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Risk in Electronic Commerce: It does matter, but not equally for all companies

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Abstract Based on the Electronic Commerce Enquête 97/98, one of the largest empirical investigations on business-to-business electronic commerce issues in the German-speaking world ($n > 900$), companies' perception of risk factors in electronic commerce is revealed using multivariate statistical procedures. As a contribution to the field this paper presents the integral relationships and the importance of technical and non-technical dimensions of risk related to electronic commerce in various industry segments. Furthermore, using the innovative Limit Conjoint Analysis the potential of Electronic Commerce in terms of market share under alternative risk scenarios is calculated.

Companies belonging to different industry segments were asked to rate eight different electronic commerce scenarios with respect to their attitude and willingness to engage in electronic commerce transactions via the World Wide Web. The scenarios incorporate different levels of associated risks capturing the fundamental trade-off between opportunity for profit making versus danger of loss. Using Conjoint Analysis the relative importance of risk factors including psychological risk, financial risk, and technical/legal risk was then quantified. In most cases technical/legal risk over financial and psychological risk is of most importance to the vast majority of firms. In order to group the responding companies for further investigation we used the variable "industry segment". Applying t-tests, main findings support the hypothesis that there are significant industry segment specific differences of risk perception. The potential of electronic commerce in terms of market share is roughly 40 times bigger if technical/legal risk is low compared to a scenario where technical/legal risk is high.

In conclusion, risk matters in varying degrees for all companies and contributes largely to the potential of electronic commerce, thus helping us to better differentiate and assess the importance of risk in electronic commerce.

I. INTRODUCTION

Security problems especially in context of valuable transactions via open networks, notably the Internet, are blamed in theory and practice for the lagging development of electronic commerce (see [3, p. 734] or [1, pp. 151]). However, there is a lack of quantifying analysis based on sound empirical data which incorporate both technical and non-technical risk factors as operationalization of security and which reveal differences of companies' risk perception related to specific industry segments (see for a Conjoint Analysis from the consumers' point of view [5]).

This research investigates empirically the perceptions of risk factors and how they affect the attitude of companies towards doing business via the World Wide Web. Specifically we aim to reveal and quantify industry segment related differences in the perception of risk factors including financial risk, psychological risk and technical/legal risk. Thus, the main research hypothesis under consideration here can be stated as follows:

H₀: There are significant differences in the perceptions of risk towards electronic commerce among certain groups of companies, e.g. among certain industry segments.

II. SURVEY DESIGN, DATA AND RESEARCH METHODOLOGY

A. Electronic Commerce Enquête 97/98

The Electronic Commerce Enquête 97/98 builds the empirical basis of this research. The Electronic Commerce Enquête 97/98 [7] is an empirical study of over 900 companies. The general objective of the study was to record the economic utility of Web-based electronic commerce from a business point of view (the key characteristics of the survey are summarized in Table I). Throughout the paper we refer to Web-based electronic commerce in a broad sense as the electronically realized preparation, negotiation and processing of business transactions between agents via telecommunication networks, using Web technology.

TABLE I
CHARACTERISTICS OF THE EMPIRICAL STUDY
"ELECTRONIC COMMERCE ENQUÊTE 97/98"

| Aspect | Attribute |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Survey period | October and November 1997 |
| Survey form | Written, anonymous and offline |
| Addresses | Decision-makers at upper and top management levels in companies of all sectors |
| Sampled population | All companies active in the German-speaking area |
| Dispersion and Return rates | Magazine inserts (116,621 questionnaires): 0.4% – 0.8%, Direct mailing (3,325): 11.5%, overall: 0.8% |
| Participants | 914 company representatives, over 60% classified themselves in the top two levels of management. 90% of companies replying had their head quarter in Germany. |
| Predominant customer segment | 76.3% business-to-business; 15.6% of the companies serve private customers exclusively. |
| Scope of data | 157 questions in 42 sections, 188,350 data points. The Electronic Commerce Enquête is thus one of the largest surveys of its kind. |
| Representativeness | The high rate of return of these questionnaires from an absolute point of view as well as the broad coverage of sectors and company size categories form the basis for a good impression of companies in the German-speaking area performing activities in Web-based electronic commerce. |

The companies participating were classified according to sector and company size following the categorization of the German Federal Statistical Office. Thus, “trade” was treated in a comparatively differentiated fashion, and “Internet services” was additionally included as a new branch of industry. The sample is distributed quite evenly across all categories, but the proportion of trading companies is relatively low. With regard to company size, the comparably high value in the upper size categories is remarkable. Over 25% of the companies number over 1,000 employees. In the categories “Internet services”, “services” and “consulting”, the relative dominance of companies with smaller turnovers should be noted. The distribution of company size is roughly 1/3 small companies (up to 19 employees), 1/3 medium sized companies (20-499 employees) and 1/3 large companies (>500 employees).

