Renegotiation)**.** *With an increased degree of cost transparency, the OEM will renegotiate prices more frequently with the tier 1 supplier, as uncertainty about production volumes, fixed costs and learning curve effects dissolves.*

$$\frac{\partial Renegot}{\partial CostTransp} > 0. \tag{3.3}$$

Hypothesis 4 (Price reductions)**.** *More frequent renegotiations will lead to higher price reductions over the production cycle of the vehicle parts.*

$$\frac{\partial PriceRed}{\partial Renegot} > 0. \tag{3.4}$$

Of course, price reductions may also be driven by other factors, e.g. certain product or market characteristics.

[21] It is not common practice in the industry to write contracts with fixed price decreases over time or prices depending on produced volumes. Instead renegotiations are frequently used.

3.4.3 Information advantage of the tier 1 supplier

As shown in Mookherjee and Tsumagari (2004) or Laffont and Martimort (1998), the disadvantages of delegation due to a double marginalization of rents may be alleviated or even offset when the principal can delegate to a better informed middleman. An informed tier 1 supplier will be able to better evaluate the costs and learning curve effects of the sub-supplier. Thus the value of delegated sourcing should increase in the degree of information that the tier 1 supplier has over the sub-supplier. Also the value of delegated sourcing should increase in the information advantage of the tier 1 supplier relative the procuring OEM.

How well informed the tier 1 supplier is relative to its sub-supplier can be evaluated on their sharing of development effort. When the sub-supplier undertakes a higher share in the overall development, the informational advantage of the tier 1 supplier should decrease, and vice versa.

Hypothesis 5 (Information advantage relative to the sub-supplier)**.** *The more development effort the sub-supplier undertakes relative to the tier 1 supplier, the less well informed will the tier 1 supplier be about the sub-supplier's costs. Consequently, the probability of observing directed business increases. The opposite holds for the development effort of the tier 1 supplier.*

$$\frac{\partial DirectBus}{\partial DevShareSS} > 0$$
$$\frac{\partial DirectBus}{\partial DevShareT1} < 0. \tag{3.5}$$

A second line of arguments also supports hypothesis 5. Directed business reduces the incentives of the tier 1 supplier to provide effort as discussed in hypothesis 1. Applying the same argument not on producing high quality, but on developing a good and reliable product also supports the expectation that the tier 1 supplier's share of development effort decreases in directed business.

The information advantage of the tier 1 supplier relative to the OEM is reduced when the OEM takes over a significant share of the development effort of the tier 1 part, because of the technical understanding that the OEM then gains. In this respect, it is important to understand that the OEM always takes over some share of the development work of every part of a vehicle. The responsibility for the overall vehicle implies that the OEM manages and coordinates the various suppliers' development activities. To a certain degree, an OEM will then always be involved in the design and prototyping of each part. The more the OEM engages in such coordination effort, the more informational asymmetries between himself and the tier 1 supplier are reduced, making directed business more likely. On the other hand, it is also easy to argue that directed business in fact induces the OEM to engage more in coordinating activities, that is selecting and later on managing the sub-suppliers himself.

Hypothesis 6 (Information advantage relative to the OEM)**.** *With an increased share of development done by the OEM, the informational advantage of the tier 1 supplier decreases. Thus the probability of observing directed business increases. Causality may also go in the opposite direction such that directed business induces the OEM to engage in more development effort.*

$$\frac{\partial DirectBus}{\partial DevShareOEM} > 0. \tag{3.6}$$

There may be systematic differences in informational asymmetries depending on the characteristics of the procured tier 1 part. We expect that more innovative tier 1 parts will be less well understood by the OEM. Technically advanced parts, like for example electronic systems, will require high fixed R&D costs. Thus the OEM will have a lower incentive or ability to engage in development activities of those parts. Instead, the tier 1 supplier will be taking over a higher share of the development effort.

Hypothesis 7 (Innovative tier 1 parts)**.** *The more innovative a tier 1 product is, the higher will be the informational advantage of the tier 1 supplier relative to the OEM.*

$$\frac{\partial DevShareOEM}{\partial RDstaff} < 0. \tag{3.7}$$

The same line of argument can be applied when comparing the development effort of the tier 1 supplier to that of its sub-supplier. Unfortunately our data set does not contain the required observations on the sub-supplier part level to be able to test this hypothesis as we only observe the sub-suppliers development effort, ($DevShareSS$), but not the characteristics of his supplied part.

Innovative products may also be more prone to quality problems because suppliers have less experience in producing and testing them, potentially further influencing the OEMs decision for or against directed business. We will validate whether this expectation holds in Section 3.5.

3.4.4 Intensity of competition in the tier 1 market

As stressed by Baron and Besanko (1992), Gilbert and Riordan (1995) or Melumad, Mookherjee, and Reichelstein (1995), the middleman will earn an informational rent under delegation. It corresponds to standard economic theory that an increase in competition in the tier 1 market will induce a reduction in rents. The OEMs should then also benefit from increased transparency about suppliers' costs. The same line of argument can as well be applied to the impact of competition on the incentives of suppliers and we would thus expect higher supplier effort under more competition. If competition increases cost transparency, decreases suppliers' rents, as well as increases incentives to provide effort, we should observe less directed business in more competitive tier 1 markets.

Hypothesis 8 (Competition)**.** *Increasing competition in the tier 1 market will increase cost transparency and induce suppliers to provide more effort.*

$$\frac{\partial CostTransp}{\partial Compet} > 0$$
$$\frac{\partial DevShareT1}{\partial Compet} > 0. \tag{3.8}$$

Competition in the supplier market may also be different when products are more innovative. In general, we would expect to have less competition in more innovative product markets due to the higher fixed R&D costs involved in development.

3.4.5 Objective of the OEM

Automotive OEMs are generally divided into two main subgroups. Premium OEMs produce fewer, more luxurious or exclusive vehicles and volume OEMs produce larger quantities of cheaper vehicles. The respective OEM strategy will influence the OEMs' objective function also in procurement. Premium OEMs will tend to place a higher emphasis on the uniqueness and quality of the parts they procure while volume OEMs should rather focus on low procurement prices. If hypotheses 1, 2, 3, and 4 hold, this should also influence the decision on directed business.

Hypothesis 9 (OEM Objective)**.** *Premium OEMs will exhibit fewer quality problems in their vehicles and be less concerned with suppliers' cost transparency (and thus the procurement price).*

$$\frac{\partial QualProb}{\partial OEM\_Type} < 0$$
$$\frac{\partial CostTransp}{\partial OEM\_Type} < 0. \tag{3.9}$$

The above arguments for hypothesis 9 all imply that premium OEMs should engage in less directed business. One counterargument may be that premium OEMs care equally about quality on the sub-supplier level. Even if directed business may reduce quality incentives of the tier 1 supplier as discussed in hypothesis 1, it may increase quality incentives of the sub-supplier. This effect may occur because the sub-supplier can extract more rents from the OEM under directed business, given that there is no double marginalization problem as put forward by hypothesis 2. Due to the lack of data on the sub-supplier level, this argument can not be tested. However, we will attempt to address this point qualitatively in the following section.

Premium OEMs may also have a preference for more innovative tier 1 products. Thus the effects of hypothesis 7 would induce less directed business by premium OEMs. On the other hand, premium OEMs may also have a preference for more innovative sub-supplier products. Then the informational advantage of the tier 1 supplier will decrease as discussed in hypothesis 5. In this case, the probability of directed business should increase.

3.4.6 Summary

From the above, we expect the basic trade-off in the decision for or against directed business to be the following:

1. By engaging in directed business, the OEM eliminates double marginalization by the tier 1 supplier and thus can procure at lower prices.

2. If the tier 1 supplier has superior information about the sub-supplier, this may overcompensate the double marginalization problem, thus inducing less directed business.

3. By engaging in directed business, the tier 1 supplier's incentives to provide high quality are reduced, thus the probability of failures increases. This goes against the interest of the OEM.

The type of product procured, notably the degree of innovation of the product, and the strategy of the OEM may influence the above trade-off and thus have an impact on directed business. By engaging in directed business, the OEM also incurs transaction costs. These comprise the costs immanent in selecting and contracting with the sub-supplier. These fixed costs also weight against the reduction in procurement prices through directed business.

Causality may also go into the opposite direction compared to the theoretical prediction. In particular, one may argue that the OEM will engage in directed business once he observes quality problems on the tier 1 level. Thus directed business is a measure to increase, not decrease quality. If this holds, the trade-off faced by the OEM would be between reducing production prices and increasing quality versus the transaction costs of directed business.

3.5 Empirical findings

3.5.1 Descriptive statistics and correlations

We first return to the summary statistics in table 3.2. Directed business (*DirectBus*) on average occurs in 22 percent of all cases. It has a high standard deviation of 25 percent.[22] Table 3.7 in the Appendix 3.8 presents the frequency distribution of responses. Here we find that in 37 percent of the cases, directed business never occurs. In 20 percent of the cases, respondents stated that directed business occurs with a probability of 50 percent or higher. Thus directed business is a strategy that OEMs employ in specific parts, potentially very frequently. On the other hand, in a high share of their procured parts, they choose not to engage in directed business at all.

Table 3.8 in the Appendix 3.8 provides the cross-correlations of the variables analyzed. These will be used as a first indication on the hypotheses derived in section 3.4.

We observe a positive correlation between quality problems (*QualProb*) and directed business (*DirectBus*) at the ten percent significance level. Nevertheless causality may go in both directions. If hypothesis 1 holds, directed business induces less quality effort, otherwise lower quality may induce more directed business. We also observe a negative correlation between responsibility of the tier 1 supplier for quality problems (*QualResp*) and directed business at the one percent significance level.[23] This in our view is a strong indication that hypothesis 1 holds and that quality problems are a results of directed business and therefore lower quality responsibility of the tier 1 supplier. The same aspect is supported by the responses in table 3.9. Under directed business[24], the OEM is more responsible for solving quality problems than when the tier 1 supplier selects his sub-supplier[25]. These findings also correspond to the assumptions and results of the simple model presented in

[22] The average and standard deviation are calculated by evaluating the responses at the averages of their respective probability interval, i.e. "Never" corresponds to 0 percent and "Very frequently" to 90 percent probability.

[23] Note also that we observe less testing by the OEM under directed business (*Testing*), which could be investigated further.

[24] Variable $QualResp\_SSOEM$.

[25] Variable $QualResp\_SST1$.

Appendix 3.7.

Between cost transparency ($CostTransp$) and directed business a positive correlation is found, confirming hypothesis 2 at the one percent significance level. Furthermore, cost transparency and the frequency of renegotiations ($Renegot$) are positively correlated at the one percent significance level, which supports hypothesis 3. We observe no correlation neither between price reductions ($PriceRed$) and cost transparency nor price reductions and renegotiation, hinting against hypothesis 4. We presume that responses regarding price reductions may be overlaid by other factors not related to directed business or that responses may be biased in this very sensitive area of the questionnaire. At least there is no obvious reason why increased cost transparency and more frequent renegotiations should not lead to higher price reductions.

Confirming hypothesis 5, the data exhibit a positive correlation between the share of development effort by the sub-supplier ($DevShareSS$) and directed business at the one percent significance level, as well as the corresponding negative correlation between the share of development effort by the tier 1 supplier ($DevShareT1$) and directed business at the five percent significance level. We also find a positive correlation between the development effort of the OEM ($DevShareOEM$) and directed business as expected from hypothesis 6. In addition, the development effort of the OEM correlates negatively with quality problems ($QualProb$). Furthermore, there is a strong positive correlation between development and testing by the OEM ($Testing$). Also, if the OEM engages in more development and testing, the tier supplier is held less responsible for quality problems ($QualResp$). These correlations do not contradict a hypothesis that the OEM engages in directed business exactly in products with quality issues and tries to resolve those.

Innovative tier 1 products ($RDstaff$)[26] are negatively correlated with the development effort of the OEM at the one percent significance level, which confirms hypothesis 7. However, we do not observe a significant correlation between innovative tier 1 products and the share of development effort by the tier 1 supplier, the second and more obvious part of hypothesis 7. In-

[26] Measuring the innovativeness of a product is subject to interpretation by the respondent. We thus opted to use a more objective measure of innovativeness. The investment in R&D effort and the number of patents are readily available concepts. However, as patenting an innovation is a strategic decision and may not be undertaken, a fact that was also found to be especially relevant in the interviews conducted by Müller, Stahl, and Wachtler (2007), we measure R&D effort by the share of engineers employed in development. In some literature, the percentage point of sales invested in R&D is also used, but this inevitably depends on sales volumes and thus may be less comparable between companies or products.

novativeness also interacts with a number of other variables significantly. A higher degree of innovativeness is related to less directed business, more cost transparency and higher price reductions. The first observation is expected, the second and third may be due to the fact that there are more learning curve effects in innovative products, thus higher price reductions and in this context also increased cost transparency. Also it is important to note that the latter correlations are based on a significantly lower number of observations than other correlations and that therefore responses may be biased.

Regarding hypothesis 8, we find no significant correlation between the intensity of competition on the tier 1 level (*Compet*) and cost transparency, development effort of the tier 1 supplier, or directed business.

Hypothesis 9, claiming that premium OEMs (*DUMMYPREM*) have less quality problems on the supplier level (*QualProb*) and try to obtain less cost transparency (*CostTransp*), is not confirmed by statistically significant bivariate correlations. Instead, we observe a positive correlation between being a premium OEM and engaging in directed business at the one percent significance level. Two possible explanations for this observation can be offered. First of all, hypothesis 9 holds and premium OEMs achieve overall higher quality. Yet, as noted before, they trade off quality on the sub-supplier level, which is not observed in our data, to quality on the tier 1 level. When OEMs do in fact care more about quality on the sub-supplier level, they will choose more directed business. The second explanation is that hypothesis 9 does not hold, even if this contradicts the common understanding of the objectives of a premium OEM. To assess which explanation applies, we can evaluate the answers of respondents when directly asked about the OEMs' motivating factors for directed business. In the survey, respondents could select out of at most 20 reasons for directed business and assess their importance. Table 3.10 provides the summary of the responses across OEM types, table 3.11 only the responses regarding premium OEMs, and table 3.12 regarding volume OEMs.[27] Overall, the most important reasons for directed business are that the OEM can gain information about costs from suppliers and the prices of the parts procured[28]. Nevertheless, also quality is regarded as important.[29] According to tables 3.11 and 3.12, premium OEMs in general put a higher importance to all reasons. However, the importance of quality relative to price is identical for premium and volume OEMs. Therefore, hypothesis 9 may in fact not hold and procurement strategies may not differ significantly between OEM types.

