Trust, Competition and Innovation:

Theory and Evidence from German Car Manufacturers*

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Abstract

We explore the interaction between competition and trust in buyer-seller relationships where non-contractible buyer specific R&D investment is important. We develop a simple theoretical model of the long term-supply relationships typical of German car manufacturing, where suppliers play a crucial role in terms of design and innovation, and derive predictions on the effects of trust and competition on suppliers' investment and buyers' procurement strategies. We then use unique survey data on individual supplier-buyer relationships in the German automotive industry to address these issues empirically. Consistent with the model's predictions, higher levels of trust are associated with higher investment levels and with more competitive procurement: trust and rents from reduced competition of suppliers in the procurement process emerge as substitutes both in theory and in the data. We also address empirically other predictions of our model related to the frequency and size of direct reimbursement of suppliers' R&D investment costs.

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1 Introduction

Trust is a key ingredient of social life, and of business transactions alike. Business transactions are often recurrent episodes of a history of exchanges, in which case trust-based relational contracts tend to be the most efficient governance instrument for non-contractible dimensions. The procurement of parts for complex products, such as automobiles, is a particularly interesting example. Indeed, some scholars regard General Motors' inability to counter the competition by Toyota in the last decades as largely due to the inability of GM's management to fully grasp the importance of collaborative management practices, by establishing and managing long-term relationships with both suppliers and employees (Helper and Henderson, 2014).

A lack of understanding of trust-based management practices was apparently also at the root of the turmoil produced among upstream suppliers when GM's manager Ignacio Lopez, poached by Volkswagen, implemented his arm's length cut-throat competition procurement practices (PICOS) in the German automobile industry. The industry was dominated by long term supply relationships, and the quasi-rents Lopez tried to expropriate were crucial to the success of the "German model" where, in contrast to the US, suppliers typically undertook a large part of the investments in specific R&D.

In this paper we theoretically and empirically study the complex interaction between trust-based relational contracts, competition, and incentives to undertake non contractable R&D investment. We develop a simple theoretical model of a long term relationships in which we incorporate features typical of German car manufacturing, that is suppliers play a crucial role with respect to design and innovation, and derive predictions on the effects of trust and competition on suppliers' investment and buyers' procurement strategies. We then use unique survey data on individual supplier-buyer relationships in the German automotive industry to empirically test the predictions of the theoretical model.

Our data set allows us to identify the long term implications of the shock to the system generated by Lopez's unexpected arrival and aggressive attempt to shift production procurement towards prices close to marginal costs (without consideration of up-front

R&D efforts by the suppliers).[1] Because the short run cost savings so generated were enormous, Lopez' and his team developed quite an in-road into re-organizing supply relationships in the German automotive industry in the very short run, although the experiment was soon interrupted by a legal battle.[2] Yet some automotive manufacturers anticipated its relationship-destroying implications, and thus were very cautious in adopting it. This generated the variation allowing us to empirically investigate, with a cross-section data, the effects of procurement modes as differing across auto manufacturers in the German car industry.

Sociologists and economists have recently studied social interactions based on trust, and the associated cooperative behavior. Clearly, trust facilitates informal relational contracts that may efficiently replace legally enforced ones. If an agent trusts that he will be treated fairly by his trading partner, he will invest in the relationship increasing surplus and efficiency. We characterize theoretically and then bring to a test this general and intuitive conclusion. Yet we also establish and test a result that appears in contrast to one of the conclusions sometimes drawn within this literature, by which governance based on long term relationships and trust requires (and is associated to) lower levels of competition. We show both theoretically and empirically that there can actually be a positive relationship between the levels of trust and the strength of competition induced between suppliers.

To perform this analysis we need the object of trust, as recorded in the evidence, to be an individual, or a specific institution. Whereas this is typically the case in the laboratory situations reflecting the trust experiment, most of the survey evidence used to analyze the implications of trust focuses on groups or large populations as the objects of trust. In the World View Survey on which most of the empirical literature on the subject is based, respondents are asked to evaluate their trust in the population of a country. Their responses are used to analyze aggregate characteristics of financial and goods markets.

To the best of our knowledge, there is very little, if any, real world evidence on individuals' trust towards other individuals or institutions, and its impact on these in-

[1] One of the schemes Lopez seem to have employed was to procure innovative designs at costs born by those suppliers, to choose the best design, and to use this as the basis for aggressive purely cost-oriented production procurement without compensating the developer of the winning design.

[2] Lopez was ousted from his role at VW not so long after he arrived because of the legal charges of having stolen industrial secrets when leaving GM headquarters in the US.

dividuals' or firms' behavior. The analysis that follows is a first step in filling this gap. Our data are derived from a unique survey we conducted under the auspices of the German Automotive Industry Association (VDA) on the input supply relationships between important first tier suppliers and their buyers, namely all ten German automobile manufacturers (plus one outsider).

Upstream buyer-supplier relationships in automobile production, in particular in Germany, are an extraordinarily good field for such a study, for several reasons. The most important is that there is plenty of room for hold-up, and expropriation. As indicated above, upstream suppliers in Europe, and in particular in Germany, are, in stark contrast to the U.S. American and indeed the Japanese car manufacturing industries, responsible for much of the ground-breaking research, which is then adapted to the specific needs of individual car-models. The resulting intermediate product exhibits buyer-specific features, and is characterized by a level of complexity substantively higher than observed in most other intermediate input markets. This specificity provides ample room for hold-up. Since the final product, the automobile, exhibits strict complementarities and model-specific interfaces between all contributing parts, efficiency considerations necessitate the early and lasting co-operation between the many agents involved in the design and the production of the parts of an automobile. This is implemented under the auspices of the car-manufacturer, and is associated with a superior market power vis-à-vis its suppliers. In all, when contracting with an upstream supplier, the car-manufacturer, is confronted with a clear trade-off between attaining the desired quality level for the individual part, and the desire to extract rents from it through lower prices.

Our data set allows us to explore in details the object of the contract between the car-manufacturers and the suppliers, the contracting environment, and both contracting partners' evaluations of their relationship. Due to the aforementioned rupture created in some of the automotive manufacturers' procurement procedures, the data exhibit the variations necessary for such an analysis. In particular, we do have survey evidence of the suppliers' perception (and associated variability) of the contracting relationship with the automotive producers they develop and produce for, as well as the corresponding evidence of the car manufacturers' perception of the same type of relationship. In this we distinguished between individual products taken from one of four categories differentiated by complexity. The contracting relationship is then documented for all development and production phases. In what follows we focus exclusively on the suppliers' responses. All suppliers involved in the survey were asked about their contracting relationship by product development and production phases, by single product, and by car manufacturer.

We first develop a theoretical model of the procurement relationship in oder to organize the ensuing empirical analysis. A buyer repeatedly procures a product which involves first the development of a blueprint requiring buyer specific R&D investment by the supplier(s), followed by the production phase. There are several firms capable to develop such a blueprint and to produce the good. The potential suppliers differ in production costs unknown to the buyer. The R&D investment is non-contractible and, after the development phase, a supplier is selected for production, possibly through a competitive auction. The buyer chooses the amount of investment he desires from the suppliers, invites one or more of them to invest and develop a blueprint, and then selects the supplier and his blueprint that will be offered the production contract. The buyer can commit to an *ex ante* monetary transfers. We focus on relational contracts where in equilibrium the buyer restricts selection for production to those suppliers that invested at the development stage, using informational rents as compensation for the non-contractible investment. A deviation by the buyer (inspired by what Lopez seems to have been doing) consists in opening competition for the production contract to all potential suppliers, independently of whether they undertook any investment.

We derive several predictions from this simple model. First we re-establish the result, and with it, provide a framework for the empirical analysis, that higher levels of trust lead to higher relationship-specific investments. Second, perhaps more surprisingly, we show that an increase in trust is associated with more competition in the procurement process, as induced by the car-manufacturer. The reason is that trust and quasi-rents from limited competition are substitutes in terms of sustaining cooperative behavior (investment and connected reward) between buyers ad seller.

We then provide evidence in support of the prediction that higher levels of trust lead to higher relationship-specific investment, proxied by lower failure-rates of the respective parts that reflect associated quality. Whereas this result is congruent with predictions from many theoretical models, it is, to the best of our knowledge, the first empirical test of this prediction.

We also provide evidence that trust and competition between upstream suppliers and the downstream firm are not necessarily mutually exclusive: suppliers' higher trust in their buyer, the downstream firm, is associated with more intense suppliers' competition as induced by the buyer's procurement scheme.

The remainder of the paper is organized as follows. After briefly reviewing the theoretical, experimental and empirical literature related to our subject in Section 2, we develop, in Section 3, our simple theoretical framework, and derive our hypotheses on the effects of trust on vertical relationships. In Section 4, we first introduce the survey on which our empirical analysis is based. We then present our measure of trust and evaluate what it captures. In section 5 we develop our empirical analysis on how trust between manufacturers and suppliers is related to the two central questions, namely suppliers' (under-)investment and sourcing decisions. We conclude with section 6.

