

Data Appendix to “Competition and Trust:  
Evidence from German Car Manufacturers”

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**Abstract**

We describe the measure of trust used in “Competition and Trust: Evidence from German Car Manufacturers” in detail and explore its characteristics. We also outline the steps used in constructing the underlying data-set.

# 1 Measures of Trust: Who Trusts Whom and Why?

## 1.1 Introduction

Our questionnaire data is relationship-specific: We ask representatives of company A about their stance and misgivings toward company B with regard to the interactions concerning a specific product. We devote the following three subsections to determine how robust the individual measures are and whether and how they can be applied. We also address potential drawbacks to this approach.

First we introduce the potential measures related to our definition of “trust”. Then we use exploratory factor analysis, a method well-established in sociology, to shed additional light on the dimensionality of the construct we are observing. In other words, we answer the question: Is there only one kind of “trust”, or do the questions we observe really depict a construct composed of various different “factors”? Finally, we study which past outcomes and behavior affect the suppliers’ evaluation of trust in the relationship.

### 1.1.1 How to Measure Trust?

As discussed in the paper, an important context for the use of trust in supplier-manufacturer relationships is the area of intellectual property. In particular, basic, non model-specific research represents an important share of suppliers’ capital and embodies their ability to differentiate themselves from competitors. This competitive advantage all but disappears, for example, if an OEM were to take a supplier’s blueprints for a part and make them accessible to competitors. Much of this know-how is important in the earliest stages, the pre-development of products, where suppliers showcase their advanced know-how. In the interviews in preparation of the study, there repeated references to the practice of denying the most advanced technology to OEMs that were expected not to treat it with the necessary care, that is, were not to be trusted.

Therefore as a first *direct measure* of trust, we posed the following question: *How important is the trust relationship with the OEM in your firm’s decision to initiate a pre-development project?* Possible answers were on a six-point scale ranging from 1–no relevance to 6–very high relevance (from now we will refer to this measure as *Trust 1*).

As the second direct measure, we asked the question: *“How do you evaluate mutual trust between OEM and supplier with respect to honoring each other’s intellectual property rights (IPR)?”* on a five-point scale ranging from 1–very little to 5–very high (from

now on *Trust 2*).

Our third direct measure of trust is the same question posed for each of the three phases of the product life cycle. The suppliers were asked *the importance of the trust-relationship between OEM and supplier as a choice criterion for the OEM's supplier selection* (pre-development: *Trust 3*, development: *Trust 4*, series production: *Trust 5*). We observe both the absolute value of the importance of trust as well as the relative importance compared to costs. Notice that here the supplier assesses both its trust relationship with the OEM, as well as how important trust was in the OEM's sourcing decision. We will closely evaluate what influences this measure.

In alternative to these direct questions, one could try to measure the supplier's trust in the OEM by reported behavior for which trust might be a prerequisite. Our potential *indirect measures* of trust are associated with IPR protection and the secrecy of the cost-structure of the supplier.<sup>1</sup> In our questionnaire, suppliers state both *how often they provide original research data to the OEM* on a five-point scale (1–very rarely to 5–very frequently) as well as *how often the OEM provides access to his original research data* on the same scale. We are interested in both the levels and the difference between the two values. Further we inquired *how often the supplier's costs are made transparent to the OEM*, on the same scale.

Two potential forces could be at play here. On the one hand, suppliers may voluntarily provide access to information to the OEM, which can be interpreted as a sign of trust. On the other hand, suppliers may be forced into revealing these data due to the OEM's superior market power which would indicate the opposite.

As a first step towards better understanding all these measures, Table 1 below displays pairwise correlations between each of them. As one would expect, there is a significant and positive correlation between all of the direct measures of trust. For the indirect measures, the picture is more interesting. The frequency with which the supplier makes his costs transparent is *negatively* correlated to two of the direct measures: The importance of trust (from the OEM's point of view) in choosing his development and series supplier. These measures also reflect the attitude of OEMs in the selection and