[27] Including OEMs producing trucks.
[28] See table 3.10, questions 2, 5, and 6.
[29] See question 7.

3.5.2 Econometric results

Hypothesis 1 to 3 treat directed business as the independent variable influencing quality incentives and procurement prices. In deciding for or against directed business, the OEM will of course be aware of these effects. Thus the decision to engage in directed business is, according to our hypotheses, a decision for more cost transparency, leading to more frequent renegotiations and lower prices, but that in return accepts lower quality incentives on the tier 1 supplier level. In addition, the sharing of development effort between the OEM, the tier 1 supplier and the sub-supplier may change. In the econometric model, directed business will be treated as the dependent variable and cost transparency, quality problems and development sharing as independents. However, all these variables are endogenous. An instrumental variables estimation is thus applied to address simultaneity.

When determining the regression model, we again face the problem of missing data on the sub-supplier product level. Thus instrumenting the sharing of development effort between the tier 1 supplier and the sub-supplier is not possible. Therefore, we will estimate a reduced, but instrumented model in a first stage. In a second stage and for the purpose of comparison, we also estimate an non-instrumented but broader model. The instrumented model is proposed as follows, with the parameters β representing the coefficients of the regression, δ the coefficients of the instruments[30], Z the matrix of instruments and ϵ the error terms. Variables with a line on top are instrumented.

$$\begin{aligned}
DirectBus &= \beta_0 + \beta_{Qual} \cdot \overline{QualProb} + \beta_{Trans} \cdot \overline{CostTransp} \\
&\quad + \beta_{DevOEM} \cdot \overline{DevShareOEM} + \epsilon \\
\text{with} & \\
\overline{QualProb} &= \delta_0^{Qual} + \delta^{Qual} Z + \epsilon^{Qual} \\
\overline{CostTransp} &= \delta_0^{Trans} + \delta^{Trans} Z + \epsilon^{Trans} \\
\overline{DevShareOEM} &= \delta_0^{DevOEM} + \delta^{DevOEM} Z + \epsilon^{DevOEM} \\
Z &= QualCost, RDstaff, Complex, \\
&\quad Compet, DUMMYPREM.
\end{aligned} \tag{3.10}$$

As instruments Z we propose the costs of quality problems ($QualCost$), which is independent of who pays these costs, the innovativeness ($RDstaff$), the complexity of the tier 1 part ($Complex$), intensity of competition ($Compet$),

[30] Please note that as Z is a matrix, δ as specified here is a matrix as well, except for the respective δ_0 coefficients.

the fluctuation range of production volumes ($VolFluct$) and the dummy variable for premium OEMs ($DUMMYPREM$). Complexity is measured by the amount of technical interfaces that a part has with the rest of the car in production. Interfaces during production are largely determined by the nature of the part concerned, and not by product design. Therefore complexity is considered largely exogenous. Furthermore, innovativeness in this context is considered to be largely exogenous. Indeed the OEM decides how technically innovative a part should be. However, this decision is exogenous to the decision how to procure such a part. In addition, we measure innovativeness by the R&D effort that the supplier exerts in this kind of product in general, which also should be largely exogenous. Supply contracts usually specify fluctuation ranges of future production volumes that imply menus of prices. This reflects the suppliers' need to be compensated for his fixed costs. By including these volume and price menus in contracts, the OEM can assess fixed versus variable costs of the supplier better and thus cost transparency increases. Thus the fluctuation range of production volumes ($VolFluct$) can serve as an instrument for cost transparency. Also the OEM's strategy, premium or volume, and the intensity of competition in the tier 1 supplier market are exogenous to the model considered and thus serve as instruments.

In a second step, we evaluate for the same sample whether higher cost transparency induces more frequent price renegotiations and whether price renegotiations induce higher price reductions. We will then instrument these variables by directed business.

$$\begin{aligned} Renegot &= \beta_0^{Renegot} + \beta^{Renegot} \cdot \overline{CostTransp} + \epsilon^{Renegot} \\ \text{with} & \\ \overline{CostTransp} &= \delta_0^{CostTransp} + \delta^{CostTransp} DirectBus + \epsilon^{CostTransp}. \end{aligned} \tag{3.11}$$

$$\begin{aligned} PriceRed &= \beta_0^{PriceRed} + \beta^{PriceRed} \cdot \overline{Renegot} + \epsilon^{PriceRed} \\ \text{with} & \\ \overline{Renegot} &= \delta_0^{Renegot} + \delta^{Renegot} DirectBus + \epsilon^{Renegot}. \end{aligned} \tag{3.12}$$

Table 3.3 presents the results of the linear two-stage least squares regression regarding directed business according to model 3.10.[31]

[31] We are well aware of the fact that more advanced econometric models than a linear regression may be suitable to our data, especially given the interval-coded responses received and the distribution of responses. As the theoretical model also implies an intensive instrumentation of variables, the linear regression still provides the most stable and reliable model to use, especially taken into account the size of the available data set.

Tab. 3.3: Instrumental variable regression: Directed business (*DirectBus*) as dependent variable

Variable	Coefficient	(Std. Err.)
QualProb	-0.138	(0.912)
DevShareOEM	0.917^{**}	(0.295)
CostTransp	$0.470^{\dagger}$	(0.261)
Intercept	-0.279	(0.189)
Instrumented:	QualProb, DevShareOEM, CostTransp	
Instruments:	Complex, QualCost, RDstaff, Compet, DUMMYPREM, VolFluct	
N	48	
R^2	0.249	
$F_{(3,44)}$	3.838	

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

As suggested by cross-correlations, cost transparency (*CostTransp*) is significant at the ten percent level in the regression and thus identified as a motivating factor for directed business, as predicted by hypothesis 2. The development effort of the OEM (*DevShareOEM*) is even more strongly significant in the regression and is shown to increase almost in parallel with the degree of directed business as β_{DevOEM} is close to 0.9. This confirms hypothesis 6. A higher coefficient of the OEMs development is not surprising if we consider that under directed business the OEM will at least take over the more coordination work of development. Thus the interaction between directed business and development effort of the OEM is much more immediate than that between cost transparency and directed business. Contrary to the cross-correlations, we do not find that quality problems (*QualProb*) have a significant impact on directed business as stated in hypothesis 1. This result can stem from two effects. First of all, the sample that forms the basis of the regression is small, due to missing values in one or several of the variables concerned. Thus a significant share of observations that were included in cross-correlations have fallen out of the analysis. Second, the instrumentation of the independent variables, notably quality problems, may not be perfect.

Tables 3.13 to 3.15 in the Appendix 3.8 present the regressions for the respective instruments. The frequency of quality problems is only weakly explained by the main instrument, the costs of such problems, which is potentially the reason for the insignificance in the regression on directed business. The most dominant instrument explaining the share of development effort is innovativeness, as predicted by hypothesis 7. Cost transparency is explained by innovativeness and the fluctuation range of production volumes, both at the five percent level.

To validate whether the variables employed are valid instruments, we also perform a standard linear regression with both independent variables and instruments, the results of which are presented in table 3.4. None of the instruments is significant on its own, confirming their applicability as instruments. In table 3.4, it can also be observed that cost transparency and development effort of the OEM have a significant impact on directed business. Their respective coefficients though change considerably. This result is as expected by standard econometric theory as for example in Wooldridge (2002) given the simultaneity problem and endogenous variables. Quality again is not significant.

Tab. 3.4: Linear regression: Directed business (*DirectBus*) as dependent variable, all other variables assumed independent

Variable	**Coefficient**	**(Std. Err.)**
QualProb	0.222	(0.199)
DevShareOEM	0.370**	(0.122)
CostTransp	0.317**	(0.082)
Complex	-0.032	(0.024)
QualCost	0.039	(0.024)
RDstaff	-1.481	(0.880)
Compet	-0.044	(0.031)
DUMMYPREM	0.031	(0.046)
VolFluct	0.104	(0.210)
Intercept	0.020	(0.138)
N	48	
R^2	0.615	
$F_{(9,38)}$	6.749	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

It is important to observe that in neither model, also not for the instrumentation, the OEM strategy and the level of competition are important for the results. We thus have to reject hypotheses 8 and 9. As we are lacking instruments on the sharing of development effort between the tier 1 and the sub-supplier, we will also for illustrative purposes perform a linear regression including these variables, but without instruments. Table 3.16 in the Appendix 3.8 presents the results and confirms again the significance of cost transparency and development effort by the OEM. Furthermore, the share of development undertaken by the sub-supplier is significant towards directed business at the five percent level. This indicates that hypothesis 5 may indeed hold. Furthermore, it may be an explanation for directed business by premium OEMs. As noted before, if the sub-products are highly important or their quality more critical to the overall vehicle than the quality of the tier 1 product, directed business should be undertaken by premium OEMs more frequently than by volume OEMs.

Given that cost transparency has been identified as a significant driver of directed business, we turn to the second model as presented in equations 3.11 and 3.12. Table 3.5 confirms that cost transparency leads to more frequent renegotiations at the five percent significance level in the linear two-stage least squares regression. Also directed business is a valid instrument for renegotiations. In turn, hypothesis 3 can be confirmed. On the other hand, hypothesis 4 is rejected in table 3.6. However, both regressions are based on a lower number of observations than the previous data, making the results less stable. In addition, the strong significance of cost transparency and renegotiation frequency in the previous findings still leads us to believe that directed business is undertaken, among others, to achieve lower prices. This view, as discussed in the preceeeding chapter, is also supported by the qualitative responses of the survey.

Tab. 3.5: Instrumental variable regression: renegotiation frequency (*Renegot*) as dependent variable

Variable	**Coefficient**	**(Std. Err.)**
CostTransp	0.546*	(0.322)
Intercept	0.274	(0.148)
Instrumented:	CostTransp	
Excluded instruments:	DirectBus	
N	41	
R^2	0-.	
$F_{(1,.)}$	2.735	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

The results of the econometric analysis should be read with one important aspect in mind. From over two hundred observations less than a quarter remain in the regression, which naturally reduces the significance of regres-

Tab. 3.6: Instrumental variable regression: price reductions (*PriceRed*) as dependent variable

Variable	Coefficient	(Std. Err.)
Renegot	1.435	(2.274)
Intercept	2.132	(1.182)
Instrumented:	Renegot	
Excluded instruments:	DirectBus	
N	38	
R^2	0-.	
$F_{(1,.)}$	.377	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

sion results.[32] We thus believe that the results from cross-correlations and the regression have to be viewed in their combination. The fact that both regressions and cross-correlations support the same hypotheses indicates that our results are more stable than the regressions alone suggest. Even those parts of the regression, that are not found significant, but where the respective variables exhibit significant correlations, indicate, although weakly, that the hypotheses in this respect can not be completely wrong.

3.6 Conclusion

We find that directed business, or centralization of contracting, leads to more cost transparency and more frequent renegotiations with the tier 1 supplier. This in turn indicates a decrease of informational rents of the supplier as predicted by theory. In this respect, our results contradict Klibanoff and Novak (2003). Directed business is chosen by the OEM to achieve a higher cost transparency and thus effectively lower prices. Even though we can not perfectly prove the latter point, we consider it fairly obvious, as there is no other reason for an OEM to seek more cost transparency. We agree with Klibanoff and Novak (2003) in the reduction of quality under directed business, even though our results are weak in this regard. The fact that tier 1 suppliers are less responsible for quality problems is nevertheless a convincing argument in this direction. It is not unrealistic to conclude that the reduced responsibility stems from the reduced incorporation of complementarity effects by the tier 1 supplier. One of the suppliers interviewed in the course of Müller, Stahl, and Wachtler (2007) explicitly confirmed this line of thought

[32] The data set thus contains a high number of missing values in different variables.

by stating that if the OEM selected the sub-supplier, quality in this area would be his responsibility, and not the responsibility of the tier 1 supplier. Thus we can also provide positive evidence in this direction of the theoretic literature. Furthermore, we hope to be able to contribute to the development of a unified approach that incorporates both asymmetric information and the provision of effort into a theoretical model.

From an industry point of view, we find it very surprising that the difference between premium and volume OEMs is low. Eventually, we could explain this phenomenon when analyzing the sub-supplier products that are procured through directed business by the different OEMs. Unfortunately, our data set does not contain the respective data. Albeit weakly, our results indicate that premium and volume OEMs have not yet realized the full implication of their procurement strategies and additional differentiation would be profit as well as efficiency enhancing. We thus hope that additional research will be able to further contribute to this discussion in the future.

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3.7 Appendix: Incentives for effort under delegation versus centralization

Let us illustrate the incentives to provide effort for quality under directed business DB versus delegated sourcing DS, i.e. when the tier 1 supplier selects its sub-supplier himself. We consider here a simple model of delegation versus centralization as an adaptation from Baliga and Sjöström (1998) or Macho-Stadler and Pérez-Castrillo (1998).

Consider a tier 1 supplier $T1$ and a sub-supplier SS. Both choose an effort level to produce a quality q_{T1} and q_{SS} respectively with $q_i, \in [0,1]$ with $i = [SS, T1]$. Quality denotes the probability that the respective product fails, i.e. needs to be replaced or repaired, thus a lower q_i represents a higher quality. Quantities supplied are normalized to 1. Profits of the suppliers are determined by the price for the part, the costs of providing a certain quality $C(q_i)$ and damages D_i that are paid in the event of a failed part. The game then evolves as follows:

1. The sub-supplier decides on his effort level and sets q_{SS}.
2. The tier 1 supplier decides on his effort level and determines q_{T1}.
3. The product is delivered to the OEM and sold in the final market.
4. The quality of the final product realizes, i.e. with probability q_i part i fails. With probability $\lambda, \lambda \in [0,1]$, failure of part i exerts a negative externality on good $j \neq i$ and induces it to fail as well. With technically highly interrelated parts this is a common scenario, consider for example a failing sealing that causes a ball-bearing to leak oil and thus fail as well. We then have the following cases to consider
   (a) With probability $q_{T1}(1 - q_{SS})(1 - \lambda)$, part $T1$ fails and SS does not fail.
   (b) With probability $q_{T1}(1 - q_{SS})\lambda$, part $T1$ fails and causes part SS to fail as well, even though SS was faultless.
   (c) With probability $q_{T1}q_{SS}$, both parts are faulty and fail.
   (d) With probability $q_{SS}(1 - q_{T1})\lambda$, part SS fails and causes part $T1$ to fail as well, even though $T1$ was faultless.
   (e) With probability $q_{SS}(1 - q_{T1})(1 - \lambda)$, part SS fails and $T1$ does not fail.