2 Literature Review

2.1 Relational Contracts and Trust

A business relationship that does not resort to legal means of enforcement would in colloquial terms be interpreted as based on *"trust"*. In this sense, trust can be seen as the basis for relational contracts: *I will stick to cooperative strategies only if I trust that my opponent/partners do.*

The rich theory on relational contracting in different contexts has initially not highlighted the (fundamental) role of trust. Classic references are Bull (1987) and MacLeod and Malcomson (1989) who provided the first formal characterizations, and Baker, Gibbons, and Murphy (1994) who demonstrate how the combination of formal and relational contracts can lead to better results than either instrument could achieve alone.[3] More recently, research has focused on more general settings, searching for optimal contract design. In particular, Levin (2003) finds that while under moral hazard optimal relational contracts exist and are relatively simple, under hidden information cases arise in which agents do not respond at all to the incentives provided therein. Calzolari and Spagnolo (2009) further extend this case. While in their model the relationship between a principal repeatedly interacting with a set of agents can suffer from both moral hazard and hidden information, they allow the principal to screen, and select from competing

[3] Gibbons (2016), MacLeod (2007) and Malcomson (2013) offer excellent surveys on this rapidly growing literature.

agents. They highlight a trade off between reputational forces and collusion among agents: restricting competition to a smaller set of agents and shortening contract duration may help limiting moral hazard, but at the risk to induce collusion among these agents against the principal. Our theoretical analysis is close in spirit to - and partly inspired by - Calzolari and Spagnolo (2009), but deals with a very different stage game where suppliers invest in non-contractible R&D before knowing if they will be selected to produce the good.

A formal representation of trust only appeared very recently. It is well known from the theory of repeated games that a high discount factor is associated with more cooperative behavior, whereas a low discount factor typically results in myopia and opportunistic behavior. That is, you cannot trust a partner with a low discount factor. More recent works on relational contracting, such as Bodoh-Creed (2013), explicitly make this connection, defining trust as the belief that a party has on the opponent's ability to resist the temptation to cheat in a relational contract. The model stresses that when agents begin a relational contract with an unknown partner, each party may face an adverse selection problem if potential partners vary in their ability to honor a relational agreement. An agent is then said to be trustworthy if he is capable of resisting the temptation to defect from a relational contract, while the level of generalized trust in the economy is defined as the probability that an unknown partner resists the temptation to defect and performs according to the relational contract in equilibrium.[4] Analogously, in a repeated principal agent relationship, Kartal (2012) defines the discount factor of the principal a proxy for his trustworthiness, and studies how belief of the principal's discount factor, i.e. trust, evolves along the relationship.

We are close in spirit to these authors as we will also interpret in our model the discount factor as an indicator of trust in a long term relationship, after learning occurred.

2.2 Empirical Literature

The basis for many empirical studies on trust is the World Values survey, and in it, the set of answers to the question: "Generally speaking, would you say that most people can be trusted, or that you have to be very careful in dealing with people?" While

[4] Trustworthiness is therefore a property of preferences innate to the agent, modeled as their discount factor, while generalized trust is an endogenous belief about the behavior of others generated by the equilibrium interaction of individual preferences and the structure of the economy.

one may doubt the power of this construct at first glance,[5] it has been used frequently in a number of studies. The basic hypothesis of La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1997) is that trust is an integral requirement for the functioning of large organizations in which the likelihood of repeated interactions is relatively small, and thus the established mechanisms for ensuring cooperative behavior are less effective. In a cross-country study they establish that populations with higher levels of trust should foster more effective governance as well as relatively larger firms.

Aghion, Algan, Cahuc, and Shleifer (2008) perform an international comparison on the nexus between levels of social capital (or trust/distrust), and the demand for (or the amount available) of state regulation. The intuition is that a lack of civic mindedness in one's fellow citizens may lead to a stronger desire for the state to regulate interactions. They find very strong evidence for this, even for societies in which the government itself is plagued by corruption. It therefore appears that trust and regulation are to some extent substitutes.

Guiso, Sapienza, and Zingales (2009) focus on the trust citizens of a given country in Europe have toward citizens of another country. Here the levels of trust are explained in part by the geographic distance between countries, but also by sociological and genetic closeness and common history. Less trust in the citizens of a country is associated with significantly lower aggregate trade and investment. In an another study, Guiso, Sapienza, and Zingales (2004) suggest that the different characteristics of Italian regions lead their citizens to develop different levels of social capital. They then show that in high social capital/trust areas people are more prone to invest in stocks instead of holding cash reserves, and have easier access to bank credit. The effect is mitigated by levels of education. Along similar lines, Guiso, Sapienza, and Zingales (2005) find that individuals who display higher levels of trust buy more risky assets relative to their wealth. They counter the natural question that this might be due to differences in risk attitudes by controlling for risk- and ambiguity-aversion. Their original result persists.

In contrast to the research mentioned so far, Butler, Giuliano, and Guiso (2009) study the effects of individuals' trust as opposed to trust towards groups. They use the European Social Survey as well as experimental evidence to argue that a medium amount of trust may be optimal for individuals. Too little trust may lead individuals

[5] See Sapienza, Toldra, and Zingales (2007) for an experimental study on the merits of this measure and a discussion of the previous literature.

to miss too many opportunities for beneficial interactions, while too much trust leads to the danger of being taken advantage of.

Finally, Bottazzi, Da Rin, and Hellmann (2009) study the willingness of venture capitalists to perform non-contractible services in a micro-economic environment. In particular, they analyze the influence of more effective legal systems in this context. Both in their theoretical model and their empirical analysis of a data-set on European venture-capital deals they find that a more efficient legal system has the following two effects. On the one hand, it is complementary to trust, in the sense that it makes venture capitalists more willing to grant non-contractible support. On the other hand, it leads venture capitalists to require more protection for the case of failure of the venture.[6]

We focus on the importance of trust in the (procurement) relationships which is not only affected by the individuals' specific characteristics such as intertemporal preferences, but also by other dimensions of the relationships. Based on this approach, we analyze how higher or lower levels of trust in the relationship affect upstream investment levels, as well as the choice of contractual details in the German automobile industry.

As to the empirical relationship between trust and competition, the only study known to us is by Francois, Fujiwara, and van Ypersele (2012). Building on a conceptual model of shirking in the labor market they use, amongst other data, the World Value Survey to show that more competition between firms induces trust. As in Brown, Falk, and Fehr (2012)'s experimental study, competition acts here as a disciplining device that induces the reliability of service provision, which in turn increases its trustworthiness. Again, our reasoning is the opposite: the very presence of high trust in the relationship allows the buyer to induce more competition between the suppliers.

3 A theoretical model of procurement

In each period a buyer needs to procure an intermediate product. This process entails first the development of the blueprint of such a product and requires an investment I (i.e. R&D for the blueprint) and, subsequently, the production of the intermediate product. The value to the buyer of the final product with embedded investment I is $v(I)$ which is an increasing and strictly concave function, $v'(\cdot) > 0$, $v''(\cdot) < 0$, and satisfies

[6] In the working paper on the same data, Bottazzi, Da Rin, and Hellmann (2007) also show that higher scores on the Euro-Barometer measure of trust between nations are associated with higher cross-country investments.

the standard Inada conditions.

There are $N \geq 1$ firms capable of investing and procuring the intermediate product. Investment is non-contractible, its cost is sunk and normalized to I for I units of investment. After the investment phase, a supplier is selected for production. We assume that production cannot be shared by more than one producer. The cost of production to supplier i is θ_{it} which is *iid* across firms and across periods and is distributed on support $[\theta_{\min}, \theta_{\max}]$ according to a time-invariant distribution $F(\theta_{it})$. The realization of each supplier's production cost is unknown to the buyer.

We assume that investment I is specific, it has no value for buyers other than the one that commissioned the intermediate product, and depletes after two periods. However, the buyer may ask supplier i to produce the intermediate product at time t using the blueprint developed by another supplier j.

We model the repeated procurement of intermediate products by an individual buyer over an infinite time horizon. The *stage game* associated with the procurement of an individual intermediate product complies the phases:

- *Phase* t_1 *(Pre-selection)*: The buyer announces to all the N firms in the industry a desired level of investment I and a number $n \leq N$ of firms invited to develop the blueprint of the intermediate product and to compete for its production. The buyer commits to a transfer w to each one of the n firms to be paid at the end of the development phase (at t_2) and to the mechanism that selects the supplier that (at t_3) will obtain the production contract (paid at t_4).

- *Phase* t_2 *(Development)*: The buyer selects the $n \geq 1$ suppliers. Each one of these suppliers chooses its investment I_i incurring the sunk cost I_i; the transfer w is paid by the buyer to each one of the n firms.

- *Phase* t_3 *(Selection)*: Each potential supplier's production cost θ_{it} is realized. The buyer invites $\tilde{n}$ firms to compete for the production contract according to the mechanism he committed to in phase t_1. Such a mechanism selects a unique supplier i and may specify an additional transfer p to be made on delivery of the intermediate product.

- *Phase* t_4 *(Production)*: The selected supplier i produces at cost θ_{it} and receives the transfer p from the buyer. We assume for simplicity that in this phase the buyer observes the investment of the n investing firms.

When stating that the buyer commits to a transfer w and to a mechanism that selects a unique producer i and a price p we assume that these transfers and mechanism are contractible and as such enforced by an outside court. If the buyer opens procurement to competition (i.e. $n > 1$), then the mechanism he commits to at t_1 is an auction (to be specified momentarily) and the price p for production is determined by such auction. When $n = 1$, the mechanism is a degenerate auction in which the buyer simply commits to a price p to be paid at t_3.[7] Throughout the stage game we assume that the buyer has all the bargaining power and the buyer, as well as the supplier obtain a nil outside option if suppliers refuse the buyer's offer at t_2.

The level of investment I_i of any firm i, as well as the number of firms admitted at the selection phase t_3, are not contractible. Nevertheless, infinite repetition of the stage game allows the buyer and the firms to rely on relational contracting. In particular, if at t_4 the buyer observes that a firm i has invested $I_i < I$, he will exclude that firm from future procurements, possibly replacing it with another firm amongst the $N - n$ previously excluded firms. On a similar vein, if the buyer decides to invite $\tilde{n} > n$ firms to compete for production at t_3, then all N firms in the industry (observe this deviation and) will never trust the buyer: they will not invest in the future if selected.[8]

Although the buyer is uninformed about θ_{it} we assume, for simplicity, that firms observe the realization of all production costs.[9] When the selection mechanism is an auction, we take it to be a second price auction and, for simplicity, we exclude multi-sourcing.