The overwhelming majority of the 914 respondents came from marketing/ distribution/ sales (20.8%), corporate planning (24.4%) or the IT department (19.4%). This is not surprising as activities in Web-based electronic commerce commence at the interface with the purchaser or the supplier. Knowledge of marketing and IT is therefore a necessary factor. The importance of electronic commerce for many companies is also reflected in the relatively high proportion of participants from the area of corporate planning. Over 60% of the respondents see themselves among the first two levels of management.

B. Conjoint Analytic Design within the Electronic Commerce Enquête

One section of the Electronic Commerce Enquête was specifically devoted to the Conjoint Analytic Design (question 15 in the questionnaire, see [7, p. 36]).

The assumptions for the design were:

- There is a fundamental trade-off between doing Web-based business towards profit maximizing and potential losses due to various risks involved while doing business via the Web,
- the decision of companies towards engaging in electronic commerce is based on a microeconomic rationale, assuming utility maximizing behavior,
- the decision can be expressed as a function of risk dimensions,
- the decision function can be modeled as a linear and additive utility function.

In order to operationalize “risk” we introduce three dimensions of risk including psychological risk, financial risk and technical/legal risk. We will later present the importance of these risk dimensions based on Conjoint Analysis.

Dimension 1: “Customer Risk”

This dimension should reflect the potential anonymous character of Web-based transactions along with the difficulty in assessing the business partner due to lack of personal contacts and experiences. Here it is assumed that this kind of psychological risk will influence the decision whether to use the WWW as buyer or seller. This variable “customer risk” can have the values “Regular customer” and “New customer”. We expect that companies c.p. will rather engage

with regular customers, because usually there is a history of their reputation available and thus the risk of failure of any transaction can be more easily assessed.

Dimension 2: “Financial Risk”

This dimension should reflect the importance of the value of the transaction and with it the financial risk involved for the decision whether the WWW will be used as a channel of delivery. The variable “financial risk” can have the values “low value” and “high value”. It can be expected that normally companies assess higher risk in case of high value transactions and vice versa.

Dimension 3: “Risk of non-bindingness”

The third dimension introduced here combines technical, network- related risk aspects (i.e. integrity) with legal risks (see for additional risks [6]). Legal risk is, for example, lack of legal liability caused by inadequate means to trace responsibility and to prove online transactions. This technical/legal dimension of risk will be named “risk of non-bindingness”. This variable can have the values “technical/legal binding warranted” or “technical/legal binding not warranted”.

Electronic Commerce Scenarios

For the assessment of the risk dimensions a complete design (full-profile) of in total $2 \times 2 \times 2 = 8$ stimuli (named hereafter as scenarios) was built incorporating a complete permutation of all three variables (customer risk, financial risk, risk of non-bindingness) with two values each. The overall question was: “Under which conditions would you decide to carry out transactions via electronic commerce/the WWW?”

Within the questionnaire the specific design looked like as shown in Fig 1.

Under which conditions would you decide to carry out transactions via electronic commerce/the WWW?

Ranging from -4= "most likely not" to +4 ="most likely yes" please try to assess each of the following scenarios.

Please mark the appropriate number with an X.

Person [a] orders goods of [b] value from you online. Integrity, verifiability, and legal binding of the online order are [c].

| Scenario | [a] | [b] | [c] | Assessment/Rating |
|----------|------------------|------|----------------|---------------------------|
| 1 | Regular customer | low | guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |
| 2 | Regular customer | low | not guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |
| 3 | Regular customer | high | guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |
| 4 | Regular customer | high | not guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |
| 5 | New customer | low | guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |
| 6 | New customer | low | not guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |
| 7 | New customer | high | guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |
| 8 | New customer | high | not guaranteed | -4 -3 -2 -1 0 +1 +2 +3 +4 |

Figure 1: Conjoint Analysis – Design of question

The applied rating scale ranged from -4 (“most likely not”) to +4 (“most likely yes”). This scale should measure the affinity of companies towards electronic commerce. The

value 'zero' for a scenario means indifference and can be interpreted as the "limit value" in terms of the Limit Conjoint Analysis. See [2] for the concept and Chapter IV for an application in order to estimate the potential of electronic commerce considering risk factors.