5. When a part fails, the responsible supplier has to pay damages D_i. The damages represent the costs of repair and replacement of this part. In the automotive industry, one of the key challenges in this respect is the case of "trouble not found". A certain share of failures in vehicles, most commonly in the case of more advanced parts of the vehicle, can not be traced back to the cause of failure. In this simplified model, we assume than in all events where both parts fail, the source of the cause can not be identified. In this case, directed business is handled differently from delegated sourcing

   - Under delegated sourcing DS, the tier 1 supplier is fully responsible for the conglomerate of parts supplied. Thus if both parts fail, he has to pay damages $D_{T1} + D_{SS}$ to the OEM. If only one part fails and does not cause the second part to fail as well, only damages D_i have to be paid by the responsible supplier $T1$ or SS respectively. In the case of failure of part SS, $T1$ pays for the damages to the OEM and recoups the same amount from SS.
   - Under directed business DB, each supplier is only made responsible for failure of his part given that this is clearly identifiable. The risk of both parts failing and of "trouble not found" is borne by the OEM.

The suppliers' expected profits under the two sourcing regimes then are

$$\begin{aligned}
\pi_{T1}^{DS} &= (p_{SS} + p_{T1}) - p_{SS} - C(q_{T1}) - q_{T1}(1 - q_{SS})(1 - \lambda)D_{T1} \\
&\quad - q_{SS}(1 - q_{T1})(1 - \lambda)D_{SS} + q_{SS}(1 - q_{T1})(1 - \lambda)D_{SS} \\
&\quad - \left(q_{T1}(1 - q_{SS})\lambda + q_{SS}(1 - q_{T1})\lambda + q_{T1}q_{SS}\right)(D_{SS} + D_{T1}) \\
\pi_{T1}^{DB} &= p_{T1} - C(q_{T1}) - q_{T1}(1 - q_{SS})(1 - \lambda)D_{T1} \\
\pi_{SS}^{DS} &= \pi_{SS}^{DB} = p_{SS} - C(q_{SS}) - q_{SS}(1 - q_{T1})(1 - \lambda)D_{SS}. \qquad (3.13)
\end{aligned}$$

We can immediately simply π_{T1}^{DS} to

$$\begin{aligned}
\pi_{T1}^{DS} &= p_{T1} - C(q_{T1}) - q_{T1}(1 - q_{SS})(1 - \lambda)D_{T1} \\
&\quad - \left(q_{T1}\lambda + q_{SS}\lambda + q_{T1}q_{SS}(1 - 2\lambda)\right)(D_{SS} + D_{T1}). \qquad (3.14)
\end{aligned}$$

We furthermore require that producing higher quality, i.e. a lower q_i, is more costly and that the marginal costs of producing higher quality increase such that[33]

$$\frac{\partial C(q_i)}{\partial q_i} < 0$$

[33] An example may be the function $C(q) = (1 - q)^2$.

$$\frac{\partial C(q_i)^2}{\partial q_i^2} > 0. \tag{3.15}$$

We now analyze the incentives of both suppliers to set the quality q_i. For the sub-supplier, the profit function and thus quality $\hat{q}_{SS}$ will be the same under delegated sourcing and directed business. On the other hand, the tier 1 supplier's profits function differs with the sourcing regime. By taking the derivative of profits with respect to quality we can show the following:

$$\begin{aligned}
\frac{\partial \pi_{T1}^{DS}}{\partial q_{T1}} &= -\frac{\partial C(q_{T1})}{\partial q_{T1}} - (1-q_{SS})(1-\lambda)D_{T1} \\
&\quad - (\lambda + q_{SS}(1-2\lambda))\,(D_{SS}+D_{T1}) \\
\frac{\partial \pi_{T1}^{DB}}{\partial q_{T1}} &= -\frac{\partial C(q_{T1})}{\partial q_{T1}} - (1-q_{SS})(1-\lambda)D_{T1}
\end{aligned} \tag{3.16}$$

Under both sourcing regimes, a lower failure probability q_{T1} decreases the expected costs of failure but increases the costs of production as $\frac{\partial C(q_i)}{\partial q_i} < 0$. Under delegated sourcing, π_{T1}^{DS} is more sensitive to failures. Hence the expected costs of failure are higher as long as $\lambda + q_{SS}(1-2\lambda) \geq 0$, which induces a higher effort for a lower q_{T1}. This condition holds for all $q_{SS}, \lambda \in [0,1]$. Not that it is independent of D_{T1} and D_{SS}. Thus under delegated sourcing, the tier 1 supplier has an incentive to produce higher quality than under directed business. This effect occurs because the tier 1 supplier internalizes the external effects between both parts which are borne by the OEM under directed business.

Note that the OEM could also incentivize both the tier 1 and the sub-supplier in any sourcing regime by setting a higher D_i. In this simple model, we assume though that the OEM can not demand a D_i that is higher than his own cost of failure (in the end market). This is a reasonable assumption given that we can expect any failure costs to in the automotive industry to be reasonably transparent to all parties, thus making an over-charging in D_i unrealistic. Besides, there are also strong legal barriers that do not allow the OEM to charge more than the real costs D.[34] In fact, the costs that the OEM can demand back from suppliers will be rather below his own costs if one takes into account the reputational effects that a failing vehicle has on the OEM, even if this failure was caused only by suppliers' parts.

We also do not model here a difference in D_i between the sourcing regimes, which would also shift incentives to provide quality. Given that the upper bound on D_i is given by the actual damage costs induced, generating differences in D_i would only reduce incentives to a lower than optimal level

[34] As e.g. put forward in the documents on quality management and purchasing conditions of the VDA.

from the point of view of the OEM. There may then be a trade-off between lower damage payments, hence lower quality incentives, and otherwise higher prices. But given the upper bound on D_i and no problems of limited liability, the OEM should always try to charge the supplier the upper bound of D_i, knowing that this will provide optimal quality incentives.

This simple model does not analyze the price setting game but one can easily add this, if desired. If the price is unrelated to quality and costs of failure, the marginal effects remain unchanged to the preceding analysis. Thus prices p_{T1}^{DS}, p_{T1}^{DB}, p_{SS}^{DS} and p_{SS}^{DB} can be used to redistribute profits as desired. In any bargaining situation where suppliers and the OEM share expected profits, prices except for p_{T1}^{DS} will depend on quality. Thus suppliers' incentives to produce higher quality increase under directed business, while the incentives for the tier 1 supplier under delegated sourcing remain unchanged, given that he already fully internalizes all marginal effects. Nevertheless, as long as suppliers do not earn all surplus from a transaction, the spirit of the analysis still holds.

If λ is common knowledge and the production is repeated, the procurer can in the long term derive from failure rates the effort level chosen by each supplier. Then contracts can be written such that optimal effort is chosen by suppliers in both regimes.

3.8 Appendix: Tables

Tab. 3.7: Responses regarding the frequency of directed business (*DirectBus*)

Response	Observations N	Percent
Never	80	37.4
Very rarely	44	20.6
Rarely	46	21.5
In ca. half the cases	20	9.3
Frequently	19	8.9
Very frequently	5	2.3
Total	214	100

Tab. 3.8: Cross-correlations: Pearson Correlation, (Std.Dev.), N

Variables	DirectBus	QualProb	QualCost	CostTransp
DirectBus	1			
	214			
QualProb	.214*	1		
	(0.017)			
	123	123		
QualCost	-0.014	.316**	1	
	(0.879)	(0)		
	121	121	121	
CostTransp	.263**	0.02	-0.036	1
	(0.001)	(0.844)	(0.729)	
	157	97	95	157
Renegot	0.105	-0.093	-0.125	.216**
	(0.198)	(0.38)	(0.24)	(0.009)
	153	92	91	146
PriceRed	0.052	0.027	0.158	0.103
	(0.536)	(0.81)	(0.152)	(0.232)
	142	84	84	136
DevShareSS	.394**	0.156	0.044	0.152
	(0)	(0.106)	(0.651)	(0.067)
	185	109	107	145
DevShareT1	-.230**	-0.092	.301**	-0.051
	(0.002)	(0.339)	(0.002)	(0.539)
	185	109	107	145
DevShareOEM	.206*	-0.119	-0.186	0.073
	(0.014)	(0.244)	(0.07)	(0.495)
	141	98	96	90
Testing	-0.151	0	0.028	-0.183
	(0.051)	(0.997)	(0.763)	(0.051)
	168	123	121	114
QualResp	-.182*	0.172	-0.084	-0.185
	(0.024)	(0.062)	(0.369)	(0.056)
	154	118	116	108
RDstaff	-0.171	0.061	0.145	.276†
	(0.051)	(0.557)	(0.165)	(0.005)
	131	95	93	100
Compet	-0.055	0.079	.244*	0.03
	(0.505)	(0.41)	(0.011)	(0.751)
	148	110	108	114
Complex	-.179*	0.075	-0.047	-0.034
	(0.03)	(0.439)	(0.632)	(0.72)
	148	110	108	114
VolFluct	0.047	-0.117	0.121	0.276**
	(0.575)	(0.245)	(0.235)	(0.002)
	146	101	99	123
DUMMYPREM	.187**	-0.026	0.086	0.068
	(0.006)	(0.779)	(0.347)	(0.398)
	214	123	121	157

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

...Tab. 3.8 continued

Variables	Renegot	PriceRed	DevShareSS	IDevShareT1
Renegot	1			
	153			
PriceRed	-0.135	1		
	(0.112)			
	140	142		
DevShareSS	-0.043	-.257**	1	
	(0.615)	(0.003)		
	138	130	185	
DevShareT1	0.146	0.119	-.471**	1
	(0.088)	(0.179)	(0)	
	138	130	185	185
DevShareOEM	0.08	-0.001	0.024	-.205*
	(0.467)	(0.991)	(0.787)	(0.021)
	85	79	126	126
Testing	-0.098	.207*	-.198*	-0.088
	(0.308)	(0.037)	(0.016)	(0.286)
	109	101	149	149
QualResp	-0.053	0.014	-0.075	0.015
	(0.597)	(0.89)	(0.386)	(0.859)
	103	96	136	136
RDstaff	-0.107	.244*	-0.048	0.08
	(0.295)	(0.019)	(0.606)	(0.386)
	97	92	118	118
Compet	0.072	0.014	-0.028	.171*
	0.(453)	(0.886)	(0.748)	(0.05)
	111	100	133	133
Complex	0.129	0.066	-.255**	0.162
	(0.176)	(0.513)	(0.003)	(0.063)
	111	100	133	133
VolFluct	0.157	-0.024	-0.002	0.014
	0.089	(0.807)	(0.982)	(0.87)
	(118)	108	133	133
DUMMYPREM	-0.031	-0.06	0.095	-0.137
	(0.702)	(0.479)	(0.2)	(0.063)
	153	142	185	185

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

...Tab. 3.8 continued

Variables	DevShareOEM	Testing	QualResp	RDstaff
DevShareOEM	1			
	141			
Testing	.349**	1		
	(0)			
	141	168		
QualResp	-0.088	0.006	1	
	(0.318)	(0.946)		
	130	154	154	
RDstaff	-.282**	-0.126	0.14	1
	(0.006)	(0.182)	(0.162)	
	95	113	101	131
Compet	0.069	-0.009	-0.042	.546**
	(0.477)	(0.919)	(0.652)	(0)
	108	129	116	131
Complex	-0.134	.289**	-0.034	-0.107
	(0.168)	(0.001)	(0.716)	(0.223)
	108	129	116	131
VolFluct	0.074	-0.022	-0.086	0.071
	(0.475)	(0.813)	(0.368)	(0.496)
	96	119	112	94
DUMMYPREM	0.054	-0.101	-0.096	-0.149
	(0.524)	(0.194)	(0.235)	(0.089)
	141	168	154	131

Significance levels : † : 10% $*$: 5% $**$: 1%

...Tab. 3.8 continued

Variables	Compet	Complex	VolFluct	DUMMYPREM
Compet	1			
	148			
Complex	-0.137	1		
	(0.098)			
	148	148		
VolFluct	-0.006	0.049	1	
	(0.953)	(0.609)		
	109	109	146	
DUMMYPREM	0.012	-0.123	-0.056	1
	(0.884)	(0.137)	(0.505)	
	148	148	146	214

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Tab. 3.9: Responsibility for solving quality problems

Variable	Mean	Std. Dev.	N
QualResp_SST1	1.37	0.498	146
QualResp_SSOEM	2.73	1.015	126
QualResp_SSjoint	2.19	0.678	126

Answer 1 = Always the tier 1 supplier, 5 = Always the OEM

QualResp_SST1 = Tier 1 supplier selects sub-supplier

QualResp_SSOEM = OEM selects sub-supplier

QualResp_SSjoint = Both select sub-supplier jointly

Tab. 3.10: Importance of factors for directed business

Variable	Mean	Std. Dev.
1. Contracting and coordination costs	1.951	1.671
2. Transfer of cost information from suppliers	2.599	1.823
3. Protection of OEMs' technical know-how	2.105	1.61
4. OEMs' development efforts	1.87	1.496
5. Purchase price of the entire system/module	2.784	1.936
6. Purchase price of the part supplied by the sub-supplier	2.772	1.839
7. Risk minimisation with respect to quality	2.556	1.672
8. Risk minimisation with respect to development success	2.284	1.621
9. Transfer of exogenous risks	1.852	1.529
10. Degree of innovativeness of the sub-supplier part	2.16	1.595
11. Degree of innovativeness of the tier 1 part	2.049	1.544
12. Importance of the sub-supplier part in the vehicle	2.525	1.706
13. Importance of the tier 1 part in the vehicle	2.358	1.678
14. Enforcement of the OEMs' bargaining power	2.401	1.757
15. Standardisation or platform strategy	2.309	1.673
16. Multiple sourcing	2.056	1.581
17. Trust in the sub-supplier	2.278	1.581
18. Trust in the tier 1 supplier	2.327	1.664
19. Long-term cooperation with the sub-supplier	2.309	1.624
20. Long-term cooperation with the tier 1 supplier	2.302	1.619
N	162	