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<sup>1</sup>The suppliers' costs are an extremely contentious issue in negotiations. Cost-cutting manufacturers (have to) accept that a supplier producing below cost will go out of business sooner rather than later. Therefore, they traditionally try to negotiate prices that are as close to costs as possible and begrudge suppliers any positive margin they might obtain. For a comprehensive discussion, see Womack, Jones, and Roos (1991).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>Trust 1</i> <sup>(1)</sup>	1.00								
<i>Trust 2</i> <sup>(2)</sup>	<b>.250</b> (.048)	1.00							
<i>Provision IPR by supplier</i> <sup>(3)</sup>	-.0296 (.764)	-.037 (.663)	1.00						
<i>Provision IPR by OEM</i> <sup>(4)</sup>	-.036 (.718)	<b>.202</b> (.016)	<b>.443</b> (.000)	1.00					
<i>Difference in the Provision IPR</i> <sup>(5)</sup>	-.009 (.930)	<b>-.185</b> (.029)	<b>.756</b> (.000)	<b>-.254</b> (.000)	1.00				
<i>Provision Costs by supplier</i> <sup>(6)</sup>	.037 (.557)	.005 (.968)	.120 (.229)	.032 (.748)	.121 (.225)	1.00			
<i>Trust 3</i> <sup>(7)</sup>	<b>.535</b> (.000)	<b>.432</b> (.000)	-.046 (.569)	<b>.136</b> (.092)	<b>-.147</b> (.071)	-.018 (.889)	1.00		
<i>Trust 4</i> <sup>(8)</sup>	<b>.339</b> (.000)	<b>.385</b> (.000)	-.030 (.663)	.052 (.447)	-.078 (.260)	<b>-.193</b> (.002)	<b>.509</b> (.000)	1.00	
<i>Trust 5</i> <sup>(9)</sup>	<b>.320</b> (.000)	<b>.382</b> (.002)	-.090 (.365)	-.011 (.912)	-.104 (.296)	<b>-.143</b> (.025)	<b>.408</b> (.001)	<b>.700</b> (.000)	1.00

Table 1: Pairwise Correlations of Trust Measures (p-values)

negotiation process of development and series suppliers. In other words, it appears plausible that it is the insistence of the OEM, therefore, and not necessarily trust that causes suppliers to bare their costs more frequently, which makes this measure non-satisfactory.

The supplier’s provision of original know-how, on the other hand, is not correlated with any of the direct trust measures, while there is a relatively strong significant positive correlation (.443) with the provision of know-how by the OEM. The latter is also positively correlated with the mutual trust regarding the treatment of IPR. What would we expect a “trusting” as opposed to a “forced” relationship to look like? If the OEM forces the supplier to reveal intellectual property secrets, this should negatively affect the level of mutual trust with regard to IPR (and, potentially, vice-versa). Further, we would expect that, in this kind of a relationship, the OEM provides relatively little intellectual property into the relationship. Finally, the relative market and bargaining power

may play a role. To determine whether this effect truly exists in the data, we regress the difference in the frequency with which the two parties to the relationship reveal their IP-secrets on the level of mutual trust with regard to IPR, a dummy whether the product is technologically sophisticated and the supplier revenues as a proxy for relative market power. The results of the OLS-regression are presented in Table 2 below.<sup>2</sup>

Variable	Coefficient	(Std. Err.)
Trust 2	<b>-0.233**</b>	(0.113)
dummy_soph	0.249	(0.201)
Supplier Revenue	<b>-0.015**</b>	(0.007)
const.	2.009	(0.413)

*Dependent Variable:* Difference in frequency of revealing original research data (N = 129), \* significant at 10%, \*\* significant at 5%, \*\*\* significant at 1%.

Table 2: Determinants of IP provision.

The regression results show a significant negative association of the difference in IP-provision and mutual trust as well as supplier revenue, which, as we argue in the paper, can be used as a proxy for relative market power.<sup>3</sup> Therefore, the lower the relative market power of a supplier, the more likely it is that he provides more original research than the OEM. We take this result as an indication that in these asymmetric settings, enforced revelation (which is negatively associated with trust) does occur. In the simple pairwise correlations the overall effect of supplier provision of IP on our measures of trust is neutral (not significantly different from zero). Therefore there must be information in this measure that countervails the effect of the on average increasing difference in provision of IP. Intuitively, one could argue the coexistence of three IP-regimes. A symmetric one characterized by distrust: Both parties provide little or no research findings to each-other. An asymmetric one characterized by “force”, the existence of which is suggested by the regressions above. And finally, a symmetric one characterized by trust: Both parties provide research inputs to each other relatively often and in similar amounts.