III. RESULTS

In total 914 questionnaires were returned, of which a surprisingly high number of 633 questionnaires (69%) had answers on the Conjoint-analytic question. 34 answers were not completed and therefore not considered. In addition 20 questionnaires were filled up improperly leading to too many ties (same rating for different scenarios) and therefore were not useful in order to derive any meaningful reconstruction of the underlying preferences. Thus, the quota of usable questionnaires resulted in $(579/633 =)$ 91.47% (respectively overall 63%) questionnaires. The calculated quota of not usable questionnaires was 8.53%. This value is small considering the demanding design of the question.

A. Relative Importance of Risk Factors

For the specified variables the relative importance (part worth) for the variables based on 579 questionnaires were calculated using the CONJOINT-procedure of SPSS. "Part worth" is a numerical expression of the value that participants place on each level of each attribute.

TABLE II: THE RELATIVE IMPORTANCE (PART WORTH) OF RISK FACTORS

| Variable/risk factor | Relative importance |
|-------------------------|---------------------|
| Customer risk | 24% |
| Financial risk | 20% |
| Risk of non-bindingness | 56% |

The dominant impact of the "risk of non-bindingness" on the decision to engage in electronic commerce compared to the other variables is notable. Furthermore, the "financial risk" which is involved in online transactions has the smallest impact.

B. Perceptions in Various Industry Segments

Among the variables applied in order to group the responding companies for further investigation we used "industry segment", "company size", "field of work of the respondent", "hierarchical position of respondent", "main customer segment", and "duration of the Web presence". The remainder of this paper will highlight significant results related to the research proposition raised in the beginning, i.e. are there significant differences in the perceptions or attitudes towards (non-secure) electronic commerce among certain industry segments?

In order to consolidate the given industry segments all trade-related segments were grouped together. The segments "Food", "Traffic and Transport" and "Travel and Tourism" were omitted because of too few cases. All questionnaires without any indication of industry segment and all questionnaires stating "Other" were omitted, too. The resulting segmentation is shown in Table III:

TABLE III: SEGMENTATION FOR COMPARISONS OF BRANCHES

| Group | Branch | Cases |
|-------|----------------------------------------|-------|
| 1 | Industry | 45 |
| 2 | Hard- & Software and Internet Services | 150 |
| 3 | Trade | 31 |
| 4 | Consulting + Services | 117 |
| 5 | Financial Services | 70 |
| 6 | Print- & Publishing | 64 |
| | | 477 |

The resulting groups were compared to each other to determine whether there were significant differences of means. For detailed information on the applied procedures and statistical measures of the presented results see [4].

The Conjoint Analysis provides data of four variables for further investigation. The following values of the variables are selected for the presentation:

- The variable "basic attitude" can be described as the overall level of willingness to engage in electronic commerce. Adding and subtracting the calculated part worths of the cited risk dimensions, we can compute the total worth of each scenario.

- Concerning the variable "risk of non-bindingness" the value "technical/legal binding warranted: yes" will be considered.

- Concerning the variable "customer risk" the value "regular customer" will be considered.

- Concerning the variable "financial risk" the value "low transactions" will be considered.

In order to characterize the various groups of companies we use two of the four introduced variables. Table IV and Table V depict the significant values for the variables "basic attitude" and "risk of non-bindingness" according to the applied LSD-procedure (see [[4] for statistical and procedural details).

The results of the variable "basic attitude" can be seen in Table IV. Group 2 ("Hard- & Software and Internet Services") is significantly different from groups 3 "Trade", 4 "Consulting and Services" and 5 "Financial Services". Furthermore, a significant difference can be observed between group 6 "Print & Publishing" and group 5 "Financial Services".