Answer 0 = Not relevant, 1 − 5 = Very low to very high importance

Tab. 3.11: Importance of factors for directed business: Premium OEMs

Variable	**Mean**	**Std. Dev.**
1. Contracting and coordination costs	2.095	1.676
2. Transfer of cost information from suppliers	2.845	1.76
3. Protection of OEMs' technical know-how	2.464	1.579
4. OEMs' development efforts	2.036	1.452
5. Purchase price of the entire system/module	3.119	1.846
6. Purchase price of the part supplied by the sub-supplier	3.048	1.783
7. Risk minimisation with respect to quality	2.869	1.581
8. Risk minimisation with respect to development success	2.5	1.533
9. Transfer of exogenous risks	1.976	1.472
10. Degree of innovativeness of the sub-supplier part	2.393	1.529
11. Degree of innovativeness of the tier 1 part	2.238	1.445
12. Importance of the sub-supplier part in the vehicle	2.738	1.651
13. Importance of the tier 1 part in the vehicle	2.583	1.6
14. Enforcement of the OEMs' bargaining power	2.738	1.715
15. Standardisation or platform strategy	2.512	1.617
16. Multiple sourcing	2.321	1.554
17. Trust in the sub-supplier	2.524	1.501
18. Trust in the tier 1 supplier	2.488	1.579
19. Long-term cooperation with the sub-supplier	2.571	1.515
20. Long-term cooperation with the tier 1 supplier	2.571	1.499
N	84	

Answer 0 = Not relevant, 1 − 5 = Very low to very high importance

Tab. 3.12: Importance of factors for directed business: Volume OEMs

Variable	Mean	Std. Dev.
1. Contracting and coordination costs	1.815	1.68
2. Transfer of cost information from suppliers	2.352	1.881
3. Protection of OEMs' technical know-how	1.666	1.541
4. OEMs' development efforts	1.651	1.52
5. Purchase price of the entire system/module	2.45	1.993
6. Purchase price of the part supplied by the sub-supplier	2.481	1.883
7. Risk minimisation with respect to quality	2.203	1.712
8. Risk minimisation with respect to development success	2.045	1.696
9. Transfer of exogenous risks	1.714	1.592
10. Degree of innovativeness of the sub-supplier part	1.894	1.655
11. Degree of innovativeness of the tier 1 part	1.818	1.644
12. Importance of the sub-supplier part in the vehicle	2.318	1.755
13. Importance of the tier 1 part in the vehicle	2.093	1.731
14. Enforcement of the OEMs' bargaining power	1.993	1.718
15. Standardisation or platform strategy	2.065	1.718
16. Multiple sourcing	1.737	1.579
17. Trust in the sub-supplier	2.018	1.659
18. Trust in the tier 1 supplier	2.168	1.78
19. Long-term cooperation with the sub-supplier	2.05	1.73
20. Long-term cooperation with the tier 1 supplier	2.025	1.723
N	78	

Answer 0 = Not relevant, $1-5$ = Very low to very high importance

Tab. 3.13: Instrumental variable regression: regression for *QualProb* as instrument

QualProb	**Coefficient**	**(Std. Err.)**
Complex	-0.005	(0.019)
QualCost	0.023	(0.019)
RDstaff	0.611	(0.593)
Compet	0.000	(0.024)
DUMMYPREM	0.013	(0.036)
VolFluct	-0.043	(0.161
Intercept	0.132	(0.102
N	48	
R^2	0.097	
$F_{(6,41)}$	0.73	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Tab. 3.14: Instrumental variable regression: regression for *DevShareOEM* as instrument

DevShareOEM	**Coefficient**	**(Std. Err.)**
Complex	-0.041	(0.031)
QualCost	0.006	(0.031)
RDstaff	-2.697**	(0.975)
Compet	0.066	(0.039)
DUMMYPREM	0.057	(0.059)
VolFluct	0.171	(0.265)
Intercept	0.424*	(0.167)
N	48	
R^2	0.230	
$F_{(6,41)}$	2.04	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Tab. 3.15: Instrumental variable regression: regression for *CostTransp* as instrument

CostTransp	**Coefficient**	**(Std. Err.)**
Complex	-0.023	(0.046)
QualCost	0.017	(0.046)
RDstaff	3.088*	(1.443)
Compet	-0.046	(0.058)
DUMMYPREM	0.098	(0.087)
VolFluct	0.704†	(0.392)
Intercept	0.239	(0.248)
N	48	
R^2	0.190	
$F_{(6,41)}$	1.60	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Tab. 3.16: Linear regression: Directed business (*DirectBus*) as dependent variable, independent variables including the sharing of development between the tier 1 and the sub-supplier

Variable	**Coefficient**	**(Std. Err.)**
QualProb	0.221	(0.152)
CostTransp	0.235**	(0.069)
DevShareSS	0.318*	(0.125)
DevShareT1	0.011	(0.109)
DevShareOEM	0.343**	(0.095)
Intercept	-0.141	(0.113)
N	70	
R^2	0.45	
$F_{(5,64)}$	10.489	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

4. THE EFFECT OF FREE TRADE AGREEMENTS ON THIRD COUNTRIES IN MARKETS WITH DIFFERENTIATED GOODS

4.1 Motivation

Let us think of a world with international trade restricted by tariffs. What are the implications when a subset of countries signs a free trade agreement (FTA)? In particular, what happens to the welfare of the rest of the world?

The standard answer to this question is explained through the "innocent bystander problem" (Krugman, 1991): the countries left out of an FTA suffer in welfare. The reduction in welfare is primarily due to trade diversion: joining countries trade more with each other because of lower after-tariff prices, even though there is a potentially more efficient producer in the rest of the world. Some literature on the innocent bystander problem is reviewed in the next section.

In contrast, we show that under some conditions, an FTA between a subset of countries can also benefit the non-participating countries. To present this result, we employ a model of international trade with horizontally differentiated products. For different parameters within the same model, we also re-establish the "innocent bystander" result. Thus, we can highlight the conditions under which the traditional result holds or breaks down.

The intuition behind our results is simple. The FTA between two countries reduces trade barriers and thus increases competition between their firms. In our model, the resulting price reduction in two countries leads to a global reduction in prices. Surplus then is redistributed from firms to consumers, which is a standard result. In addition, however, increased competition also leads to a more equal pricing pattern across countries, which reduces the average disutility cost borne by consumers for consuming a product mix not in line with their (non-price) preferences. This is a pure global welfare creation. For a third, non-FTA country, the reduction of its firms' profits due to increased competition re-establishes the trade diversion effect in the literature. However, if that country's consumer population is large, the country's consumer surplus addition will be larger than its firms' losses and thus it will benefit from the FTA.

A key feature of our model is the non-existence of perfect price-discrimination across countries. Each of our firms has a home country but sells its goods globally. Price-discrimination is constrained in our model by potential cross-border arbitrage of consumers. When a firm raises or lowers its prices in one country, its prices in another country will then change equally. Our findings do not necessarily require that prices of a firm are equal everywhere, but we will assume this for simplicity reasons, without loss of generality. That price movements between countries are correlated and there is no perfect price discrimination is supported by several findings (see, e.g., Knetter, 1993).

In the next section, we review the relevant literature and highlight our differences and similarities. In Section 4.3, we introduce a two-country model to familiarise the reader with the workings of the model, before we move on to the welfare analysis in a multi-country case. Section 4.4 concludes.

4.2 Literature

Our paper relates to two strands of literature. The first strand of literature involves the “innocent bystander problem” (Krugman, 1991), which, as the name suggests, discusses adverse effects for third countries left out of an FTA between other countries. To the best of our knowledge, authors in this literature concur with this assessment. In contrast, we highlight conditions under which the country that does not participate in an FTA is happy to be an innocent bystander.

Of course, it has to be noted that *global* barrier-free trade is welfare-maximising in our model. However, the third country will not object to an FTA between others, because it is a welfare improvement relative to the case of all-around protection, not only for the FTA-countries but even for that third non-participating country.

The examples of an “innocent bystander problem” in literature are abundant: Kose and Riezman (1997, 1999) compute a general equilibrium model with asymmetric countries and examine two cases: Case 1, when a small country is left out of the FTA made up of two large countries, and Case 2, when one large country is left out of the FTA made up of the remaining large and small countries (Kose and Riezman, 1999). They find, among other results, that in Case 1, the small innocent bystander suffers a lot, and in proportion to its relative smallness. Also in Case 2, the third large country loses from the FTA because of a deterioration in its terms of trade.

Bond, Riezman, and Syropoulos (2004) show how the third country can win from the creation of an FTA between two other countries, through the strategic incentives of the FTA members to change their outside tariff policy after the creation of the FTA (cited in Andriamananjara, 2004). When such effects are not present, the third country typically loses; in contrast, we find conditions where the third country (and the world, in total) benefits without any strategic re-adjustment of tariffs by any country.

Andriamananjara (2004) shows that the countries left out of the FTA have an incentive to retaliate with their own trading bloc or with increased protection.

Winters and Chang (2000) and Chang and Winters (2002) discuss what happens to the non-members’ firms when several countries enter into an FTA and drop the tariffs against members. The non-member countries’ exporters to the member countries face the competition from the member countries' firms. Thus, as the member tariffs go down, the member countries' firms become more competitive, which puts pressure onto the non-member firms to lower their prices. Like in the present paper, this is an effect on the prices of imports that results purely from competition: Winters and Chang (2000) show this empirically for the case of Spain and EC, and, respectively, Chang and Winters (2002) for the case of MERCOSUR.

Ornelas (2007) provides a partial equilibrium model with differentiated goods, with redistributional effects of an FTA: that is, the FTA redistributes the welfare from third countries to the member countries, even if the countries are small compared to the rest of the world (but large enough to influence their own import prices). In our model, too, member countries can appropriate a part of non-member welfare, but this is not the only effect.

The second strand of literature introduces Hotelling line into the international trade framework, either as a spatial economy with countries occupying different segments of the Hotelling line, or as differentiated markets in different countries, connected via trade (think of two parallel Hotelling lines as two countries, see Schmitt, 1990, 1993, 1995), and asks a question of optimal trade policy.

When a spatial economy is involved, it is found that under some conditions the optimal tariff rate is strictly positive: if the companies are able to relocate, a tariff may induce a company to locate away from the border, thus leading to lower average transportation costs inside a country, and hence lower delivered prices to the consumers (Herander, 1997; Porter, 1984). In our framework, free trade is always optimal for the world as a whole. A FTA between a subset of countries is welfare-improving compared to fully restricted trade, but the distribution of the generated surplus between member and non-member countries depends especially on their respective size.

Benson and Hartigan (1983) propose a spatial model with a set-up similar to ours. However, they discuss only the case of two countries, therefore the effect of a tariff on third countries is not discussed. The authors focus on the redistributional effects of a tariff on consumer surplus. They find that if a domestic firm is protected by a tariff on imported goods, it may under some conditions still lower its price relative to the situation without the tariff. Yet this results requires specific assumptions on firms' behaviour and certain specifications of the demand function of consumers. In our model, we concentrate on the effect of a tariff on a third country. In addition, we avoid avoid specific assumptions on firms' behaviour or consumer demand, and therefore a tariff unambiguously increases the price of the protected firm in our model.

4.3 The model

To study the effect of an FTA on the welfare of the non-member countries, we propose a partial equilibrium three-country model of trade in differentiated goods, in the Hotelling style. Two countries will form an FTA, and we will focus on the welfare of the non-FTA country. No effects are lost with the restriction to only three countries.

Our model can represent a world of connected spatial "line" economies, where the ends of the line stand for address-of-sale of otherwise identical goods, and consumers live along these lines at different distances from the points-of-sale. Thus, each line represents the area between the economic centres of two of the three countries, with the border somewhere on that line.

On the other hand, the model also conforms with a "tastes" interpretation, in which the ends of the line represent (national) characteristics of the goods, and consumers are distinguished by how much they prefer one country's good over another's at given prices. As in the spatial interpretation, there is a border between each pair of countries, which mainly serves to distinguish countries by their size. We prefer this second, "tastes" approach.

Countries in our model are asymmetric in the size of their population. In the "geographic" interpretation, this implies that at given population density, consumers will be more dispersed in the large than in the small country. In the "tastes" interpretation, this means that the preferences in the large country are more dispersed. In fact, there is weak evidence that large countries are in fact more diverse (see Rose, 2006). It would also be possible to disentangle the number of consumers and their dispersion with no gain of insight but at a cost of losing simplicity.[1]

We consider a partial equilibrium analysis of one industry, similar to Ornelas (2007).[2] Our industry is small in the sense that the prices in this industry do not affect prices (and thus marginal decisions) in any other industry or market (including factor markets).

Within this industry, firms compete globally in differentiated products.

[1] Note that as discussed before, models with similar setups as ours have been used before in the international trade context, e.g., (Benson and Hartigan, 1983; Herander, 1997; Porter, 1984). Therefore we consider this to be a realistic setup.

[2] The model can be closed by an introduction of a competitively produced and traded numeraire good, which serves to balance the trade and fix labour income, but this is not our focus. None of our main results would change. In particular, the results of creation of consumer surplus though a more symmetric consumption of the differentiated good in an asymmetric-country world would still hold. The partial equilibrium nature of our model lets us concentrate on the imperfect competition in our chosen industry, and the associated effects.