Perfect observability of all investment at time t_4 is an extreme assumption, but similar results could be obtained assuming that the buyer only observes (exogenously) imperfect signals of the investments, possibly different for the blueprint that has been actually used in production.[10]

We assume the buyer does not offer contingent payments such as discretionary bonuses.[11] The discount factor across different phases of the same stage game is one and

[7] When the buyer chooses $n = 1$ we assume that he does not commit to a mechanism that screens the type θ_{it} of the supplier by allocating production to this supplier with a probability smaller than one. This is due to the fact that for the buyer failing to procure, not allocating the production contract to any supplier, is extremely costly.

[8] A formal definition of relational contracts and of the strategy profiles supporting them in equilibrium is provided in the Theoretical Appendix below.

[9] Incomplete information among firms would not qualitatively alter our results, at the cost of complicating the expressions of the informational rents earned by firms.

[10] Non-observability of the investments in blueprints not used in production would add an extra incentive compatibility constraint to avoid that a firm i sets $I_i = 0$, avoids winning the auction and systematically cashes w (if positive). This constraint would have no effect on our results.

[11] This assumption is theoretically justified in Calzolari and Spagnolo (2009) that shows that when

is δ across stage games.

3.1 Relational procurement

In this section we characterize the main properties of a relational procurement equilibria. We consider stationary relational contracts where the n suppliers, selected by the buyer, develop the required blueprint undertaking investment I and the buyer invites no more than the announced n firms to compete for the production contract.[12]

At the development phase, each of the n selected suppliers decides how much to invest, anticipating his expected informational rent $\beta(n)\pi(n)$ associated with the production contract in this stage game, where $\beta(n)$ is the probability that a given supplier will obtain the production contract among the n firms and $\pi(n)$ is the rent accruing to the producer. When $n \geq 2$ suppliers compete for production, the most efficient supplier wins the auction and receives a price a price $p = \theta(n)$ obtaining the rent $\theta\,(n) - \theta'(n)$, where $\theta\,(n)$ and $\theta'(n)$ are respectively the cost of the second and the first most efficient firm. Let $\pi(n) = \theta^e\,(n) - \theta^{e\prime}(n)$ be the expected rent with $\theta^e(n) = E[\theta(n)]$ and similarly for $\theta^{e\prime}(n)$. When instead $n = 1$, then $\pi(n) = p - E[\theta]$ where p is the price the buyer commits to at t_1 and, obviously, $\beta(1) = 1$.

A supplier that decides to invest, will optimally set his level of investment equal to the buyer's requirement I. Hence, his expected payoff over the infinite horizon game is

$$[\beta(n)\pi(n) + w - I]\frac{1}{1-\delta}.$$

If instead the firm decides to invest less than required, then he knows that the buyer will notice this deviation in phase t_4 of the stage game and exclude the supplier from all future procurements. Clearly in this case it is optimal for the deviating firm to set $I = 0$, the expected profit of this firm is then

$$w + \beta(n)\pi(n).$$

the number of firms selected in the pool is $n < N$, as is the case for all observations in our data, discretionary bonuses are not sustainable in equilibrium (because of the buyer's ability to defer paying the bonus and replacing the current supplier). Empirically, we are not aware of any single case of (public or private) procurement in which bonuses have been used, and the German car industry is not an exception.

[12] As shown in MacLeod and Malcomson (1989) and Levin (2003), with unlimited liability stationarity of contracts is without any loss of generality.

The supplier than chooses exactly the required investment i if the following incentive compatibility constraint is satisfied

$$w + \beta(n)\pi(n) \geq \frac{I}{\delta}. \tag{1}$$

In any stage game, a selected supplier chooses investment I as required if the expected rent from production $\beta(n)\pi(n)$ net of any transfer w is not smaller than the contemporaneous cost of investment I/δ. If δ is small this cost is higher and firms face a stronger temptation to cheat at the investment phase and cash in the informational rent at the production phase.[13]

Let $p(n)$ be the expected price that the buyer expects to pay for production when n firms compete. If suppliers choose the required investment I in the development stage, the buyer's infinite horizon payoff is,

$$[v(I) - nw - p(n)] \frac{1}{1-\delta},$$

If, instead, at t_3 the buyer invites more than n firms to compete, he knows that all suppliers will punish this deviation by not investing in the future. This implies that it is optimal for the buyer in this case to invite all the N available firms in order to profit from the lowest production cost. Since none of the suppliers invest in the future, the buyer will also set $w = 0$ in future procurements so that the buyer's expected discounted payoff from deviating is

$$v(I) - nw - p(N) + [v(0) - p(N)] \frac{\delta}{1-\delta}$$

The buyer does not deviate and invites more than the selected n firms to participate in the auction if the following incentive compatibility constraint is satisfied

$$[v(I) - nw - v(0)]\,\delta \geq p(n) - p(N). \tag{2}$$

In other words, the buyer does not deviate if the production-cost saving from having more firms competing, $p(n) - p(N)$, is smaller than the loss in the value of procurement (net of the transfers nw) that the buyer will face in the future (the square bracket).

[13] Notice also that constraint (1) implies firms' participation.

When δ is small the buyer has a stronger temptation to deviate and benefit from the reduction in the cost of production. Notice that when $n = 1$ even if the buyer could deviate inviting more firms and organizing an auction at t_3, this deviation is dominated. Indeed, when choosing $n = 1$ the buyer commits to pay p to the selected firm in any case and with such deviation he would simply duplicate the payments for production.

The optimal procurement program of the buyer is then

$$\begin{aligned}
&\max_{I,w,n} \quad [v(I) - p(n) - wn] \tfrac{1}{1-\delta} \\
&s.t. \quad \beta(n)\pi(n) + w \geq I/\delta \qquad (IC_s) \\
&\qquad\quad \delta [v(I) - wn] \geq p(n) - p(N) \text{ if } n > 1 \quad (IC_b)
\end{aligned}$$

where the buyer's incentive compatibility constraint only applies when $n > 1$ and is irrelevant when negotiating with a single firm, $n = 1$. This program shows that if the buyer wants to induce a high investment, he has to account for the suppliers' incentives, here represented by (IC_s). These put a limit on I. Relatedly, increasing the number n of competing reduces the cost of production $p(n)$ but adversely affects firms' incentives because the expected rent $\beta(n)\pi(n)$ decreases in n. On the other hand, a larger n reduces buyer's temptation to deviate because the higher cost of production that the buyer pays with respect to the case in which he invites all firms to compete, $p(n) - p(N)$ in (IC_b), decreases with n. Clearly, a higher discount factor δ helps to better control the buyer's and the suppliers' incentives.

It is immediate to see the optimal solution requires that the suppliers' incentive compatibility constraint (IC_s) is binding. Suppose it is not, then the buyer could reduce w thus increasing both the objective function and relaxing the (IC_b) constraint. From the fact that (IC_s) is binding we can derive a first simple but interesting set of observations.

Proposition 1 *Keeping constant two of the three procurement variables of the buyer (n, w and I), a higher level of trust δ is associated with: (i) a larger number of suppliers n, (ii) a higher level of investment I and (iii) a lower transfer w.*

Intuitively, the binding (IC_s) constraint

$$w = \frac{I}{\delta} - \beta(n)\pi(n) \tag{3}$$

implies that when the level of trust increases, δ increases, keeping w and I constant the buyer can afford a higher number of competing suppliers, associated with a lower production cost, since a higher n reduces each suppliers' expected rent from production: $\beta(n)\pi(n)$ is decreasing in n. A symmetric reasoning applies for the the other two results, (ii) and (iii).

We now move the analysis of *optimal procurement*, that is the values of n^*, I^* and w^* that solve the buyer's procurement program, and how they are affected by δ, the main parameter of interest. The comparative statics with respect to the level of trust is complicated by the fact that a higher δ has several and possibly countervailing effects on optimal procurement. For example, an increase in δ may induce an higher level of investment which, in turns, may call for a reduction in n to grant a larger informational rent to the suppliers which is required to create incentives for the selected suppliers to make the higher investment.

Substituting w from (3), the buyer's objective function becomes

$$H(I,n) = v(I) - n\frac{I}{\delta} - \bar{\theta}^e(n) \tag{4}$$

where $\bar{\theta}^e(n)$ is the actual cost of production, respectively equal to $\theta^{e\prime}(n)$ for $n > 1$ and $E[\theta]$ for $n = 1$. The cost of investment as faced by the buyer is thus nI/δ which implies that the optimal level of investment I_n for a given n is implicitly defined by

$$v'(I_n) = \frac{n}{\delta}. \tag{5}$$

Indeed, notice also that if for a given n constraint (IC_b) is violated at I_n then it is so also for any other I because the l.h.s. of (IC_b) is the very same objective function maximized by the supplier's choice I_n. It is thus worth noticing that if at I_n and n constraint (IC_b) is violated, then the previous reasoning implies that n is not *feasible* in the sense that the buyer will never be able to procure with n suppliers and optimal procurement must necessarily require a different number of suppliers.

Notwithstanding the complications to determine the effects of an higher δ on optimal procurement, we can derive the following.