TABLE IV: COMPARISON OF BRANCHES,
VARIABLE "BASIC ATTITUDE TOWARDS ELECTRONIC COMMERCE"

| Group | Means of the variable "basic attitude" | Significant differences to group ... according to LSD... |
|-------|-------------------------------------------|----------------------------------------------------------------|
| 2 | 1.15 | 3 (0.022) 4 (0.040) 5 (0.000) |
| 6 | 0.94 | 5 (0.034) |
| 1 | 0.83 | - |
| 4 | 0.83 | - |
| 3 | 0.59 | - |
| 5 | 0.49 | - |

TABLE V: COMPARISON OF BRANCHES,
VARIABLE "RISK OF NON-BINDINGNESS"

| Group | Means for the variable "risk of non- bindingness" | Significant differences to group ... according to LSD... |
|-------|---------------------------------------------------------|----------------------------------------------------------------|
| 5 | 2.27 | 1 (0.001) 2 (0.000) 4 (0.001) 6 (0.002) |
| 3 | 2.17 | 1 (0.017) 2 (0.007) 4 (0.044) 6 (0.043) |
| 4 | 1.77 | - |
| 6 | 1.73 | - |
| 2 | 1.64 | - |
| 1 | 1.62 | - |

How to read the Tables IV and V:

– The parting line between group 6 and group 1 in Table IV respectively group 3 and 4 in Table V helps to identify the above and the below average values of the part worths under consideration.

– The values are sorted in decending order.

– The values in parenthesis indicate the verifiability that the results are non-random based on the rejection of the hypothesis "the means are equal".

The results for the variable "risk of non-bindingness" are shown in Table V. Accordingly the "risk of non-bindingness" is considered in group 5 much more important than in any other group. Also, group 3 "Trade" assesses the importance of this risk dimension as above average.

The basic attitude towards electronic commerce as well as the technical/legal requirements are significantly different between group 2 (Hard- & Software/Internet Services) and group 5 (Financial Services). Whereas the basic attitude of the companies in group 2 towards electronic commerce is highest among all groups, the technical/legal risk dimension

is of topmost interest to financial service companies. These differences can be explained by the degree of affinity or involvement in electronic commerce which should be high for companies of group 2 (especially for Internet service providers; WWW-related electronic commerce is their core business). Furthermore, we can expect a high sensitivity to security issues, e.g., in terms of threats of reputation, in the financial services segment (group 5). This result is plausible. More surprising is the fact that the basic attitude of financial services companies towards electronic commerce compared to all other groups is extremely low.

Striking are the similar perceptions of risks of group 5 (Financial Services) and group 3 (Trade) as measured by all four variables ("basic attitude", "customer risk", "financial risk" and "risk of non-bindingness"). Most important for these groups is the warranted technical/legal binding of transactions in electronic commerce. Customer risk and financial risk are not that relevant.

Also striking are the similar perceptions of group 4 (Consulting and Services), 2 (Hard- & Software/ Internet Services) and group 6 (Print & Publishing) according to all four variables. Compared to group 2 (Trade) and group 5 (Financial Services) the importance of the technical/legal dimension is less dominant.

Finally, group 1 (Industry) has some similarity with the three groups just mentioned. The values of "basic attitude", "financial risk" and "customer risk" are average, whereas in terms of technical/legal risk the companies are most indulgent. This might be explained by companies in the segment "industry" having relatively intense and individual producer-client-relationship thus creating reputation and trust among the business partners offline. Subsequent online transactions within the context of these relationships can be better assessed in terms of all risk dimensions, especially potential high technical/legal risk of online transactions compensated by trust based on earlier experience.

IV. ESTIMATION OF THE IMPACT OF RISK FACTORS ON THE POTENTIAL OF ELECTRONIC COMMERCE USING LIMIT CONJOINT ANALYSIS

Based on the data we further investigate the impact of alternative risk factors on the potential of electronic commerce. As shown, if especially the technical/legal risk is high firms hesitate to engage in electronic commerce. We now try to answer quantitatively the question how much larger the potential of electronic commerce would be if especially the technical/legal risk is low. As a first step we compute the relative importance of each electronic commerce scenario.

Table VI depicts the calculated total worth of the eight electronic commerce scenarios based on the derived part worths. Positive values correspond to an open-minded attitude towards electronic commerce and vice versa.