For our results, it suffices that the firms' price setting in various countries is inter-dependent: i.e., when a firm lowers its price in one country, its price in another country must also decrease, and vice versa. Firms may still set different prices between countries, but we abstract from this for simplicity of the model exposition and with no loss of generality.

To motivate parallel price changes of a firm across countries, arbitrage through parallel imports as discussed e.g. by Malueg and Schwartz (1994) is an immediate argument. Tariffs or other barriers-to-trade will limit arbitrage and thus price discrimination may occur. However, arbitrage will still ensure that price changes through exogenous shocks go into the same direction everywhere.

Two examples shall be discussed in more detail: the automotive and the textile market. In the European automotive market, international price discrimination has been shown to exist e.g. by Ginsburgh (1994) over a long period of time.[3] By virtue of exemption from complying with Article 85 of the European Common Market Treaty, as well as purely illegal activities, the European automotive industry has set up many and varying barriers to cross-border trade in cars. However, even given widespread cross-border price discrimination, the price *movements over time* are still correlated. Table 4.1 at the end of the paper shows cross-market price correlations for selected car models across several geographic markets during 1970–1999. Within continental Europe, the price correlations are above 90 percent. The correlations between the continental and the UK markets are never below 77, and often above 90 percent.[4] The relatively low UK-related correlation might be best explained by differences in the driver's wheel position.

The textile market is subject to tariff negotiations in and with Europe, due to perceived threat of cheap Chinese and Indian textile products. This market would be prime for price discrimination. However, textiles are often traded at several textile expositions, where the buyers come from all over the world to buy centrally, at one price. An example is the Texworld Fabrics fair in Paris, organised by Messe Frankfurt.

Governments set tariffs at the border.[5] We assume that tariffs apply equally in both directions: with countries asymmetric in size, this assump-

[3] The article by Ginsburgh (1994) has also been revised and in its latest version in 1997 still concurs with this conclusion.

[4] The European Commission has been actively trying to reduce price discrimination in recent years. If a convergence of prices has in fact occurred, such a convergence will have had a negative effect on the stated correlations, as prices then move in opposite directions. Thus the true underlying correlation would be even higher.

[5] Tariffs are either paid by firms or consumers on a purchase: these settings are equivalent, in our model.

tion is not binding, for trade only happens in one direction in our industry. We concentrate on the case of asymmetric countries, as it provides the most interesting insights; our model is Ricardian in nature, such that symmetric countries do not trade—the discussion of this case is relegated to the Appendix 4.5. Firms pay the tariffs when exporting into a foreign country. Furthermore for the firms, we assume zero marginal cost of production. As we model market power within our industry, we assume one firm in each country.

Next, we present the details of the model and establish results in a setting with two asymmetric countries to familiarise the reader with the workings of the model, before analysing the welfare implications of tariff movements in a three-country setting in Section 4.3.2.

We attempt to explicitly state and discuss every critical assumption as we go on.

4.3.1 Two asymmetric countries

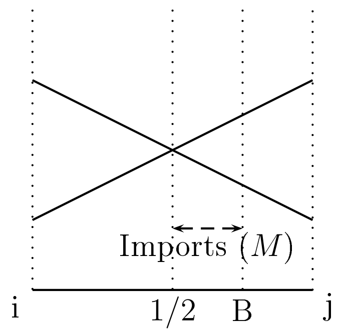
In the case of two countries, our model is a version of a Hotelling (1929) model. There are two products, i and j, sold in the global market, which is represented by a line of length s normalized to unity. The ends of this line constitute the point of sale of these two products. Consumers are distributed along this line from 0 to 1 with constant density $f(x) = 1$ and thus have a total mass of one (so the CDF $F(1) = 1$). Somewhere on the line is a border B, such that the segment $[0, B)$ represents consumers of one country, and the segment $(B, 1]$ the consumers of the other country.

The location x of a consumer on the line depicts that consumer's (non-price) preferences over the products. The further away x is from the point of sale at 0 or 1, the lower the utility of consuming the respective product. This can be interpreted either geographically such that consumers incur travel costs when purchasing at 0 or 1, or as tastes where distance relates to disutility because product characteristics do not fully match the preferences. As an example for the tastes interpretation, take the car market in Germany and France: the point of sale in France would then correspond to "Frenchness" and the consumers would be distinguished by how much they prefer, all else equal, a French car over a German one or vice versa.[6]

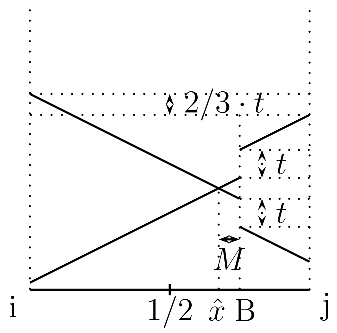
Consumers are utility maximisers and buy one or zero units of a good of at most one of the countries present. Consumers closer to the border have a stronger preference for buying a foreign product, at given prices, than

[6] The taste dispersion can also correspond to geography. Casual observation in Germany shows that Saarland has many more French cars than Bavaria. Indeed, the official police cars in Saarland are Peugeot, while in Bavaria they are BMW or Audi.

their fellow citizens from the "centre" of the country. Consumers at 1/2 are indifferent between buying domestic or foreign good, at equal prices. An example of the model is depicted in Fig.4.1.



(a) Free trade, two countries



(b) Trade with tariff

Fig. 4.1: Free trade and tariff with two asymmetric countries

A consumer located at x with $0 \leq x \leq B$ has an additive separable utility from consuming his domestic good i or the foreign good j such that:

$$u_x(p_i) = a - p_i - r \cdot |x - 0| , \tag{4.1}$$

$$u_x(p_j) = a - p_j - t - r \cdot |1 - x| , \tag{4.2}$$

The parameter a is the maximal utility from consumption, p_i and p_j are company i's and respectively j's prices, t is the tariff that the consumer has to pay when purchasing the foreign product and r is the transportation costs or reduction in utility because the consumed product is away from the individual preferences.[7]

The above utility function refers to a consumer x living in country i, i.e. with $0 \leq x \leq B$. The utility for a consumer x in country j, i.e., with $B \leq x \leq 1$, is symmetric in the sense that a consumption from i costs an additional t while consuming the domestic product j only costs p_j plus $r \cdot (1 - x)$.

The countries presented are asymmetric only due to their relative population sizes. If the border between countries i and j lies closer to where the

[7] Assuming another well-used form of the transportation cost function—the quadratic transportation costs—will make distance even more important and should strengthen the results presented in this paper.

good j is positioned, i is said to be *large* compared to j. Then i has more consumers and more dispersed preferences. At equal prices, the average consumer of country i prefers good i, while the reverse holds for country j. This is true irrespective of the size of the country.

We assume that at zero prices and a tariff $t = 0$, every consumer would have a positive utility from buying one of the products.[8] That is, we restrict our exogenous parameters to those values that lead to an effective equilibrium between both countries at $t = 0$. This in particular requires $a - \frac{3}{2}r \cdot 1 \geq 0$, or: $a \geq \frac{3}{2}r$. This is the same as saying that the market is covered.[9]

In each country, there is one profit-maximising firm. Thus there will be one firm i and one firm j, selling their products at 0 and 1 respectively. Firms have zero marginal cost and set prices to maximise profit. If the market is covered, the quantities demanded at a given price are then determined by the distance to the consumer $\hat{x}$ who is indifferent between their and their rival's products. The indifferent consumer can be found at the intersection of the consumer utility curves in Fig.4.1, which due to the tariff include discontinuities at the border. The firms' profit functions are then as follows:

$$\begin{aligned} \pi_i &= \hat{x}(p_i, p_j) \cdot p_i \\ \pi_j &= (1 - \hat{x}(p_i, p_j)) \cdot p_j. \end{aligned} \tag{4.3}$$

We now solve this simple model with two countries for the equilibria with and without tariffs. We set the border at $\frac{1}{2} < B < 1$, such that i is a large and j a small country.

Without a tariff and with equal prices, consumers in country i with $\frac{1}{2} < x \leq B$ will purchase the foreign product from country j. The consumer in country i who is indifferent between the domestic and the foreign good is at $\hat{x} = \frac{1}{2}$, such that there are imports of size $M = B - \hat{x}$ from country j into country i.[10] This is depicted in Fig.4.1(a).

Let us now introduce a tariff t—as in Fig.4.1(b):

Lemma 1. *Assume the market is covered ($a \geq \frac{3}{2}r$). If the countries are sufficiently asymmetric and the tariff t is sufficiently low, there exists an equilibrium with imports from the small into the large country.*

Proof. Assume that there are imports from j into i even under the tariff such that the indifferent consumer lies at $\hat{x} < B$. We then solve for the equilibrium prices:

[8] The utility from consuming a hypothetical outside good is normalized to 0.

[9] For a detailed discussion of what happens if the market is *not* covered, and the resulting equilibria, please refer to Ivanov and Müller (2006).

[10] Prices will be symmetric at $p_i = p_j = r$. This is the standard Hotelling result.

$$
\begin{aligned}
\pi_i &= \hat{x} \cdot p_i = && (\frac{1}{2r}(p_j - p_i + t) + \frac{1}{2}) \cdot p_i \\
\pi_j &= (1-\hat{x}) \cdot p_j = && (\frac{1}{2r}(p_i - p_j - t) + \frac{1}{2}) \cdot p_j \\
&\Rightarrow && \begin{cases} p_i^* = r + \frac{1}{3}t \\ p_j^* = r - \frac{1}{3}t \\ \hat{x} = \frac{1}{2} + \frac{1}{6} \cdot \frac{t}{r} \end{cases}
\end{aligned}
\tag{4.4}
$$

The prices p_i^* and p_j^* constitute an equilibrium under the following conditions. The indifferent consumer must lie in country i and the indifferent consumer must derive positive utility from consuming either product:

$$\hat{x} < B \Leftrightarrow t < r \cdot (6B - 3). \tag{4.5}$$

$$U_{x=\hat{x}}(p_j - t) = a - p_j - t - r(1 - \hat{x}) > 0 \Leftrightarrow t < 2a - 3r. \tag{4.6}$$

Given $B > \frac{1}{2}$ and $a > \frac{3}{2}r$, there is always a positive t that fulfills both conditions 4.5 and 4.6. □

At this stage, the direction of trade deserves to be commented in more detail. Trade in our model flows from the small into the large, more diverse country. Our firms are completely identical. Therefore, having a small domestic consumer base to satisfy is actually a comparative advantage in the sense that it pushes a firm to export. On the other hand, a firm with a large domestic market is content with its own domestic consumers and does not want to export. In the absence of economies of scale, the small country–to–large country trade is the natural (partial) equilibrium outcome.

It would be possible to introduce economies of scale, which would benefit the firm in the larger country, such that it then behaves "bigger" on the global scale, exporting to smaller countries. This would move away from the focus of this paper and conceal the main drivers behind our results, but should not remove them. In either case, considering economies of scale would be an interesting extension to our model, but for the time being, we abstract from this consideration.

In what follows, we will focus on equilibria that always exhibit trade under a specified tariff equal to or larger than zero. That is, we look at a world with asymmetric countries, $a > \frac{3}{2}r$ and low enough tariffs. The motivation is simple. If we compared a no-trade equilibrium under a tariff with a trade equilibrium under an FTA, the FTA effects would be stronger. Instead, we want to compare "apples" to "apples".

Next, we discuss the welfare implications of the tariff. Welfare of each country is measured by the sum of consumer surplus CS, producer profits π and, where applicable, a tariff revenue. In the situation of countries i and j as discussed in lemma 1, this implies

$$\begin{aligned} W_i &= CS_i(p_i^*, p_j^*) + \pi_i(p_i^*, p_j^*) + t \cdot \big(B - \hat{x}(p_i^*, p_j^*)\big) \\ W_j &= CS_j(p_i^*, p_j^*) + \pi_j(p_i^*, p_j^*). \end{aligned} \tag{4.7}$$

Note that the tariff proceeds enter the welfare of countries but are redistributed to neither consumers nor firms. We can immediately derive the following:

Lemma 2. *Assume the market is covered ($a \geq \frac{3}{2}r$). With a tariff and asymmetric countries, equilibrium prices will be unequal. Equal prices and, thus, highest welfare can be achieved* only *under free trade: starting with a tariff equilibrium, welfare strictly increases the closer the countries get to the free trade situation.*

Lemma 2 is a standard result in Hotelling-style models. However, it is central to understand welfare effects in these models. Therefore, instead of a proof, we provide a detailed discussion of the Lemma. Let us look at the case of two asymmetric countries: the intuition is the same with more than two countries.

First, lemma 1 shows that with a tariff and asymmetric countries, equilibrium prices will be unequal. Let us now motivate why overall welfare is maximized with equal pricing and no tariff.

To understand the welfare effects of a tariff, it suffices to compare two cases as depicted in Fig.4.2: Equal prices without a tariff and the introduction of a tariff t, holding prices fixed. The second case does not constitute an equilibrium, as argued in lemma 1. Instead, prices will be unequal in equilibrium. We ignore this aspect in Fig.4.2 for the purpose of simplicity but will get back to it later on.

In Fig.4.2, the consumer surplus given producer prices $p_i = p_j$ is the total area under the consumer utility curves, $U(p_i)$ and $U(p_j)$. The producer surplus is given by the dotted rectangle at the top between a, $U(p_i)$ and $U(p_j)$, and including the area (A). The parts of these areas to the left of the border B belong to country i, and to the right of B, to country j.

Now, imagine for a moment that a tariff t is introduced and prices $p_i = p_j$ stay constant. Then, the effective price that consumers in country i pay for products imported from j increases to $p_j + t$. Thus, imports into i decrease from M to $\hat{M}$ (the indifferent consumer moves from $\frac{1}{2}$ to $\hat{x}$).