We are, therefore, left with the five direct trust measures. Our knowledge of the relationship between these measures, up until this point, is purely based on pairwise

<sup>2</sup>We also performed ordered logit regressions, which are more suited to the structure of the data. The results are qualitatively identical (signs and p-values), we report the OLS regression for the easier interpretability of the coefficients.

<sup>3</sup>The corresponding regression with mutual trust as a dependent and the difference as an independent variable shows a significant negative effect of the difference on trust.

Variable	Factor loading	Uniqueness
<i>Trust 1</i>	.594	.648
<i>Trust 2</i>	.473	.776
<i>Trust 3</i>	.679	<b>.539</b>
<i>Trust 4</i>	.844	<b>.288</b>
<i>Trust 5</i>	.771	<b>.406</b>

Principal-factor method (N = 59).

Table 3: Factor Analysis of Trust Measures

correlations. Factor analysis is our method of choice to better understand these “within” correlations. Using a latent variable approach, it maximizes and records the share of variation in the observed variables that can be explained by one (or more) unobserved factor, while reproducing the correlations between variables.<sup>4</sup> The method has been criticized in the past mainly for producing results that are not unique, a critique that does not apply if one posits a single underlying factor. In addition, we find it perfectly suited to produce a kind of “upper bound” in our setting, that is it helps identifying how much of the variation in our measures can be explained through the unobserved underlying factor, which we assume to be (at least associated with) trust. One remaining difficulty is that we only have 59 observations where all 5 variables are included, but even this low number of observations can be sufficient in a 1-factor, 5-variable model as argued, for example, in MacCallum, Widaman, Zhang, and Hong (1999).<sup>5</sup>

Table 3 displays the factor loadings and uniqueness of the individual variables using the principal-factor method and limiting the admissible number of factors to 1. The resulting pattern is robust to using the maximum-likelihood estimation approach, allowing a second and third underlying factor and recursively eliminating individual factors (thereby obtaining significantly more observations). In all specifications, the uniqueness for the variables that measure the importance of trust in procurement negotiations at different stages (Trust 3-5) is close to or below the level of .5, which is seen as the relevant threshold in the literature. Among these, the explanatory power regarding pre-development negotiation (Trust 3) seems to be smallest. The general rules of thumb would suggest to remove all variables except for (Trust 3-5) from the model.

We interpret these finding as support for the following result. While it appears that

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<sup>4</sup>See, for example, Harman (1976).

<sup>5</sup>As a robustness test, we used stepwise elimination of the individual measures. The qualitative results remain unchanged.

the five measures do not capture the exact same thing, they are closely associated with each other. To better understand their basis, in the following section we perform a closer analysis of the potential determinants of trust to achieve an understanding of causal relationships.

### 1.1.2 Determinants of Suppliers' Trust: IPR Hold-up, Pay and Fairness

Both our model and our industry survey suggest that the inherent hold-up problem is at the center of any need for trust: Suppliers "sink" effort into research and design for parts which result in blueprints. After obtaining these blueprints, the superior bargaining position of the OEM enables him to extract additional rents. Therefore our favored interpretation of trust is the supplier's belief regarding the probability that the OEM will refrain from such undesired behavior.

To test this interpretation, we turn to the suppliers evaluation of such behavior by the OEM in our questionnaire, specifically the frequency of conflicts regarding the treatment of patents and trade-secrets as well as the frequency with which the OEM passes technological secrets of the supplier on to third parties without permission.

Clearly, there are more direct ways to extract rents from a position of power, especially by exerting pressure in price negotiations. Therefore for pre-development we looked at the degree to which the OEM shares the (considerable) risk of higher than expected costs. For development, we use the evaluation of the adequacy of license fees in the case that the OEM makes use of protected know-how of the supplier. Finally, for series production, we use both an evaluation of the frequency with which the OEM demands lump-sum price reductions in renegotiations as well as the extent to which he attempts to extract cost information by employing sub-supplier management.

We performed OLS-regressions with the individual trust-measures as the dependent variables and the measures mentioned above as explanatory variables, while controlling for the size and technological sophistication of the part. Table 4 below presents the coefficients and p-values of these regressions.