TABLE VI: RELATIVE IMPORTANCE OF THE ELECTRONIC COMMERCE SCENARIOS

| Electronic Commerce Scenario | Total worth, averaged over all companies |
|------------------------------|------------------------------------------|
| 1 | 3.9 |
| 2 | 0.3 |
| 3 | 2.9 |
| 4 | -0.7 |
| 5 | 2.4 |
| 6 | -1.2 |
| 7 | 1.5 |
| 8 | -2.2 |

Table VI underpins the fundamental pertinence of warranted technical/legal binding for the usage of electronic commerce. Those scenarios within this vein of “technical/legal risk-free” basic conditions (scenarios 1, 3, 5 and 7) show all positive total worth values, whereas No. 2 is the only “risky scenario” which is considered by the companies as still useful for online transactions. It seems that the factor “regular customer” and implicitly along established (personal) trust compensates for lacking technical/legal safety.

In scenarios 4, 6 and 8 we cannot see such compensation effects. Here, the lack of technical/legal bindingness results in an attitude not in favor of WWW-based electronic commerce.

Thus, only the scenarios 1,2,3,5 and 7 are considered as a useful context for electronic commerce. Scenario 1 with an averaged total worth of 3.9 meets the optimal scenario as expected. It combines low value transactions (low financial risk) with “regular customers” (low psychological risk) with warranted bindingness (low risk of non-bindingness).

Using the total worth values of the scenarios derived from Conjoint Analysis we can now calculate their (market) share. For that we have to cope with a serious problem: Basically in classical Conjoint-analytic approaches it is assumed that always at least one stimuli (product) is chosen independently of its total worth [8, p. 14]. However, this assumption does hold true only in rare exceptional cases. The more common cases imply that some or even all stimuli may have a very low or even negative total worth meaning that those or all stimuli will not be chosen at all. Neglecting this consideration may lead to substantial error in market share estimation due to the fact that “non-buyers” are not taken into account. As a solution we apply for the first time in a electronic commerce context the innovative Limit Conjoint Analysis (see [2] for a description of that idea)

The basic line of calculation can be stated as follows: Those scenarios which have negative total worth are not attractive for firms thinking of engaging in electronic commerce. These scenarios (i.e. scenarios 4, 6 and 8) are excluded from further calculation. Thus, the total market share (100%) is not divided among the eight scenarios but among the remaining scenarios 1, 2, 3, 5, and 7 as shown in Table VII.

TABLE VII: ESTIMATED (MARKET) SHARES OF ELECTRONIC COMMERCE SCENARIOS

| # Scenario | Estimations of total worth of the scenario, averaged over all companies | Relative (market) share |
|------------|-------------------------------------------------------------------------|-------------------------|
| 1 | 3.89 | 35.4% |
| 2 | 0.27 | 2.5% |
| 3 | 2.93 | 26.7% |
| 5 | 2.43 | 22.1% |
| 7 | 1.47 | 13.4% |
| | 10.99 | 100,1% |

Sum over 100% market share due to rounding errors.

The relative (market) shares can be interpreted as the shares of the different scenarios of the volume of electronic commerce transactions.

Table VII shows that scenario 2 as the only one with high technical/legal risk has a potential share of only 2.4%. In 97,6% of the cases low technical/legal risk is the crucial force attracting electronic commerce. This yields an electronic commerce environment with low technical/legal risk is roughly 40 times more attractive (respectively 40 times bigger) than one with low technical/legal risk.

V. CONCLUSION

The analysis shows that technical/legal risk compared to customer risk (psychological risk) and financial risk is of utmost importance for the vast majority of firms. The decision whether the Web will be used for electronic commerce is very dependent on adequate levels of technical security especially for integrity and documentation (for verification) of transactions combined with adequate legal frameworks.

The calculation of the total worth values based on the part worths for the eight electronic commerce scenarios leads to the conclusion that financial as well as psychological dimensions of risk are not totally overruled by technical/legal risk issues, but rather these contribute to a substantial degree to the decision whether WWW will be used for electronic commerce. Using the Limit Conjoint Analysis it can be shown that an electronic commerce environment with *low* technical/legal risk is roughly 40 times more attractive (respectively 40 times bigger) than one with *high* technical/legal risk.

In conclusion, there is a fairly differentiated perception of risk in two respects: First, the risk factors themselves are significantly different in importance, and second, there are significant differences in the perceptions of risk towards (non-secure) electronic commerce among certain groups of companies, e.g. among certain industry segments. These results including the derived influence of technical/legal risk on the potential of electronic commerce may contribute towards a better understanding and a more differentiated view on risk factors and risk perceptions of companies involved in electronic commerce: risk does matter, but not equally for all companies.

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