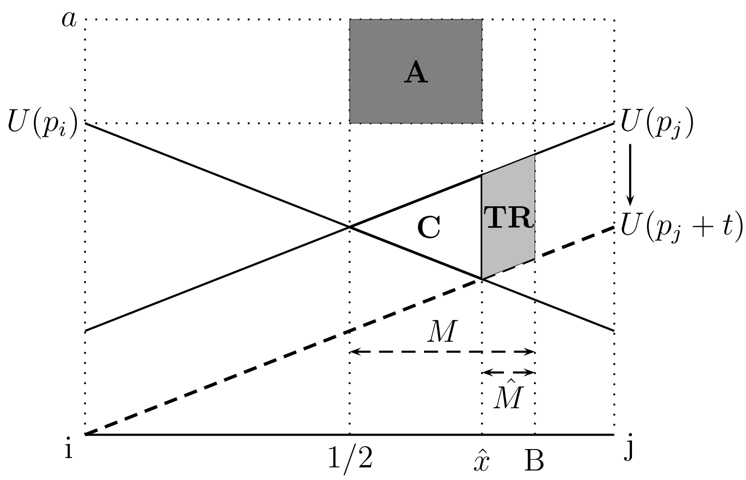


Fig. 4.2: Welfare change from a price increase by firm j

The welfare changes in the following way: Country i now has a tariff revenue (TR) (light grey parallelogram) on the remaining imports from j. This tariff revenue is paid by those consumers in i that remain purchasing product j. Thus, (TR) is a pure redistribution of welfare from consumers to the government in country i. In addition, firm i appropriates surplus from firm j because of decreased imports, depicted by the grey rectangle (A). All the other surpluses belong to the same actors also after introducing t, except for the white triangle (C).

This triangle (C) is a pure dead-weight loss, as consumers lying between 1/2 and $\hat{x}$ now purchase their less preferred good (from firm i) over their more preferred one (from firm j). In fact, such a dead-weight loss will always occur once the indifferent consumer $\hat{x}$ lies away from $\frac{1}{2}$. The dead-weight loss (C) could *only* be avoided when the effective price of firm j in country i was equal to the price of firm i, i.e., $p_j + t = p_i$. As lemma 1 shows, this does not constitute an equilibrium because $p_j^* + t = r + \frac{2}{3}t \neq r + \frac{1}{3}t = p_i^*$, $\forall t > 0$. Thus, under a tariff, the indifferent consumer will lie to the right of $\frac{1}{2}$ as $\hat{x} = \frac{1}{2} + \frac{1}{6} \cdot \frac{t}{r} > \frac{1}{2}$. The welfare maximizing equilibrium can result *only* from free trade, when prices are equal: with tariff $t > 0$, an asymmetric equilibrium necessarily obtains.

Note that in Fig.4.2, we compared equal prices without a tariff and the introduction of a tariff t, holding prices fixed. From lemma 1 instead we know that under the tariff, firms will adjust their prices compared to the pre-tariff situation. Thus the effect of the tariff is compensated by pricing to some degree, but not completely. As lemma 1 shows, imports will still decrease relative to the non-tariff situation and the basic intuition of Fig.4.2 holds.

Under a free trade agreement between these two countries, prices are $p_i = p_j = r$ and therefore, the overall world welfare is maximised and equal to

$$W^a = a - \frac{1}{4}r.$$

On the other hand, with a tariff t, the (asymmetric price) equilibrium of lemma 1 results in the overall welfare of

$$W^t = a - \frac{1}{4}r - \frac{1}{36}\frac{t^2}{r} < W^a,$$

where W^t is strictly decreasing in t.

The effect of a tariff on the welfare of the importing country is determined by the dead-weight loss in its consumer surplus versus the increased domestic firm's profit due to the appropriation of surplus from the foreign firm. Depending on the size of these changes, country i can gain or lose overall. For the exporting country, we know that welfare will be lower under the tariff as the price of its products as well as the size of exports decrease.

4.3.2 Three asymmetric countries

Let us expand the analysis to three countries i, j, as well as k, and assume that consumers of these countries are arranged along the sides of a triangle as depicted in Fig.4.3. The corners of the triangle represent the points of sale[11] of (domestic) products, just as in the case of two countries. Each side of the triangle is assumed to have length and consumer mass of one. There is one large country i and two identical small countries j and k. The borders are then $\frac{1}{2} < B_{ij} = B_{ik} < 1$ and $B_{jk} = \frac{1}{2}$.[12]

To understand the welfare analysis for individual countries, it is important to keep in mind that any move to a more equal pricing pattern, moving the indifferent consumer closer to $\frac{1}{2}$, increases welfare.

We start with the restricted trade situation between all pairs of countries, where symmetric tariffs $t_{ij} = t_{ik} = t_{jk} = t$ apply at every border.

[11] Or (national) characteristics.

[12] We now define without loss of generality that in the market between countries i and j, i is the origin and the position of j is at 1. In the market between countries i and k, i is the origin and the position of k is at 1. In the market between countries j and k, j is the origin and the position of k is at 1.

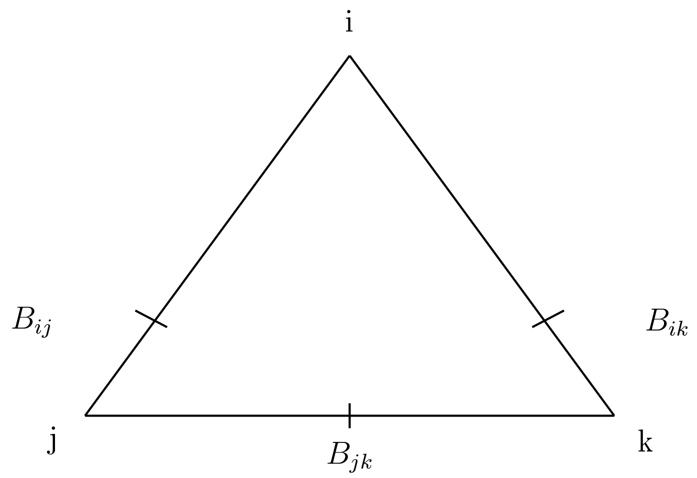


Fig. 4.3: One large and two small countries

Proposition 1. *Let there be two small and one large country with symmetric tariffs; let the market be covered ($a \geq \frac{3}{2}r$). Then, as long as tariffs* t *are low enough, there are two possible equilibria with imports M into the large country from the two small countries. With a low valuation* a *of the good by consumers, $a \in \left(\frac{3}{2}r, \frac{7}{2}r\right)$, a "high" price equilibrium is obtained where firms in the small countries behave like a two-product monopolist. For a high valuation $a > \frac{15+4\sqrt{2}}{10}r$, there is a "low" price equilibrium.*

Proof. Because j and k are symmetric and the border between them is set to $B_{jk} = \frac{1}{2}$, the price level in both countries will be the same and there will thus be no trade across the border B_{jk}.

One possible equilibrium includes the price $p_j^h = p_k^h = a - \frac{1}{2}r$ (see Fig.4.4(a)). Under these prices, all consumers in countries j and k consume and the consumer at the border B_{jk} receives zero utility (i.e., he is just indifferent between buying any of the two closest goods or not buying at all). This price would also obtain if there were no tariff but the firms j and k colluded—we call this "high" price equilibrium. We get the following outcome:

$$
\begin{aligned}
p_j^h &= p_k^h = a - \tfrac{1}{2}r \\
p_i^h &= \tfrac{1}{2}a + \tfrac{1}{4}r + \tfrac{1}{2}t \\
\Rightarrow M^h &= 2 \cdot \left(B - \tfrac{1}{8} - \tfrac{1}{4}\tfrac{t}{r} - \tfrac{1}{4}\tfrac{a}{r}\right) \\
\Rightarrow W_i^h &= 2 \cdot \left(\tfrac{1}{8} + \tfrac{1}{4}\tfrac{t}{r} + \tfrac{1}{4}\tfrac{a}{r}\right)\left(\tfrac{7}{8}a - \tfrac{1}{16}r - \tfrac{1}{8}t\right) \\
&\quad +2 \cdot \left(B - \tfrac{1}{8} - \tfrac{1}{4}\tfrac{t}{r} - \tfrac{1}{4}\tfrac{a}{r}\right)\left(\tfrac{1}{2}Br + \tfrac{1}{8}a - \tfrac{7}{16}r + \tfrac{1}{8}t\right), \qquad (4.8)
\end{aligned}
$$

where W_i^h is the welfare of country i, and M^h are the imports into i from country j and k. Note that because j and k are symmetric, we express M^h only as dependent on $B = B_{ij} = B_{ik}$.

This equilibrium needs to be stable against deviating strategies by a single player. This requires specific conditions on a, r, and t. The details can be found in the Appendix 4.6.1, but for our discussion it suffices to note that, in particular, t needs to be sufficiently small and a can not be too high. It can be shown that

$$
\forall\,(a,B)\ :\ a \in \left(\frac{3}{2}r, \frac{7}{2}r\right) \quad \& \quad B \in \left(\frac{1}{2}, 1\right), \qquad (4.9)
$$

there exists a sufficiently low t such that the collusive equilibrium is obtained.

Another possible equilibrium is when companies j and k charge lower-than-collusive prices due to competition with i in the foreign market. This equilibrium is labeled "low" and exhibits the following properties:

$$
\begin{aligned}
p_j^l &= p_k^l = \tfrac{5}{3}r - \tfrac{1}{3}t \\
p_i^l &= \tfrac{4}{3}r + \tfrac{1}{3}t \\
\Rightarrow \quad M^l &= 2 \cdot \left(B - \tfrac{2}{3} - \tfrac{1}{6}\tfrac{t}{r}\right) \\
\Rightarrow \quad W_i^l &= 2 \cdot \left(\tfrac{2}{3} + \tfrac{1}{6}\tfrac{t}{r}\right)\left(a - \tfrac{1}{3}r - \tfrac{1}{12}t\right) \\
&\quad +2 \cdot \left(B - \tfrac{2}{3} - \tfrac{1}{6}\tfrac{t}{r}\right)\left(a - \tfrac{7}{3}r + \tfrac{5}{12}t + \tfrac{1}{2}Br\right). \qquad (4.10)
\end{aligned}
$$

Again, for the existence of this equilibrium, conditions on a, r, and t must hold, and the firms' individual rationality conditions have to rule out profitable deviations. This requires, in particular:

$$
a > \frac{15 + 4\sqrt{2}}{10}r \quad \& \quad B \in \left(\frac{2}{3}, 1\right), \qquad (4.11)
$$

i.e., that the countries are sufficiently asymmetric in size and consumer valuation of the good is high enough. The detailed conditions can be found in the Appendix 4.6.2.

The attractiveness of one equilibrium over the other depends on the surplus that can be extracted from domestic consumers, determined by a, and the export potential into i, which depends on the border $B = B_{ij} = B_{ik}$. If a is large, the FTA countries' firms may forgo export revenue and extract as much surplus as possible from their domestic consumers. Otherwise, the export revenue is more attractive than the domestic revenue. When discussing the two equilibria, it has to be kept in mind that we only analyze situations with trade. For a particularly high a, surplus extraction from domestic customers will be more attractive than exporting and a no-trade equilibrium may then be obtained. We do not consider this case because we want to compare equilibria with trade.[13] The detailed conditions for the attractiveness of one equilibrium over the other are relegated to the end of Appendix 4.6.2. □

It is possible to show that the two equilibria in Proposition 1 are the only two pure-strategy equilibria possible under given conditions, using the arguments of the proof of Proposition 3 in Appendix 4.5.

Next, we abolish the tariff t_{jk} between countries j and k through the formation of an FTA, while the tariffs $t_{ij} = t_{ik} = t$ are upheld. We show its implications for the world welfare through the following proposition:

Proposition 2. *Let there be two small and one large country with symmetric tariffs; let the market be covered ($a \geq \frac{3}{2}r$). When the small countries j and k set up an FTA, the overall world welfare increases. If the tariff t is low enough and the third, non-participating, country i is large enough, that country's welfare also increases.*

Proof. First, we obtain the post-FTA equilibrium prices and imports (depicted in Fig.4.4(b)):[14]

$$\begin{aligned} p_j^a &= p_k^a = r - \tfrac{1}{5}t \\ p_i^a &= r + \tfrac{2}{5}t \\ \Rightarrow \quad M^a &= 2 \cdot \left(B - \tfrac{1}{2} - \tfrac{1}{5}\tfrac{t}{r}\right) \\ \Rightarrow \quad W_i^a &= 2 \cdot \left(\tfrac{1}{2} + \tfrac{1}{5}\tfrac{t}{r}\right)\left(a - \tfrac{1}{4}r - \tfrac{1}{10}t\right) \\ &\quad +2 \cdot \left(B - \tfrac{1}{2} - \tfrac{1}{5}\tfrac{t}{r}\right)\left(a - \tfrac{7}{4}r + \tfrac{3}{10}t + \tfrac{1}{2}Br\right). \end{aligned} \tag{4.12}$$

Prices set by firms j and k are clearly lower than before the FTA, due to stronger competition with each other.[15] Note that, due to the abolition of

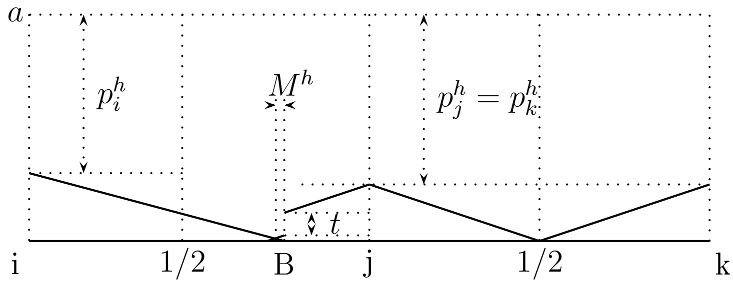
[13] Otherwise we would be comparing "apples" with "oranges". Our results comparing to the situation with the FTA would be stronger, but inadequate.

[14] Identical effects apply respectively to the comparison between the FTA equilibrium and a pre-FTA competitive equilibrium and are depicted in Fig.4.6 in the Appendix 4.6.3.