Proposition 2 *Let n and $\tilde{n}$ be two feasible number of competitors, that is (IC_b) is binding neither at n nor at $\tilde{n}$, with $n > \tilde{n}$. If $\frac{v''(\zeta)}{v'(\zeta)}\zeta + 1 < (>)0$, that is the relative* *concavity of $v(\cdot)$ is high (low), then the buyer prefers to procure with fewer firms $\tilde{n}$ instead than with more firms n if $\delta \leq (\geq)\delta_{\tilde{n}n}$. The threshold $\delta_{\tilde{n}n}$ is implicitly defined by*

$$\bar{\theta}^e(\tilde{n}) - \theta^{e\prime}(n) = \left[v(I_{\tilde{n}}) - \frac{\tilde{n}I_{\tilde{n}}}{\delta_{\tilde{n}n}}\right] - \left[v(I_n) - \frac{nI_n}{\delta_{\tilde{n}n}}\right]. \tag{6}$$

This result shows that an increase in the level of trust may induce a larger number of firms, i.e. n^* is increasing in δ, as long as the relative concavity of the value of investment is sufficiently high. Moreover, we may expect that the optimal solution contemplates few firms, that is n^* is small. In particular, there exists configurations of parameters that imply that the solution to the optimal procurement problem for the buyer occurs for $n^* = 1$ or $n^* = 2$. As we will see, these values of n^* are compatible with our empirical observations in the German car manufacturers sector.

Consider the buyer objective function in (4) above and consider the case $n > 1$. With a slight abuse of notation we obtain that

$$\frac{\partial H(I,n)}{\partial n} = -\frac{I}{\delta} - \frac{d\theta^{e\prime}(n)}{dn}$$

where

$$\frac{d\theta^{e\prime}(n)}{dn} = \int_{\underline{\theta}}^{\overline{\theta}} [1 - F(\theta)]^n \ln(1 - F(\theta))d\theta < 0.$$

In other words, the objective function $H(I, n)$ is decreasing in n for $n > 1$ if and only if:

$$\frac{I}{\delta} > \int_{\underline{\theta}}^{\overline{\theta}} [1 - F(\theta)]^n \ln(1 - F(\theta))d\theta \tag{7}$$

Consider now the function (I_2/δ), from the definition of I_2

$$v'(I_2) = \frac{2}{\delta} \tag{8}$$

we have that

$$\frac{d(I_2/\delta)}{d\delta} = -\frac{v'(I_2)}{\delta^2 v''(I_2)}\left[\frac{v''(I_2)}{v'(I_2)}I_2 + 1\right]$$

In other words, the function (I_2/δ) is monotonic increasing in δ if the relative concavity of $v(\cdot)$ is low:

$$-\frac{v''(I_2)}{v'(I_2)}I_2 < 1. \tag{9}$$

It is instead monotonic decreasing in δ if the relative concavity of $v(\cdot)$ is high:

$$-\frac{v''(I_2)}{v'(I_2)}I_2 > 1. \tag{10}$$

This implies that there exists a threshold δ_n defined by

$$\frac{I_2(\delta_n)}{\delta_n} = -\int_{\underline{\theta}}^{\overline{\theta}} [1 - F(\theta)]^n \ln(1 - F(\theta)d\theta \tag{11}$$

such that under (9) for every $\delta > \delta_n$, or under (10) for every $\delta < \delta_n$, the buyer objective function $H(n, I)$ is decreasing in n for $n > 1$, condition (7) is satisfied.

Under the latter conditions it is then clear that if $n^* > 1$ the solution to the buyer optimal procurement problem is at a corner. In other words, the key comparison for the buyer is between the choice of a unique supplier, $n = 1$, or the choice of two potential suppliers, $n = 2$.

Then there exist parameter values and specific functional forms for $v(I)$ such that when the relative concavity of $v(I)$ is sufficiently high, the two thresholds δ_n, as defined in (11), and δ_{12}, as defined in (6) for $\tilde{n} = 1$ and $n = 2$, are such that:[14]

$$\delta_{12} < \delta_n$$

moreover for every $\delta < \delta_{12}$ it is optimal to procure development and production to a unique firm, $n^* = 1$, for $\delta_{12} < \delta < \delta_n$ it is optimal for the buyer to select two potential suppliers, $n^* = 2$, and for $\delta > \delta_n$ it is optimal for the buyer to select a number of supplier strictly higher than two, $n^* > 2$. Clearly, this specific example is characterized by the fact that it is optimal for the buyer to procure from just one or two potential supplier for relatively low values of trust, δ is not too high. Notice, however that, in general, the relative concavity of the value function $v(I)$ may change for different value of the desired investment I and hence not necessarily a choice of a low number of suppliers is associated with relatively low value of trust.

In what follows we will test empirically the predictions of Proposition 1 above. The predictions of Proposition 2 are harder to bring to the data given that they heavily rely on the relative concavity of the value to the buyer, the OEM in the case of car

[14] A specific functional form of the function $v(I)$ that is associated with a constant and higher than one relative concavity is the function $v(I) = v(0) - I^{-b}$ where $v(0) > 0$ and $b > 0$.

manufacturer. In other words, what is needed for this test is a measure of the marginal productivity of the supplier investment, a clearly difficult variable to identify.

3.2 Mapping theory into our data

We now specify the predictions of our analysis that we want to bring to the data. Key to our analysis is the notion of trust, we summarize here our the interpretation of such a notion. In a bilateral long term relationship possibly affected by opportunism, parties are characterized by their ability to resist the temptation to defect from the agreement. The higher this ability is for one party, the more trustworthy this party is considered. Equivalently, the other party trusts more him or her. As shown in the incentive compatibility constraints for suppliers and the buyer (respectively IC_s and IC_b in the optimal procurement program), the ability to resist to the temptation to deviate is affected by many ingredients: the level of investment, the level of competition contemplated in the relational contract, and the discount factor δ. This last ingredient δ can be conveniently used to parametrize changes in the ability to resist temptation and analyze its effect on procurement.

With this interpretation in mind, Proposition 1 states that a buyer can ask for a high level of investment from a supplier if, ceteris paribus, he knows (or has expectations) that the latter has a high discount factor. In such a relationship characterized by high investment, it is important that trust is high otherwise the supplier will prefer to deviate. Conversely, when the agreed I is lower, trust is less important in the sense that the relational procurement is viable even if the supplier is characterized by a low δ. A similar reasoning can be applied substituting the level of competition for the level of investment.

In the empirical analysis, suppliers' competition, as chosen by the buyer's procurement strategies, will correspond to the number of suppliers invited to the development stage and allowed to compete for production: our n in the model. The investment in research and development I will be proxied by the observed failure rate, known to be strictly related to the suppliers' effort and quality of the blueprint. Finally, the transfer w contemplated in the model for all investing suppliers will be proxied with the direct compensation of suppliers for R&D development costs, in addition to the mark-up that a supplier can obtain if it is selected to actually produce the part.[15]

[15] We will also use alternative measures for w as the lump-sum payments that the buyer guarantees

We can now formulate the predictions we derive from the model in terms of the following three hypotheses.

Hypothesis 1 *For given level of competition and direct compensation of R&D costs, higher relationship specific investments by suppliers (resulting in lower failure rates of parts) are associated with higher importance of trust.*

The analysis of the effect of trust on the level of competition induced by the OEM is perhaps more complex and surprising. In a large part of the relational contracting literature, it is argued that depending, for example, on the enforceability of complex clauses, competitive (arms-length) contracts are at the opposite end of the spectrum from relational contracts, which appear more closely related to trust. The two therefore are considered mostly mutually exclusive.

On the basis of these findings one might expect, at first blush, that supplier-OEM relationships governed by trust should be associated with less competition being induced by the OEM. Yet our previous analysis shows that generically the opposite should be true if we are in a world governed by long term relationships: the higher is the level of competition, the more important will be trust to sustain that competition.

The intuition behind this result is as simple as it is striking. From the perspective of the OEM, a reduction of competition is costly (in the terms of higher production payments) and vice-versa. The OEM's ability to induce more competition is limited by the level of investment on the side of the supplier it wants to induce. Intuitively, a higher level of trust relaxes this constraint and enables the OEM to pick a higher level of competition. This can be interpreted as trust and rents (to suppliers) from reduced competition being substitutes, or, equivalently, trust and competition being complements. Our second hypothesis from the formal model is then:

Hypothesis 2 *For given level of investment (failure rate) and direct compensation of R&D costs, more intense competition between suppliers is associated with higher importance of trust.*

The last hypothesis resulting from Proposition 1 concerns the association between trust and the direct compensation in addition to production mark-up.

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to suppliers for investment that are not reflected in the price for production.

Hypothesis 3 *For given level of competition and investment (failure rate), lower direct compensation of suppliers for their R&D costs by the OEM is associated with higher importance of trust.*

In what follows, we bring these Hypotheses to the data and test whether they are reflected in what we observe in the German car industry in recent years.

4 Data and Descriptive Statistics

4.1 Data Source

Our data are the outcome of a unique online questionnaire survey study that we conducted under the auspices of the VDA between Fall 2007 and Summer 2008. The questionnaire design was based on the results of a pilot study performed in Spring 2007, in which we had conducted numerous interviews with high ranking executives in the industry.[16] The questionnaire data provide us with a view of the relationship between OEMs and their first-tier suppliers in a detail unmatched heretofore. Each participating supplier was asked to evaluate its relationship with each OEM it supplied to in Germany in clinical detail, and this separately for up to four products representative for each of the four product classes of an established industry classification.[17] The four product classes are:

Commodities: physically small and technologically unsophisticated (e.g. shock absorbers);

(High-tech) Components: physically small but technologically sophisticated (e.g. electronic sensor clusters);

Modules: physically large but technologically unsophisticated (e.g. front ends);

Systems: physically large and technologically sophisticated (e.g. break systems).

The questionnaire consisted of more than 300 questions covering all central functions within the firms. In total, more than 1,500 questionnaires were filled in by competent

[16] For the qualitative results of this case study, see Müller, Stahl, and Wachtler (2008).