Different patterns emerge. The first trust-measure (*Turst 1: Importance of trust for the supplier to initiate pre-development cooperation with OEM*) is not significantly influenced by any of the answers to the questions aiming at compensation and pay. Instead, it has a strong negative correlation (-.637) with the reported frequency of IPR conflicts during pre-development, that is the more frequent IPR conflicts, the lower this

	<b>Trust 1</b>	<b>Trust 2</b>	<b>Trust 3</b>	<b>Trust 4</b>	<b>Trust 5</b>
<b>Pre-Development</b>					
Frequency IPR conflicts	-.637 (.05)	-.323 (.01)	-.632 (.00)	-.149 (.277)	-.416 (.02)
How often does OEM leak supplier's IPR	-.147 (.05)	-.521 (.00)	-.291 (.00)	-.153 (.00)	-.225 (.00)
OEM shares risk of higher development costs	.180 (.06)	-.156 (.31)	.040 (.82)	.242 (.00)	.301 (.00)
<b>Development</b>					
Frequency IPR conflicts	-.302 (.08)	-.463 (.00)	-.450 (.00)	-.118 (.11)	-.089 (.39)
How often does OEM leak supplier's IPR	-.170 (.17)	-.392 (.00)	-.333 (.00)	-.134 (.01)	-.116 (.09)
Adequacy of license fees	-.035 (.74)	.100 (.32)	.398 (.00)	.134 (.04)	.256 (.00)
<b>Series Production</b>					
Frequency price re-negotiation (lump sum)	.007 (.91)	-.124 (.13)	-.079 (.45)	-.180 (.00)	-.265 (.00)
Efforts of OEM to extract cost information	-.026 (.65)	-.042 (.41)	-.038 (.54)	-.151 (.00)	-.166 (.00)

Coefficients of OLS regressions and (p-values) reported..

Table 4: Determinants of Trust measures.

measure of trust. A much weaker, but still significant effect with the expected sign (-.147) results from the frequency of the OEM leaking sensitive IP-related data to third parties. IPR-conflicts during the development phase have a relatively strong negative effect (-.302).<sup>6</sup>

The second trust-measure (*Trust 2: Mutual trust with respect to IPR*) follows the same general pattern. Again, the compensation measures show no significant influence on the trust-measure. But here, the leaking of sensitive information shows a far stronger effect (-.521 in pre-development, -.392 in development) than in the former case. Further, with respect to this measure the importance of IPR-conflicts during the development phase (-.463) is higher than during the pre-development phase (-.323), which probably reflects the fact that a higher share of respondents to this question were involved in later development stages.

The picture changes for the remaining trust measures (*Trust 3, 4, 5: Importance of trust for the OEM's supplier choice*, for pre-development, development and series production, respectively). For Trust 4 and 5, the importance of IPR-related behavior decreases markedly, while the effects of adequate compensation and price-cutting become significant with the expected signs across the board. Interestingly, Trust 3, related by

<sup>6</sup>The p-value of .08 is in part explained by the smaller number of common observations.

construction to pre-development, is a hybrid case. The IPR-related factors are still predominant, but nevertheless also the adequacy of license fees plays an important role (.398), while the other compensation related measures do not. These results clearly address the question: Whose trust these measure truly size? As perceived misbehavior by the OEM affects them in a significantly negative manner, we consider them the best measures for our definition of the supplier's trust in the OEM.

To summarize, Trust 1 and Trust 2 are negatively associated with attempts at rent extraction by the OEM in the area of IPR with slightly different focuses, while they are not affected by direct attempts at price-reductions. This balance shifts toward direct attempts at price-reductions for Trust 3 and even more so for Trust 4 and Trust 5. In the paper, we construct an index of trust from Turst 3, 4 and 5, as the factor analysis revealed them to be internally consistent and the ensuing section showed them to be significantly negatively associated with OEM efforts at rent extraction. As a side benefit, this choice provides us with the largest possible number of usable observations.

## 2 Technical Details

The data were collected through an online questionnaire, screenshots of which are available upon request. The structure of the data is described in the paper. Observations were merged across product classes, supplier and customer. This procedure was chosen, because it is consistent with the instructions for the questionnaire to the participants. The alternative procedure of merging across products instead of product classes yields qualitatively identical results. All data routines are contained within the Stata dofile: **dofile\_with\_comments.do** which extracts the data directly from the source data-sets: **daten1.txt** and **daten2.txt**.

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