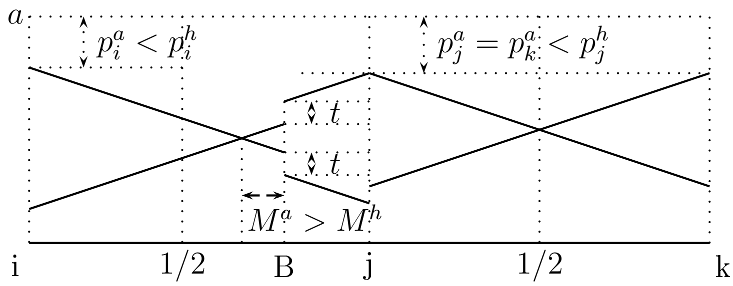
[15] Note also that prices are below the competitive prices $p_j = p_k = r$ in two countries.

the tariff between them, firms j and k compete more fiercely with each other, but there will still be no trade between these countries due to their symmetry. Because the firms cannot price discriminate internationally, competition is carried over into country i where firm i lowers its price in its own market. The FTA also leads to more imports from the small countries j and k into i. Given the market is covered ($a > \frac{3}{2}r$), we have $M^h < 2\cdot\left(B - \frac{1}{2} - \frac{1}{4}\frac{t}{r}\right) < M^a$. And for a small t, also $M^l < M^a$.[16]

Under conditions (4.9) and (4.11) that ensure collusive and competitive equilibria, respectively, also the FTA equilibrium exists. This is due to the fact that under the FTA, there are more imports and the indifferent consumer in i lies further away from the border than before. The details of the calculations of the FTA equilibrium are presented in the Appendix 4.6.3.



(a) Collusive tariff (pre-FTA) equilibrium



(b) Post-j/k-FTA equilibrium

Fig. 4.4: Pre-FTA and post-FTA equilibria with one large and two small countries

With the post-FTA equilibrium in mind, we now proceed to the welfare discussion. We have shown that the indifferent j/k consumer stays at $\frac{1}{2}$

[16] A small t is any $t < 5r$. As discussed in Appendix.4.6.2, the competitive equilibrium also requires $t < 2r$ such that the the former condition is always fulfilled.

and the i/j and i/k consumers move closer to the middle of their respective markets: thus, as was discussed at the end of Section 4.3.1, we immediately know that the total world welfare post-FTA is higher than before the FTA. We now show under which conditions the non-FTA country i gains, compared to the collusive pre-FTA equilibrium:

$$\begin{aligned} W_i^a &> W_i^h \\ &\Leftrightarrow \quad -\tfrac{(10a-15r+2t)(30a+(75-160B)r+14t)}{800r} > 0, \end{aligned}$$

which, together with $t > 0$, implies:

$$0 < t < \frac{5}{14}\left(32Br - 6a - 15r\right) \text{ and thus } B > \frac{1}{2} + \frac{3}{16}\frac{a}{r}. \tag{4.13}$$

A similar condition when comparing with the competitive pre-FTA equilibrium is then:

$$\begin{aligned} W_i^a &> W_i^l \\ &\Rightarrow \quad \tfrac{(5r-t)(5(-7+8B)r-t)}{150r} > 0, \end{aligned}$$

which with $t > 0$ implies:

$$0 < t < 40Br - 35r \text{ and thus } B > \frac{7}{8}. \tag{4.14}$$

The welfare effect of the FTA on country i is determined by three factors: First, higher imports into i increase consumer welfare because the equilibrium moves closer to the situation with free trade. The same effect has also been discussed in the case of two countries in Section 4.3.1. Second, higher imports increase the tariff revenue of country i. And third, higher imports and lower prices reduce the profits of firm i. The sum of these countervailing effects determines the net welfare effect on country i.

The sum of the effects is positive for a large enough border B because a large border ensures that a high number of consumers in country i benefit from the downward movement in prices. On the other hand, the loss of firm i does not depend on the border but on the indifferent consumer before and after the FTA. □

We have just shown how an FTA can benefit a third country, but it still remains to check the incentive for countries j and k to conclude an FTA agreement in the first place. Because all welfare effects of the FTA within countries j and k are purely redistributional, we concentrate on the potential welfare gain generated through increased exports from j and k into i. It thus suffices to compare firm j's (alternatively, k's) overall revenues from exports before and after the FTA:

$$M_j^a \cdot p_j^a > M_j^h \cdot p_j^h,$$

which implies (with $t > 0$):

$$t > \max\left\{0, \frac{5}{8}(8Br - 2a - 3r)\right\}, \quad \text{with}$$

$$0 < \frac{5}{8}(8Br - 2a - 3r) \quad \Leftrightarrow \quad B > \frac{3}{8} + \frac{1}{4}\frac{a}{r}, \tag{4.15}$$

for the collusive pre-FTA equilibrium, and separately for the competitive pre-FTA equilibrium:

$$\begin{aligned} M_j^a \cdot p_j^a > M_j^l \cdot p_j^l & \\ \Leftrightarrow \quad \tfrac{5}{7}(12Br - 11r) < t < \quad 5r. \end{aligned} \tag{4.16}$$

There is a range of parameters (a, B, t) with $t > 0$ that simultaneously satisfy conditions (4.13) and (4.15) (or (4.14) and (4.16), with the competitive pre-FTA equilibrium). In the case of (4.13) and (4.15) this holds for any $B > \frac{13}{24} + \frac{5}{36}\frac{a}{r}$ (and in the case of (4.14) and (4.16) for $B > \frac{7}{8}$). For these parameters, not only do countries j and k gain from forming an FTA agreement with each other, but also the "innocent bystander" i gains in welfare, because its consumers benefit from the global competition of j's and k's firms.

4.4 Conclusion

We have presented a partial equilibrium model of international trade, in which an exogenous reduction in the barriers-to-trade may have welfare implications for third, as well as for directly affected countries. When applied to the establishment of an FTA, by treating the barriers-to-trade as tariffs, we show the following: On the one hand, under some parameters, the non-participating country loses in welfare, a situation widely known as the "innocent bystander problem". On the other hand, there are situations under which *all* countries in our model world, including the non-member, may gain in welfare after setting up an FTA between a subset of countries.

The intuition behind our result is simple. Through the FTA, firms in the member countries compete more fiercely with each other and lower their prices. Competition is carried over into the third country. This moves the equilibrium outcome closer to the free trade situation. Since the free trade situation is welfare-maximising, this increases the world welfare.

For the non-participating country, in a certain parameter range, the loss in profit of its firms is outweighed by the gain in its consumer surplus plus the tariff revenue from imports, such that even the non-participating country can gain from an FTA between other countries.

There are potentially many historical settings in which the model can be applied. Setting up of Benelux Customs Union in 1948 may have lead to stronger competitive behaviour of the Benelux companies abroad. New EU members typically have had an FTA agreement with the EU prior to joining, but may have been forced to accept a reduction of barriers to *other* new members, which in turn may have lead to stronger competition of their companies in the old EU, even though nothing has changed on those borders.

Taking the model in the other direction, the break-up of former Yugoslavia and the USSR may have lead to their companies behaving in a less competitive fashion elsewhere in the world. The break-up of these countries can be considered as turning from an FTA to a protective world, with an introduction of tariffs and other barriers-to-trade between former trade partners. Within our model, this would lead to a less aggressive behaviour (i.e., higher prices) by the firms of the ex-member countries.

To sum up, we have attempted to highlight some factors, under which an FTA between a subset of countries may be welfare-improving for all countries, and thus may be viewed as a stepping-stone to the completely free-trade world.

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4.5 Appendix: Equilibrium under two symmetric countries

Assume that there are two countries i and j and the border between them lies exactly at $B = \frac{1}{2}$. With a tariff $t = 0$, the result of this setup is familiar: each company will set prices equal to $p_i = p_j = rs = r$. The consumer indifferent between purchasing from country i or from country j lies directly at $B = \frac{1}{2}$, thus no trade occurs. Producer surplus in each country is $PS_i = PS_j = \frac{1}{2}r$. Consumer surplus in each country is $CS_i = CS_j = \frac{1}{2}a - \frac{5}{8}r$. Overall welfare in both countries is then $W = r + a - \frac{5}{4}r = a - \frac{1}{4}r$.

Now a tariff $t \geq 0$ is introduced. The following proposition then can be derived.

Proposition 3. *With a tariff t, there can be at most one symmetric equilibrium in pure strategies, with prices $p_i = p_j = a - \frac{r}{2}$.*

Proof. Assume that an asymmetric price equilibrium exists, such that country j exports into country i (see Fig.4.5(b)). Then the indifferent consumer in country i is given by:

$$\begin{aligned} a - p_i - r\hat{x} &= a - p_j - t - r(1-\hat{x}) \\ \Rightarrow \qquad \hat{x} &= \frac{1}{2} + \frac{1}{2r}(p_j - p_i + t), \end{aligned} \tag{4.17}$$

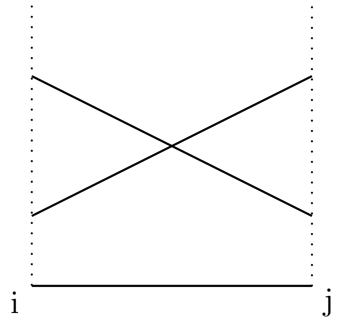
This leads to equilibrium prices being:

$$\begin{aligned} p_i &= r + \frac{t}{3} \\ p_j &= r - \frac{t}{3}, \end{aligned} \tag{4.18}$$

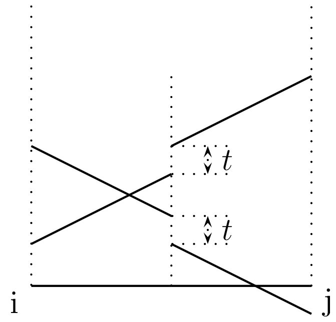
which leads to the indifferent consumer outside country i with $\hat{x} = \frac{1}{2} + \frac{1}{6} \cdot \frac{t}{r} > 1/2$, a contradiction.

Alternatively, consider a candidate for an asymmetric equilibrium depicted in solid lines in Fig.4.5(c). Prices are such that firms share the market in half. Consider firm j's incentives. It has at least one profitable deviation from the solid price schedule (as shown by the dashed price schedule in Fig.4.5(c)). Therefore, the solid price schedule cannot be an equilibrium. The dashed price schedule cannot be an equilibrium, either, because firm i would now want to deviate.

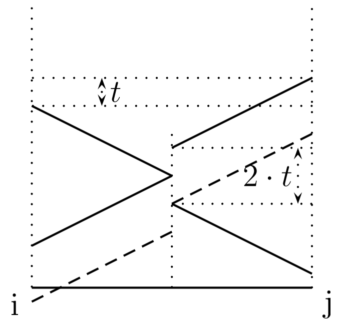
Thus, consider symmetric price schedules in solid lines in Fig.4.5(d). Clearly, firm i has at least one profitable deviation (a dashed price schedule), so this cannot be an equilibrium.



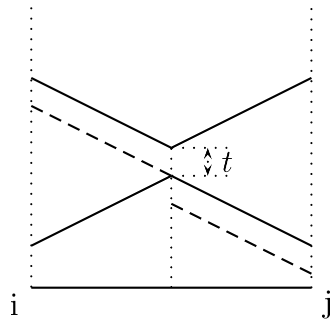
(a) Free trade, two countries



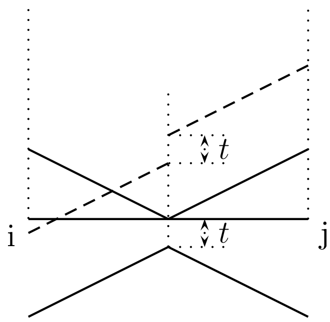
(b) Asymmetric prices



(c) Asymmetric prices, no trade



(d) Tariff, two countries



(e) Tariff equilibrium

Fig. 4.5: Free trade and tariff with two countries

Consider price schedules depicted in solid lines in Fig.4.5(e): $p_i^h = a - \frac{r}{2}, \quad i = 1, 2$. This equilibrium corresponds to the collusive or monopoly pricing outcome as it would also be obtained if the same firm offered its product in both countries.[17]

This is an equilibrium if a deviation is not profitable. Increasing prices would lead to a local monopoly outcome where some consumers in a country would not be served, which has been ruled out to be profitable already with free trade due to the assumption $a \geq \frac{3}{2}r$[18]. When firm j decreases its price, the dashed line in Fig.4.5(e) represents the highest attainable profit. Firm j's price and profit in this case is:

$$p'_j = \frac{1}{2}\big(a + \frac{r}{2} - t\big), \tag{4.19}$$

$$\pi'_j(p_i = a - \frac{r}{2}, p_j = p'_j) = \frac{1}{8r}\big(a + \frac{r}{2} - t\big)^2, \tag{4.20}$$

For the price p'_j to be a successful deviation strategy for j, it needs to be by at least t smaller than $p_i = a - \frac{r}{2}$ because otherwise no consumer in i will switch to consuming j. We can thus write:

$$\frac{1}{2}\big(a + \frac{r}{2} - t\big) \leq a - \frac{r}{2} - t, \tag{4.21}$$

$$t \geq a - \frac{3}{2}r, \tag{4.22}$$

To confirm whether a deviation strategy is profitable for j, we thus have to compare j's deviation profit with the collusive profit. The collusive price schedule (solid line) under tariff t yields:

$$\pi_j^h = \frac{1}{2}\big(a - \frac{r}{2}\big). \tag{4.23}$$

As the deviation profit π'_j is strictly decreasing in t, we can analyze the deviation strategy for the lowest possible $t = a - \frac{3}{2}r$ given that this $a > \frac{3}{2}r$. The deviation profit π'_j then becomes $\pi'_j(t = a - \frac{3}{2}r) = \frac{1}{2}r$. Requiring deviation not to be profitable thus yields:

$$\begin{aligned} \pi_j^h &> \pi'_j \Rightarrow \\ a &> \tfrac{3}{2}r. \end{aligned} \tag{4.24}$$

[17] We thus label the equilibrium tc for collusive given a tariff.

[18] See Ivanov and Müller (2006) for detailed discussion on this assumption and the possibility of kink equilibria if it is relaxed.

Thus, for all $a > \frac{3}{2}r$ deviating from the collusive price schedule $p_i^h = p_j^h = a - \frac{r}{2}$ is not profitable.