[17] In addition, the OEMs were asked to provide a general evaluation of their sourcing relationships for each of the four different product classes.

engineers, procurement, and sales officers. A participant first would have to indicate his function within the company out of the following seven:[18] *pre-development* ("basic" technological research, not model-specific technological development), *vehicle development* (car-model specific technology adaptation), *series production*, *quality control*, *sales*, *logistics*, *aftermarket production*. Finally, the participant was asked to choose a product for which he had the necessary know-how, as well as the customers he worked with. For each product and customer, he would then answer the set of questions suited to his function within the company.

In the present study, we use only responses provided by the suppliers rather than the OEMs. We consider as one observation the set of answers to the *entire* supplier questionnaire for a given product and customer. Thus, each observation describes one supplier's view of the relationship with a given OEM for a product representative for the technical class.[19] Potentially, therefore, differing individuals, working for the same supplier, contributed answers to the different parts of the questionnaire. In order to obtain observations that covered as much of the questionnaire as possible, we merged the answers received from a given supplier for a given product class and customer over all functions to cover all aspects of the relationship.[20]

4.2 Descriptive Statistics

With the underlying questionnaire we sought to depict complex supply relationships in hitherto unmatched detail. Therefore, we first introduce (perhaps in more than usual detail) the variables we focus on, in the hope to shed some light on the basic forces and tensions that are at play between manufacturers and their suppliers.

[18] For a detailed description of the individual functions and the automobile development and production process, we refer to Müller, Stahl, and Wachtler (2008). The characteristics of Pre-development, Development and Series Production is discussed in Section 4.2.2.

[19] We do have missing observations for two reasons: First, the questionnaire was not necessarily completed for each product within each function of a company. Second, participants occasionally skipped individual questions. Therefore the number of observations over questions differs, as reported in the descriptive statistics below. In addition to this, not every supplier cooperated with every OEM in every product class.

[20] Whenever parts of questionnaires overlap, we use the arithmetic mean of the answers.

4.2.1 Participating Companies, Class Specification and Bargaining Power

On the OEM side, all automotive manufacturers producing in Germany participated in the survey, 7 producers of passenger cars and 3 truck makers. Upstream 13 suppliers active in the German market completed the survey on 11 OEMs (the 10 participating automotive manufacturers plus one outside player). The supplier sample is strongly biased towards large participants, with average revenues in 2007 of 9.4 billion Euro (std. 12.4). Even the smallest participant posted revenues of more than 700 million Euro. This is reflected by the self-reported European market shares for the individual products in our sample: This was provided on a 5-point scale with an average of 3.74 (std. 0.94), which translates into a share of more than 25% of the European market.

One might worry that the larger suppliers are able to exert monopoly power over OEMs for some of the parts we study. As a result we might pick up the effects of differentials in relative bargaining power instead of differentials in trust, as discussed in the theoretical model above. Using data from a separate commercial database,[21] we verified that each product in our sample was produced by at least two firms active in the German market. Further, we use proxies to control for relative market power in our regressions, as this may clearly affect bargaining strength and the OEM's outside option, as described below.

The first proxy for relative bargaining power is the relative size of the companies, therefore we include the 2007 revenues of suppliers in the regressions. The second set of proxies is related to the product class or type specification introduced above, which are strongly related to relationship specificity: Suppliers were asked to estimate the R&D-share of total costs for the particular part being analyzed. The item is measured on a 5-point scale provided in 5% increments — ranging from less than 1% to more than 15%. The following Table 1 displays the statistics for the R&D cost shares by product class.

Cost share R&D	Mean (Std. Dev.)	Min	Max	Obs
Systems	3.00 (0.96)	1	5	42
Modules	2.54 (0.78)	1	5	44
Components	3.10 (0.89)	2	5	53
Commodities	2.45 (0.63)	2	5	91

Table 1: Cost share R&D of total cost by product type.

[21] "Who supplies whom" collected by supplierbusiness.com.

The average R&D cost shares for the high-tech parts systems and components are significantly higher – by about 2.5 percentage points than for modules and commodities.[22] The averages are around 7.5% for the high-tech parts and only 5% commodities and modules, so the difference is very substantial. To use as many of our observations as possible, we capture the technological sophistication of a part (and, in a sense, the specificity of the relationship) by introducing a dummy variable which takes the value 1 if the part is a system or high-tech component. We also introduce a dummy taking the value 1 for systems and modules, in order to account for potential price differences due to the sheer size of the part. To account for potential system-specific effects, we introduce an interaction term between the two dummies.[23] Finally, to capture remaining effects of market structure, we include "customer fixed effects," that is dummies for each of the individual OEMs in the regressions.

4.2.2 Product Development Life-cycle and Supplier Competition

In our theoretical model, we depict two different stages in the development life-cycle of a product: The development stage, in which suppliers invest to create a blueprint, and the production phase, in which the surplus is generated and allocated. While clearly a simplification, this structure is mirrored in our data. Indeed, we observe three distinct phases in the product life-cycle: *pre-development*, *development* and *series production*. Below, we briefly sketch these phases and describe how we use them in our empirical approach.

In *series production*, suppliers work with existing blueprints and completely designed (or existing) tools to produce the part in question. The product and services can be clearly specified through contracts, determining in detail, for example, acceptable failure rates and delivery conditions. None of this is possible in the model-specific *development* phase. While the desired functionality of a part can be described, potentially highly complex interfaces with other parts cannot be specified ex-ante. Blue-prints for the part do not exist at the beginning of the design phase, indeed they are the outcome of such a phase. The evolution of interfaces in the course of the part's (and other parts'

[22] Pairwise sample mean comparison tests reveal significant differences between systems/components and modules/commodities, but not within each of these groups. Among these two groups the hypothesis of equal means cannot be rejected, which is in line with the product class specification.

[23] In what follows, in particular in the regression tables, these variables are labeled "tech. soph.," "size of part" and "interaction," respectively.

simultaneous) design poses limitations to precise specifications in ex ante contracts; this requires a continuous cooperative process. *Pre-development* covers R&D on new technology, often purely based on the supplier's initiative. By necessity, even if this involves contracts, they cannot be clearly specified. For example, take the design of a new brake-technology: Engineers may have no knowledge of how fast or heavy is the car model, in which this breake-system will be implemented. Pre-development often involves fundamental research, as a result it is even harder to write enforceable contracts on the expected outcomes.[24]

How do the OEMs' procurement decisions differ over the different development phases? Parallel to the theoretical model, we asked how many competing suppliers worked on the product in question within each of the design and production stages. For this set of questions, the development stage was further subdivided into the four sub-phases (starting with the earliest): product planning, product specification, concept development and detailed development. Detailed development generates the final blueprint — this is what we interpret as the investment period in our theoretical model. For series production, we observe the number of suppliers at series start, after 1-2 years and after more than 2 years.

For pre-development on average more than two (2.29) suppliers compete.[25] This number stays about constant in the first three stages of development, before it significantly *decreases* for the last development phase down to 1.51.[26] It reaches its nadir at the beginning of series production with 1.20, before it increases again to 1.59 two years into production.[27] How can we interpret these results? During pre-development, the OEMs have multiple hand-picked suppliers work in parallel on the designs. The most promising approach is brought into the development process. As the contractual reimbursement for pre-development work is on average below 60% of the actual costs, whether or not the company is awarded a subsequent development contract, there is a strong incentive for suppliers to do everything possible for their preliminary design to be selected. An analogous process is repeated again for the development process, resulting

[24] Overall, it is to be expected that contracts in the earlier phases are less specific, and rely on enforceability by repeated relationships, while contracts written in the production phase are more specific and rely on enforceability by the courts. See Brown, Falk, and Fehr (2004) for experimental evidence on a similar question.

[25] See Table 8 in the Appendix.

[26] See Table 9 in the Appendix.

[27] See Table 10 in the Appendix.

in the specific blueprint. With this, the quality uncertainty is practically eliminated, given that firms are generally certified through stringent quality assurance processes. In production, fewer suppliers with higher volumes promise the highest economies of scales and the steepest learning curves. In addition, obtaining a sole production contract is the carrot waiving in front of the suppliers in the previous design and investment process. Therefore the number of suppliers drops significantly at production start, in most cases down to a sole producer. Once the learning curve effects have been realized, the OEM can start to bring additional suppliers in.

These considerations are supported by a second set of observations. The respondents were asked to specify how often different procurement strategies are employed by the OEM for the product class in question in each of the different stages.[28] For pre-development, the options offered were *preselection of a specific supplier* and *procurement among a limited number of suppliers*, each on a 6-point scale from 1 (never) to 6 (very frequently). For development and series production, *open procurement* was added as a further option. From the above, we would expect a shift from relational to more arms-length contracting over the three phases and the results clearly support this hypothesis.

For pre-development, OEMs are significantly more likely to contract with specific suppliers (mean 4.43) than to go through a limited competitive procurement process (mean 3.95, t-test for difference of means significant at 1% level).[29] In contrast to this, pre-selection of suppliers is significantly less likely both for development (mean 3.06) and series production (mean 2.98).[30] For development, the OEMs are significantly more likely to procure among a limited number of suppliers (mean 5.18), so there is a clear shift to more market-based interactions from pre-development to development.[31] Similarly from development to series production, where procurement among a limited number of suppliers grows less important (mean 4.55), but there is a significant increase in the use of open procurement (2.44 instead of 1.97).[32]

[28] Note that there is substantial variation in this measure as the pre-development, development and production of parts are often procured separately. In addition, production is frequently procured anew for each new series of a given model. There may be a new procurement process every 18 to 24 months, and different strategies could be used at different points in time.

[29] See Table 8 in the Appendix.

[30] See Tables 9 and 10 in the Appendix, respectively.

[31] See Table 9 in the Appendix.