Introducing a tariff $t \geq a - \frac{3}{2}r$ then results in no trade as in the situation without a tariff. Consumer surplus in each country is $CS_i^h = CS_j^h = \frac{1}{8}r$. Overall welfare in both countries then is $W^h = \frac{1}{4}r + a - \frac{1}{2}r = a - \frac{1}{4}r$. Because all consumers are served and the average transportation cost does not differ, overall welfare does not change relative to the situation without a tariff. Yet the price in each country will increase to the collusive outcome and thus surplus is redistributed from consumers to firms. □

4.6 *Appendix: One large and two small countries - calculation of price equilibria*

4.6.1 *Collusive price equilibrium before FTA*

The collusive equilibrium with symmetric tariffs yields the following:

$$\begin{aligned}
& p_j^h = p_k^h = && a - \frac{1}{2}r \\
& p_i^h = && \frac{1}{2}a + \frac{1}{4}r + \frac{1}{2}t \\
\Rightarrow\quad & \hat{x}_{jk}^h = && \frac{1}{2} \\
\Rightarrow\quad & \hat{x}_{ij}^h = \hat{x}_{ik}^h = && \frac{1}{8} + \frac{1}{4}\frac{t}{r} + \frac{1}{4}\frac{a}{r} \\
\Rightarrow\quad & \pi_j^h = \pi_k^h = && \left(\frac{11}{8} - \frac{1}{4}\frac{t}{r} - \frac{1}{4}\frac{a}{r}\right) \cdot \left(a - \frac{1}{2}r\right) \\
\Rightarrow\quad & \pi_i^h = && \frac{1}{r} \cdot \left(\frac{1}{2}a + \frac{1}{4}r + \frac{1}{2}t\right)^2 .
\end{aligned} \tag{4.25}$$

Note that given $a > \frac{3}{2}r$ it holds that $\hat{x}_{ij}^h > \frac{1}{2} + \frac{1}{4}\frac{t}{r} > \frac{1}{2}$.

There are three conditions that need to be met such that the collusive equilibrium with trade between one large and two small countries exists.

A. 1. *(Trade condition) Equilibrium prices allow trade, i.e. especially i imports from j and k respectively, i.e.*

$$\begin{aligned}
& \frac{1}{2} \leq \hat{x}_{ij}^h < B < 1 \\
\Rightarrow\quad & t < 4Br - \tfrac{1}{2}r - a.
\end{aligned} \tag{4.26}$$

A. 2. *(Consumer's individual rationality) All consumers consume one of the available products, especially the indifferent consumers in country i, i.e.*

$$\begin{aligned} U(x = \hat{x}_{ij}^h, p_j - t) &= a - p_j - t - r\hat{x}_{ij}^h > 0 \\ \Rightarrow \quad & t < \tfrac{1}{3}a - \tfrac{1}{2}r. \end{aligned} \tag{4.27}$$

A. 3. *Firms have no incentive to deviate from the equilibrium and there is no incentive to deviate to another price, i.e. especially a price lower than p_j^h:*

$$\begin{aligned} \pi_j(p_j^h, p_k^h, p_i^h) \quad & > \pi_j(p_j', p_k^h, p_i^h) \\ \Rightarrow \quad & \tfrac{1}{9}a + \tfrac{29}{18}r - \sqrt{\tfrac{5201}{44}r^2 + 704ar - 224a^2} < t \\ & < \tfrac{1}{9}a + \tfrac{29}{18}r + \sqrt{\tfrac{5201}{44}r^2 + 704ar - 224a^2}. \end{aligned} \tag{4.28}$$

Because of condition A.1 we known that a can not be too high, in fact $a \leq \frac{7}{2}r$ as otherwise no positive t can fulfill the condition for any value of B. Inserting a low $a = 2r$ into the admissible range for t as given by A.3 yields $-23.3 < t < 26.9r$. Thus in this case A.2 is binding and requires a $t < \frac{1}{6}r$. Instead also A.1 can be binding given $B < \frac{13}{24}r$. We conclude that a low a and a sufficiently high B will always allow for a range of parameters t such that the collusive equilibrium exists.

4.6.2 Competitive price equilibrium before FTA

Finding the prices $p_j^l = p_k^l < a - \frac{1}{2}r$ that are below the collusive prices and that can support an equilibrium requires solving the following firms' profit functions:

$$\begin{aligned} \pi_j \quad = \pi_k = \quad & \frac{1}{2r}(p_i - p_j - t + 2r) \cdot p_j \\ \pi_i \quad = \quad & \frac{1}{2r}(p_j + p_k - 2p_i + 2t + 2r) \cdot p_i \end{aligned} \tag{4.29}$$

This yields:

$$\begin{aligned} p_j^l \quad = p_k^l = \quad & \frac{5}{3}r - \frac{1}{3}t \\ p_i^l \quad = \quad & \frac{4}{3}r + \frac{1}{3}t \\ \Rightarrow \quad \hat{x}_{jk}^l \quad = \quad & \frac{1}{2} \\ \Rightarrow \quad \hat{x}_{ij}^l \quad = \hat{x}_{ik}^l = \quad & \frac{2}{3} + \frac{1}{6}\frac{t}{r}. \end{aligned} \tag{4.30}$$

The profits then are:

$$\pi_j^l = \pi_k^l = \frac{1}{2r}\left(\frac{5}{3}r - \frac{1}{3}t\right)^2$$
$$\pi_i^l = \frac{1}{r}\cdot\left(\frac{4}{3}r + \frac{1}{3}t\right)^2. \tag{4.31}$$

As in the situation of the collusive equilibrium, several conditions need to me met such that the competitive price equilibrium is stable.

A. 4. *The competitive price needs to be below the collusive price, i.e.*

$$p_j^l < p_j^h$$
$$\Rightarrow \; t > \tfrac{13}{2}r - 3a. \tag{4.32}$$

A. 5. *(Trade condition) Equilibrium prices allow trade, i.e. especially i imports from j and k respecively, i.e.*

$$\frac{1}{2} < \hat{x}_{ij}^l < B < 1$$
$$\Rightarrow \; t < 6r\left(B - \tfrac{2}{3}\right). \tag{4.33}$$

A. 6. *(Consumer's individual rationality) All consumers consume one of the available products, especially the indifferent consumers in country i, i.e.*

$$U(x = \hat{x}_{ij}^l, p_j - t) = a - p_j - t - r\hat{x}_{ij}^l > 0$$
$$\Rightarrow \; t < 2a - 4r. \tag{4.34}$$

A. 7. *Firms have no incentive to deviate from the equilibrium. We first consider a deviation upwards by t by the firm in country j . This would yield the potentially highest profit for an upwards deviation which is:*

$$\pi_j(p_j^l + t, p_k^l, p_i^l) = \tfrac{1}{18}\left(25r - 10t - 8\tfrac{t^2}{r}\right) < \pi_j(p_j^l, p_k^l, p_i^l). \tag{4.35}$$

Deviating upwards by t yields a profit below the competitive equilibrium profit and thus a deviation is never profitable. We therefore also check a deviation downwards and find:

$$p_j^*(p_k^l, p_i^l) = \tfrac{5}{4}r - \tfrac{1}{2}t$$
$$\Rightarrow \; \pi_j(p_j^*, p_k^l, p_i^l) = \tfrac{25}{16}r - \tfrac{10}{8}t + \tfrac{1}{4}\tfrac{t^2}{r}. \tag{4.36}$$

To uphold the equilibrium, the resulting profit needs to be lower than the profit in the competitive equilibrium and thus:

$$t > \left(2 - \tfrac{6\sqrt{2}}{5}\right)r. \tag{4.37}$$

We conclude that the competitive equilibrium exists only for values of t that are larger than the values stated in condition A.4 and condition A.7 as well as smaller than the values given by A.5 and A.6. A common range of values for all the conditions exists for $B > \frac{2}{3}$ and $a > \frac{15+4\sqrt{2}}{10}r$, i.e. when the countries are sufficiently asymmetric in size and consumer valuation of the good high enough.

For $a \in \left(\frac{15+4\sqrt{2}}{10}r, \frac{7}{2}r\right)$ and $B \in \left(\frac{2}{3}, 1\right)$, both the collusive and the competitive equilibrium exist. The collusive equilibrium then yields higher profits given any $a < \frac{23}{6}r - \frac{2}{3}t$.[19]

4.6.3 Price equilibrium after FTA

Abolishing the tariff t_{jk} induces competition between countries j and k and will thus generally reduce prices. Reducing prices p_j and p_k is expected to lead to more imports from the small countries j and k into i. Thus we solve:

$$\begin{aligned}
\pi_j &= \pi_k = \frac{1}{2r}(p_k + p_i - 2p_j - t + 2r) \cdot p_j \\
\pi_i &= \frac{1}{2r}(p_j + p_k - 2p_i + 2t + 2r) \cdot p_i
\end{aligned}$$

Equilibrium prices then are:

$$\begin{aligned}
p_j^a &= p_k^a = r - \frac{1}{5}t \\
p_i^a &= r + \frac{2}{5}t \\
\Rightarrow \quad \hat{x}_{jk}^a &= \frac{1}{2} \\
\Rightarrow \quad \hat{x}_{ij}^a &= \hat{x}_{ik} = \frac{1}{2} + \frac{1}{5}\frac{t}{r}
\end{aligned} \tag{4.38}$$

and the profits are:

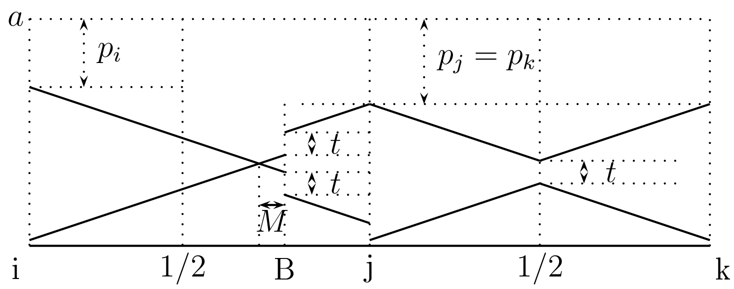
$$\begin{aligned}
\pi_j^a &= \pi_k^a = \frac{1}{r}\left(r - \frac{1}{5}t\right)^2 \\
\pi_i^a &= \frac{1}{r}\left(r + \frac{2}{5}t\right)^2
\end{aligned} \tag{4.39}$$

By comparing with Appendices 4.6.1 and 4.6.2, one can readily observe that $\hat{x}_{ij}^a < \hat{x}_{ij}^h$ and for $t < 5r$ also $\hat{x}_{ij}^a < \hat{x}_{ij}^l$. Thus, there are more imports

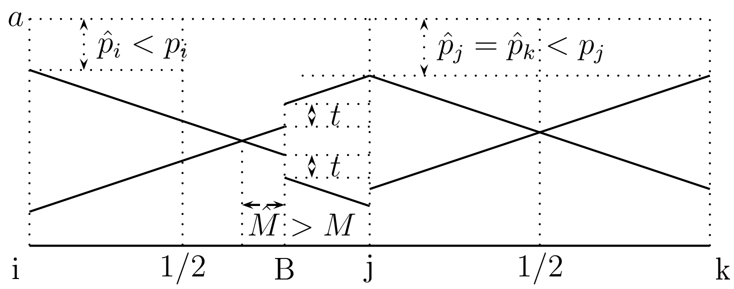
[19] And consequently for any $t < 5r$.

from the small countries j and k into i. Thus, when conditions A.1, A.2, A.5 and A.6 are fullfilled, also the FTA equilibrium exists.

The comparison between the FTA equilibrium and the pre-FT competitive equilibrium yields similar results as the comparison to the pre-FTA collusive equilibrium: Prices decrease and imports M into country i increase. Fig.4.6 depicts the two equilibria.



(a) Competitive tariff (pre-FTA) equilibrium



(b) Post-j/k-FTA equilibrium

Fig. 4.6: Pre-FTA and post-FTA equilibria with two small and one large country

4.7 Appendix: Tables

Tab. 4.1: Cross-market price correlations for selected car models and geographical markets. The models have been selected to have been in the European car market for the longest possible period of time (in the boundaries of 1970-1999), and to represent different European car producers.

	Belgium	France	Germany	Italy	UK
1. VW Golf					
Belgium	1				
France	0.98	1			
Germany	0.99	0.98	1		
Italy	0.97	0.97	0.98	1	
UK	0.94	0.96	0.96	0.98	1
2. Opel Astra					
Belgium	1				
France	0.95	1			
Germany	0.98	0.95	1		
Italy	0.89	0.93	0.91	1	
UK	0.8	0.78	0.77	0.85	1
3. Renault Clio					
Belgium	1				
France	0.99	1			
Germany	0.98	0.98	1		
Italy	0.92	0.94	0.96	1	
UK	0.91	0.93	0.94	0.96	1
4. Opel Corsa					
Belgium	1				
France	0.95	1			
Germany	0.98	0.95	1		
Italy	0.89	0.93	0.91	1	
UK	0.8	0.78	0.77	0.85	1
5. VW Polo					
Belgium	1				
France	0.96	1			
Germany	0.99	0.95	1		
Italy	0.93	0.93	0.93	1	
UK	0.91	0.9	0.92	0.97	1

Continued on next page...

... Tab. 4.1 continued

	Belgium	France	Germany	Italy	UK
6. Ford Fiesta					
Belgium	1				
France	0.96	1			
Germany	0.98	0.97	1		
Italy	0.92	0.97	0.95	1	
UK	0.83	0.9	0.85	0.91	1
7. BMW 3er					
Belgium	1				
France	0.98	1			
Germany	0.99	0.99	1		
Italy	0.96	0.96	0.97	1	
UK	0.94	0.96	0.95	0.97	1
8. VW Passat					
Belgium	1				
France	0.99	1			
Germany	0.99	0.98	1		
Italy	0.95	0.95	0.94	1	
UK	0.94	0.9	0.92	0.92	1
9. Peugeot 306					
Belgium	1				
France	0.97	1			
Germany	0.96	0.94	1		
Italy	0.94	0.93	0.94	1	
UK	0.89	0.85	0.89	0.91	1
10. Fiat Bravo					
Belgium	1				
France	0.93	1			
Germany	0.97	0.96	1		
Italy	0.9	0.95	0.91	1	
UK	0.8	0.88	0.81	0.94	1

Curriculum Vitae

03/2005 - 03/2008	**University of Mannheim**, Germany Ph.D. studies in Economics
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