[32] See Tables 9 and 10 in the Appendix.

4.3 Measures of Trust

Trust is a sensitive concept which has proven to some degree elusive to attempts at explanation and measurement by economists. Existing studies have mostly employed either experimental/behavioral evidence, or subjects' answers to variations on the question "Can other people be trusted in general?" so the addressees of trust were not specified. In contrast, our data has the advantage that it is relationship-specific. We ask representatives of company A about their specific evaluation of the trust relationship with company B with regard to the interactions concerning a type of product in three ways, each with a slightly different emphasis:

1) *What is the importance of trust for your firm's decision to initialize a pre-development with the OEM?*

2) *How do you evaluate mutual trust between OEM and supplier with respect to honoring each others intellectual property rights?*

3) *Please evaluate the importance of mutual trust between the supplier and OEM for the OEM's supplier selection (respectively for each of the 3 product developments stages).*

In a separate appendix,[33] we show in detail that the resulting measures are strongly positively correlated with each-other, as well as by which measures of OEM behavior, such as aggressive price re-negotiations, they are affected. In addition, we perform a factor analysis to demonstrate that significant shares of the variation in the measures can be explained by a single underlying factor. In the analysis below we use the third measure, in our view the most consistent of these measures both in terms of the phrasing of the question as well as the results of the factor analysis.

These questions were posed in a particular context: Suppliers were asked to evaluate the OEM's supplier choice criteria on a six-point scale from 1 (no relevance) to 6 (very important), for each stage of the development and production process, i.e., pre-development, development and series production. One item, our main variable of interest, was mutual trust between supplier and OEM. But suppliers were also asked to evaluate the importance of price on the same scale. Our preferred measure of trust is

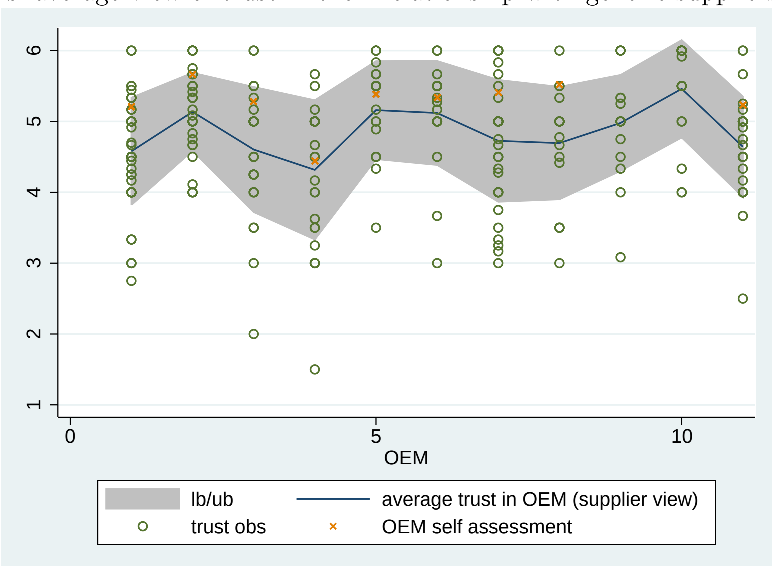
[33] Available at: *Trust Appendix*.

the arithmetic mean of the answers to the importance of trust items. The measure has a mean of 4.81, a minimum of 1.5, a maximum of 6 and a standard deviation of .81, with 309 observations.[34]

The identical trust questions were also posed to OEMs in our questionnaire (but not all OEMs in the sample participated) – with the crucial difference that they did not give relationship-specific answers, but instead evaluated their trust relationship with a "generic" supplier. Figure 1 depicts both the assessments of individual suppliers regarding the different OEMs', as well as how each of these sees their relationship with generic suppliers. The figure underlines the different sources of variation in our data: On the one hand, trust (by suppliers) differs substantially across OEMs. But in addition to this, the relationships between suppliers with any given OEM can differ substantially with regard to the level of trust they involve. In our empirical approach in the following, we will use both of these sources of variation to identify the effects we are interested in.

Figure 1: Sources of variation in the trust measure.

Individual assessments and the average of trust in each OEMs from the perspective of suppliers, as well as the OEMs' average view of trust in their relationship with generic suppliers.



[34]One issue with this type of response item is that individuals have idiosyncratic interpretations of what is "important". In one major robustness-check, as a normalization we use the relative importance of the trust-item to the price item by taking the differences between the two as the trust measure (i.e., the relative importance of trust vs. price). Our findings are not affected by this. Also, we performed the regressions below using the individual measures instead of the arithmetic mean. The results are qualitatively the same, though significance levels vary a bit due to the number of observations being smaller.

5 Empirical Analysis

In this section, we directly test the hypotheses resulting from our theory using this trust measure. Each question is related to central aspects of the buyer-supplier relationships: First we study how trust is related to relationship specific investment, then we study the role of trust with regard to suppliers' compensation for development costs and finally, we consider the relationship between trust and the level of supplier competition induced by the OEM (measured by the number of competing suppliers).

There is one important caveat. Due to the cross-sectional structure of our data set, determining the direction of causality is an issue. One can make the argument that higher investment by suppliers leads to higher levels of trust in the OEM: Less investment by the supplier may lead to more conflicts between the parties, which in turn negatively affects trust. We apply an instrumental variable approach to explore the issue of causality more closely.

With regard to our second hypothesis, even within our analytical framework there is no clear causal direction between trust and the competition which the OEM chooses to induce, instead, it is an equilibrium effect – we would expect to find settings, in which high levels of trust coincide with more supplier competition and vice-versa. Therefore, we will refer only to the correlation between trust and competition.

5.1 Trust and Investment

Hypothesis 1 from our model states that higher levels of trust should be associated with more relationship specific investment by suppliers. Measuring supplier investment poses a serious challenge. As we do not observe product-specific investment directly,[35] we apply proxies based on the quality of parts. It is a standard interpretation of quality related effort in the literature that supplier investment directly affects the failure rates of parts (see, for example, Taylor and Wiggins (1997)).

Along these lines, the suppliers were asked: *With respect to the part considered, how often do quality problems occur?*, measured on a 5-point scale, with 1 identifying the lowest and 5 the highest frequency, and the middle of the scale anchored at 50%. We create a dummy variable which takes the value 1 only if no quality problems occur,

[35] In our qualitative interviews, the suppliers stated that even they themselves have difficulties in specifying the development costs or the capital outlay for the production of a particular part.

that is a 1 was reported for the quality question. In general, severe difficulties would arise when trying to assess under-investment-related quality issues empirically, as a) the observed failure rates of cars cannot necessarily be linked to individual parts, b) the diligence of the manufacturer in assembly also affects quality and c) if quality problems are diagnosed and solved before the parts are installed, this is generally not observable. The huge advantage of our questionnaire is that the responses are part-specific, which addresses issue a). The phrasing of the question addresses issue c), as it was meant to include all of the development and production phases involving the part in question. By including customer- or OEM-effects in the regressions, we address issue b).[36]

We choose the following Probit specification with robust standard errors: y_{ij} denotes the probability that no quality problems arise with part i at OEM j, κ is a constant, α the customer fixed-effect, and Z represents the control variables (dummies for the technological sophistication and size of the part, the interaction term, and the supplier revenues in 2007).

$$y_{ij} = \kappa + \alpha_j + \beta * trust_{ij} + \gamma * Z_i + \epsilon_{ij} \tag{12}$$

Our hypothesis predicts a positive coefficient for β. We estimate the model with and without customer dummies.

Further, to make use of all information in the original question, we also carry out fractional Probit regressions; the results can be found in the same Table 2. Notice that due to the definition of the dummy, the effects in these regressions move in opposing directions and have to be interpreted accordingly.

Finally, as discussed above, there is a potential issue of reverse causality. To address this, we implement an instrumental variable approach (2SLS linear probability model). We instrument our trust measure by another questionnaire item. Suppliers were also asked the following question: *How often during the (pre-)development process does information leak, via the OEM to competing suppliers, in a way undesired by the supplier involved in the (pre-)development?*.[37] One might be worried that quality issues resulting

[36] A potential drawback is the fact that the frequencies are self-reported, so that respondents may be tempted to under-report problems. To counter this, complete anonymity was guaranteed at the outset and upheld throughout the course of the study.

[37] Answers provided on a 5-point scale 1-very rarely, 5-very frequently, anchored at 3-50% of cases. Mean of the variable is 2.24, standard deviation 0.95. Correlation with our trust measure is -.3525, p-value below 0.0001. As the instrument, we use dummies for each of the answer categories.

from lower investment might cause cracks in the trust relationship, instead of the lack of trust leading to lower investments. Our instrument is exogenous to this for two central reasons: First, it addresses issues arising at an earlier stage in the development process. Second, it inquires after behavior on the side of the OEM that is detrimental to the supplier's interests, but not vice-versa. As one would expect, the instrument is strongly negatively correlated with our trust measure. Nevertheless, due to the low number of observations, we run into weak instrument issues (First stage F-values of around 4.3, well below the "critical" level of 10), therefore the coefficients are potentially biased. This caveat must be borne in mind; we present the results as qualitative evidence for the direction of causality, but would be very careful in interpreting the size of coefficients.

The results of the regressions can be found in the following Table 2.[38]

Variables	**Probit ♠**		**Fractional-Probit♡**		**IV-2SLS♣**	
trust index	**.333****	**.461****	**-.161****	**-.206*****	**.481****	**.745****
	(.024)	(.004)	(.016)	(.001)	(.016)	(.045)
tech. soph.	-.302	-.358	.146	.147	-.151	-.234
	(.274)	(.199)	(.344)	(.335)	(.168)	(.101)
size of part	**-.730****	**-.734****	**.598*****	**.607*****	-.186	.128
	(.015)	(.017)	(.000)	(.000)	(.166)	(.458)
interaction	-.317	-.251	-.077	-.090	-.008	.164
	(.607)	(.685)	(.775)	(.734)	(.981)	(.653)
supplier revenues	-.003	-.005	-.004	-.004	-.004	-.008
	(.776)	(.664)	(.410)	(.434)	(.569)	(.325)
const	-1.206	**-1.716****	**-.551**	-.284	**-1.642***	-2.751
	(.100)	(.038)	(.095)	(.433)	(.090)	(.113)
OEM-FE	**no**	**yes**	**no**	**yes**	**no**	**yes**
# obs.	140	140	140	140	121	121
Ps-R^2	.120	.137	-	-	-	-

♠ probability of *not* observing quality problems, coefficients and (p-values) reported; ♡ frequency of quality problems arising (in percent), coefficients and (p-values) reported;♣ probability of *not* observing quality problems, coefficients and (p-values) reported; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: Trust and Investment: Probit, Fractional-Probit and IV regression results

Consider the results of the Probit estimation first: The coefficients of the trust variable are indeed significantly positive, that is, higher levels of supplier trust are associated with less frequent quality issues. The size of the coefficients is relevant from an economic

[38]We analogously observe assessments of the frequency of product related recalls. Performing the same exercise for these yields qualitatively identical results.

perspective. Computing the marginal effects (.132 without FE, .183 with FE), increasing trust by one standard deviation coincides with a decrease in the probability of quality problems by more than 16%, if one disregards the identity of the customer. If one controls for the identity of the customer (OEM dummies) then there is an even stronger effect that corresponds to a decrease in the probability of quality issues by more than 22%. The difference between the two values is in itself interesting. One explanation is that the OEM undertakes a complementary investment, in its absence both the supplier's trust and the quality of parts may decrease. In other words, the effect of trust on quality (via the suppliers' investment) is underestimated. In the fractional-Probit regressions, we find the same qualitative picture, with slightly higher effects of trust. An increase of trust by one standard deviation would be associated with a decrease in the probability of quality issues by about 20% (no FE) and about 25% (with FE), respectively. Larger, more complex parts, i.e., systems and modules, are more likely to suffer quality problems. Finally, when instrumenting trust by past misbehavior on the side of the OEM, we still find a positive and significant association between trust and investment, which is an indication that the direction of causality actually does run from trust towards investment; though, as described above, due to the low number of observations, this result and especially the magnitudes of the coefficients have to be taken with a grain of salt.

Overall, we conclude that the evidence from the results supports our first hypothesis: As far as investment can be measured by the (inverse) frequency of quality problems, higher levels of trust are associated with higher levels of investment by the supplier.

5.2 Trust and Transfers for Development Costs

The second hypothesis that we test empirically concerns the relationship of trust and transfers, w, from OEMs to suppliers as reimbursements for development costs. In our survey, we have a direct way to measure this, with the the corresponding question asking for the percentage of development costs that the OEM reimburses via a lump-sum payment. For an indirect approach to assess his hypothesis, see the following section.

We estimate the following specification with robust standard errors: w_{ij} denotes the share of costs reimbursed as a lump-sum for part i produced for OEM j, κ is a constant, α the customer fixed-effect, and Z represents the control variables (dummies for the technological sophistication and size of the part, the interaction term, and the supplier revenues in 2007).

$$w_{ij} = \kappa + \alpha_j + \beta * trust_{ij} + \gamma * Z_i + \epsilon_{ij} \tag{13}$$

Again, we test two different estimation procedures, OLS and fractional probit since the dependent variable is a share.

Variables	**OLS** ♠		**Fractional-Probit**♡	
trust index	.011	-.003	.034	-.006
	(.636)	(.907)	(.623)	(.941)
tech. soph.	.026	.043	.085	.131
	(.585)	(.361)	(.580)	(.378)
size of part	**.181*** **	**.147** **	**.518*** **	**.432*** **
	(.005)	(.015)	(.003)	(.009)
interaction	-.072	-.086	-.190	-.232
	(.474)	(.347)	(.504)	(.373)
supplier revenues	**-.003** **	**-.003** **	**-.011** **	**-.010** **
	(.025)	(.015)	(.019)	(.033)
const	**.205** **	**.216***	**-.825*** **	**-.803**
	(.048)	(.090)	(.001)	(.037)
OEM-FE	**no**	**yes**	**no**	**yes**
# obs.	167	167	167	167
R^2	.102	.248	-	-

♠ reimbursement share in percent, coefficients and (p-values) reported; ♡ reimbursement share in percent, coefficients and (p-values) reported; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Trust and Reimbursement: OLS and Fractional-Probit regression results

From this direct approach, we cannot derive a confirmation of Hypothesis 2 – there is no significant effect of trust on the share of development costs directly reimbursed through a lump-sum by the OEM. Note that the measure used as the dependent variable is not perfect, as it only covers one of the potential channels of reimbursements of costs; in addition to this, information with regard to the reimbursement of costs and prices is highly sensitive, which may have introduced additional noise to this self-reported measure. In the following subsection, we discuss the third hypothesis, but also present additional information with regard to hypothesis 2.

5.3 Trust and Competition

Our third central hypothesis is that higher levels of trust should be associated with more competition induced by the OEM. The supplier faces attempts at rent extraction by the OEM either through the exploitation of the hold-up situation, or through competition at the investment stage. More competition may then be associated with higher levels of compliance to property rights by the party with the superior bargaining power, and therefore higher levels of trust.

In view of the structure of our data, our model predicts a specific, somewhat counterintuitive pattern:

1. For the pre-development stage (in which the investments by the supplier are not model-specific and therefore the underlying holdup-problem is mitigated), our model provides no reasons to expect a significant positive relationship between trust and competition.

2. In the development stage, model- and relationship-specific investments are required from the supplier. This is the exact setting envisioned in Proposition 1. Therefore, we would expect trust and competition to be positively associated in this phase (Hypothesis 2).

3. In the series production stage, our model also predicts a positive association, but for another reason. A higher level of trust relaxes the supplier's IC constraint. For given quality levels, this means that the OEM can reduce compensation (Proposition 1, ii). In the automotive industry, compensation for development investments is to a large share granted through markups for the supplier during series production. Therefore, controlling for quality (measured by failure rates, as above), we would expect that with higher levels of trust, more competition can be induced in series production (Hypothesis 3).

Notice that the existing relational contracts literature would generally predict a negative relationship between arms-length contracting/competition and trust.

Our empirical test is therefore to analyze how supplier competition in the different stages of production — measured by the number of parallel suppliers involved in the pre-development, development and production of the specific model, respectively — are associated with our trust measure. We report OLS results below. [39] In the following specification n_{ij} is the number of suppliers employed by customer (OEM) j for part i, κ a constant, x is the trust measure and Z the vector of control variables including the investment level/quality level of the part.

$$n_{ij} = \kappa + \beta * x_{ij} + \gamma * Z_i + \epsilon_{ij} \tag{14}$$

Higher levels of trust should be associated with a higher incentive to extract rents by means of more competition, that is employing more parallel suppliers. According to our second hypothesis, we would expect a positive sign for β in the specification for development, but not for the pre-development phase. As higher trust allows a reduction of compensation, the second prediction is a positive relationship between trust and competition in the series production stage when controlling for quality. The results are in table

Variables	**Pre-development**♠	**Development**♠	**Series Production**♠
trust index	.084	**.364*****	**.232****
	(.585)	(.006)	(.018)
tech. soph.	-.214	**-.421****	**-.459*****
	(.430)	(.035)	(.002)
size of part	-.459	.292	**-.482*****
	(.168)	(.422)	(.000)
interaction	.328	-.591	**.448*****
	(.466)	(.228)	(.033)
supplier revenues	.004	**.038*****	.003
	(.654)	(.006)	(.547)
quality of part	**1.27****	-.104	0.033
	(.042)	(.843)	(.900)
constant	1.236	-.669	0.190
	(.125)	(.333)	(.436)
OEM-FE	**yes**	**yes**	**yes**
# obs.	71	112	113
Adj. R^2	.167	.275	.272

♠ (p-values) reported; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Trust and Competition: OLS-regression results

[39] Taking the structure of our data into account, since significant shares of the observations are at the lower limit of 1 supplier we also carried out Tobit regressions. The results are qualitatively identical.

With regard to our central hypothesis, we find that the trust measure is strongly, positively and significantly associated with the number of suppliers at the development stage. An increase of trust by one standard deviation is related to an expected additional .45 suppliers in this stage, almost one third of the average number of suppliers at this stage (1.54). During pre-development, we do not find a significant coefficient of trust on competition.[40] In series production, we do find a positive relationship between trust and competition, though the coefficient is smaller than in the development stage. An increase of trust by one standard deviation is associated with an increase in the number of suppliers by .29. Since fewer suppliers on average are employed at this stage (1.22), this increase is equivalent to somewhat less than 25% of the average number.

Considering the results in the other stages sheds further light on the issue and corroborates our characterization of the different phases. Noticeably, for the pre-development phase, our standard controls, in particular the size and sophistication of the part, do not play a significant role. This reflects the observation that the non-model-specific fundamental research involved at this stage follows a different set of rules. It is often initiated purely by the upstream suppliers, and when it is not, the greater uncertainty involved in the project gives an additional incentive to involve more firms.

6 Concluding Remarks

Trust is an important ingredient in almost all meaningful social and economic interactions. While, largely due to availability of data, most empirical research on trust has focused on the willingness of individuals to trust others in general. We are here able to shed light on the role of trust as fostered or squandered in pairwise economic relationships, both with a theoretical analysis and a consistent empirical investigation.

Our simple theory shows that higher levels of trust lead to higher relationship-specific investments and, more surprisingly, an increase in suppliers' trust is associated with more competition in the procurement process because trust and the quasi-rents from limited competition are substitutes in terms of sustaining cooperative behavior (investment and connected reward) between buyers ad seller.

[40] If we omit the quality variable in this regression, we can include 116 instead of only 71 observations. For this specification, the coefficient of the trust measure becomes negative (-.066) and remains insignificant, with a p-value of .632.

We are then able to document how an OEM's investment in supplier trust, characterized by the OEM decision to forgo (often short-term) opportunities of appropriating rent, can pay off. Contractual relationships characterized by higher levels of trust are associated with significantly higher investment by suppliers, resulting in fewer failures and callbacks on the parts supplied.

More surprisingly, we also show that higher levels of trust by suppliers are associated with the downstream procurer's decision to have a larger number of upstream suppliers compete for the development, or production contract.

Theoretical Appendix

[A formal definition of relational contract.]

Proof of Proposition 1.

Consider the case $n \geq 2$ and take the binding constraint (IC_s) :

$$w + \frac{\theta^e(n) - \theta^{e\prime}(n)}{n} = \frac{I}{\delta}$$

We have

$$\frac{\theta^e(n) - \theta^{e\prime}(n)}{n} = \int_{\underline{\theta}}^{\overline{\theta}} F(\theta)[1 - F(\theta)]^{n-1} d\theta$$

with a slight abuse of notation we obtain

$$\frac{\partial \left(\frac{\theta^e(n) - \theta^{e\prime}(n)}{n} \right)}{\partial n} = \int_{\underline{\theta}}^{\overline{\theta}} F(\theta)[1 - F(\theta)]^{n-1} \ln(1 - F(\theta)) d\theta < 0$$

The result in this case follows from the observation that

$$\frac{\partial I}{\partial \delta} = \frac{I}{\delta} > 0$$

together with

$$\frac{\partial w}{\partial \delta} = -\frac{I}{\delta^2} < 0$$

and

$$\frac{\partial n}{\partial \delta} = -\frac{I}{\delta^2} \left[\frac{\partial \left(\frac{\theta^e(n) - \theta^{e\prime}(n)}{n} \right)}{\partial n} \right]^{-1} > 0.$$

Consider now the case $n = 1$ the binding (IC_s) is then:

$$w = \frac{I}{\delta} - \pi(1) \tag{15}$$

since $\pi(1) = p(1) - E(\theta)$. Clearly in this case we still have

$$\frac{\partial I}{\partial \delta} = w > 0$$

and

$$\frac{\partial w}{\partial \delta} = -\frac{I}{\delta^2} < 0$$

To identify the effect of an increase of δ on n in the case $n = 1$ we need to compare the buyer objective function in the case $n = 1$ and $n = 2$. For a given level of investment I, once we substitute the binding (IC_s) in the buyer's objective function we have that $n = 2$ is preferred by the buyer to $n = 1$ if and only if:

$$\left[v(I) - \frac{2I}{\delta} - \theta^{e\prime}(2)\right] \frac{1}{1-\delta} \geq \left[v(I) - \frac{I}{\delta} - E(\theta)\right] \frac{1}{1-\delta}$$

which can be written as:

$$[E(\theta) - \theta^{e\prime}(2)] \geq \frac{I}{\delta}$$

Clearly, for given I, this condition is more likely to be satisfied the higher is δ.

Q.E.D.

Proof of Proposition 2.

Recall that we are considering $n > \tilde{n}$. The solution with n is preferred to $\tilde{n}$ if

$$\left[v(I_n) - \frac{nI_n}{\delta} - \theta^{e\prime}(n)\right] \frac{1}{1-\delta} \geq \left[v(I_{\tilde{n}}) - \frac{\tilde{n}I_{\tilde{n}}}{\delta} - \bar{\theta}^e(\tilde{n})\right] \frac{1}{1-\delta}$$

or equivalently

$$\bar{\theta}^e(\tilde{n}) - \theta^{e\prime}(n) \geq \left[v(I_{\tilde{n}}) - \frac{\tilde{n}I_{\tilde{n}}}{\delta}\right] - \left[v(I_n) - \frac{nI_n}{\delta}\right]$$

Now we need to show how the r.h.s. varies with δ. Using the Envelope Therefore,

$$\frac{d}{d\delta}\left\{\left[v(\tilde{n}) - \frac{\tilde{n}I_{\tilde{n}}}{\delta}\right] - \left[v(I_n) - \frac{nI_n}{\delta}\right]\right\} = \frac{1}{\delta}[v'(I_{\tilde{n}})I_{\tilde{n}} - v'(I_n)I_n]$$

and with a Taylor approximation

$$v'(I_{\tilde{n}})I_{\tilde{n}} - v'(I_n)I_n = \left[v''(\zeta)\zeta + v'(\zeta)\right](I_{\tilde{n}} - I_n) = \left[\frac{v''(\zeta)}{v'(\zeta)}\zeta + 1\right]\frac{(I_{\tilde{n}} - I_n)}{v'(\zeta)}$$

so that, finally,

$$\operatorname{sgn}\left\{\frac{d}{d\delta}\left\{\left[v(I_{\tilde{n}})-\frac{\tilde{n}I_{\tilde{n}}}{\delta}\right]-\left[v(I_n)-\frac{nI_n}{\delta}\right]\right\}\right\}=\operatorname{sgn}\left\{\left[\frac{v''(\zeta)}{v'(\zeta)}\zeta+1\right]\right\}.$$

From this the Proposition immediately follows.

Q.E.D.

7 Empirical Appendix: Descriptive Statistics

Variable	Mean (Std. Dev.)	Min	Max	Obs.
When is supplier asked to participate?	2.77 (1.37)	1	6	144
How often is progress coordinated?	2.98 (.57)	1	5	151
Share of efforts absorbed by supplier	3.50 (1.33)	1	5	142
Cost reimbursement if subsequent contract	2.31 (1.52)	1	5	246
Cost reimbursement if no subsequent contract	2.39 (1.59)	1	5	232
Specificity development objectives wrt...				
... content	2.33 (.97)	1	5	350
... time-frame	1.85 (.96)	1	5	350
... financial engagement	2.22 (1.14)	1	5	343
OEM's supplier choice criteria:				
... importance of supplier price	5.10 (1.16)	1	6	158
... importance of duration cooperation	4.70 (.99)	1	6	160
... importance of trust	4.89 (.98)	1	6	159

Table 5: Relationship Characteristics: **Pre-Development** (Suppliers' view)

Variable	Mean (Std. Dev.)	Min	Max	Obs.
How specific and detailed are specifications?	2.39 (1.02)	1	5	231
Supplier's degree of freedom	2.91 (.86)	1	5	231
Desired degree of freedom	3.62 (.77)	1	5	229
OEM's contribution to development	2.37 (1.10)	1	5	200
Frequency of IPR conflicts	2.24 (.87)	1	5	194
OEM's supplier choice criteria:				
... importance of supplier price	5.37 (.72)	2.5	6	387
... importance of duration cooperation	4.52 (1.00)	1	6	387
... importance of personal contact	4.52 (.98)	1	6	387
... importance of certification	4.39 (1.14)	1	6	377
... importance of trust	4.90 (.93)	1	6	384

Table 6: Relationship Characteristics: **Development** (Suppliers' view)

Variable	Mean (Std. Dev.)	Min	Max	Obs.
How often does OEM produce part himself?	1.69 (1.31)	1	6	210
OEM's supplier choice criteria:				
... importance of supplier price	5.70 (.52)	3	6	253
... importance of duration cooperation	4.38 (1.07)	1	6	253
... importance of personal contact	4.44 (1.10)	1	6	253
... importance of certification	4.28 (1.19)	1	6	250
... importance of trust	4.73 (.98)	1	6	252

Table 7: Relationship Characteristics: **Series Production** (Suppliers' view)

Variable	Mean (Std. Dev.)	Min	Max	Obs.
Number of competing suppliers	2.29 (.92)	1	5	144
Frequency of subsequent development projects	3.23 (1.11)	1	5	322
How often were projects discontinued in last 5 yrs.	2.00 (.88)	1	5	139
How often were the following employed...				
... preselection of a specific supplier	4.43 (1.26)	1	6	351
... procurement among a ltd. number of suppliers	3.95 (1.44)	1	6	338

Table 8: Procurement Decisions: **Pre-Development** (Suppliers' view)

Variable	Mean (Std. Dev.)	Min	Max	Obs.
Frequency joint procurement dev. and production	3.76 (1.24)	1	5	363
Number of suppliers employed during...				
... product planning	2.32 (1.13)	1	5	167
... product specification	2.03 (1.02)	1	5	177
... concept development	2.12 (1.07)	1	5	208
... detailed development	1.51 (0.90)	1	5	210
How often were the following employed...				
... preselection of a specific supplier	3.06 (1.52)	1	6	259
... procurement among a ltd. number of suppliers	5.18 (1.10)	1	6	264
... open procurement	1.97 (1.41)	1	6	255

Table 9: Procurement Decisions: **Development** (Suppliers' view)

Variable	Mean (Std. Dev.)	Min	Max	Obs.
Number of suppliers employed...				
... at production start	1.22 (.63)	1	5	251
... after 1-2 years	1.47 (.78)	1	5	249
... after more than 2 years	1.59 (.81)	1	5	246
How often were the following employed...				
... preselection of a specific supplier	2.98 (1.63)	1	6	248
... procurement among a ltd. number of suppliers	4.55 (1.52)	1	6	248
... open procurement	2.44 (1.66)	1	6	243

Table 10: Procurement Decisions: **Series Production** (Suppliers' view)

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