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An Analysis of Co-Operations between Software Firms: An Economic Perspective

Edward W.N. Bernroider
Assistant Professor, Department of Information Business, Vienna University of Econimics and Business Administration, Aug. 2-6, 1190 Vienna, Austraia, edward.bernroider@wu-wien.ac.at

Volker Stix
Assistant Professor, Department of Information Business, Vienna University of Econimics and Business Administration, Aug. 2-6, 1190 Vienna, Austraia, volker.stix@wu-wien.ac.at

ABSTRACT

This paper confronts the consensus building on the importance of co-operation between firms, particularly software enterprise. It is based on an empirical study of the Austrian computer software industry, showing three types of interfirm co-operations and their diffusion, factors affecting the extent of co-operation, and the impact on business success. Most of the assumed influences on the amount of co-operations were supported by the data analysis, e.g. the level of IT staff recruitment problems. Evidence was found to support the view that a higher level of co-operation intensity leads to better business performance. Due to the highly globalize nature of the software industry the findings can also be very informative for other geographical areas, esp. for other European countries.

INTRODUCTION

In the last decades the software market has shown rapid growth, together with an acceleration of technological change and innovation (EITO, 1999, 2000, 2003). Against the background of globalisation more intense competition has created many corporate challenges, especially threats. To survive in this new environment, many firms have had to re-organise and become more responsive to change (Vickery, 1999).

Central to globalisation is firm-level innovation and the search for productivity improvements in order to achieve international competitiveness. Academic literature reports that faster innovation and a higher productivity is fostered by more cross-border operations, increased inter-company collaboration and joint ventures (DTI, 2001; Keeble, 1996; Naisbitt, 1995; Nowak & Grantham, 2000; Vickery, 1999). (Naisbitt, 1995) predicted that large organizations have re-constituted themselves as a collection of small companies, respectively business networks that will survive and flourish. (Keeble, 1996) stated that collaborative networking carried a positive implication for long-term competitiveness of SMEs in Great Britain in the 1990s. More specifically for the software sector, authors (Nowak & Grantham, 2000) reported that software companies are increasingly reliant on strategic alliances to remain competitive. (Mendelson, 2000) has shown that there is a positive correlation between organizational characteristics of a software firm, in particular the extent and quality of business co-operations, and success criteria such as turnover per employee.

Technological advances are helping to implement interfirm co-operations. They have enhanced the abilities to share data and to communicate (Grover & Vaswani, 2000); computer based systems have emerged for co-operative work (Alavi, 1993; Kraemer & King, 1988; Poltrock & Engelbeck, 1999).

In this paper the focus lies upon relations between software companies, by which they seek to improve the output and quality of there products. Current forms of interfirm co-operation, factors affecting the extent of co-operation and the impact on business success will be examined to confront the consensus building on the importance of co-operation between firms, particularly software enterprises.

RESEARCH OBJECTIVES

The goal of this article is to outline the structure, intensity, and influencing factors of co-operations between software firms in Austria as well as dependent performance measures. It was assumed that a number of characteristics (see section “Factors affecting the co-operation intensity”) have an impact on the amount and type of co-operations taking place. As a second step we tried to analyze the effect of co-operating on the performance of the organization.

The methodology employed to investigate these research topics is an empirical study of the Austrian computer software industry, which was carried out in the year 2000. The empirical findings will be presented in the same order as the points presented above. The results shown in this paper represent only a part of the wider field of research topics considered by the undertaken empirical survey.

DATA ACQUISITION

For both, the pre-liminary (for screening purposes) and the main analysis, the design of a questionnaire which was validated in several pre-tests was necessary. For the pre-liminary phase random sampling was employed and the 600 chosen companies were contacted by telephone. The achieved response rate was 70.4%. Some companies could not be contacted, because they had ceased to exist, the address was wrong or could not be found, etc. These neutral dropouts were considered in the calculation of the response rate and therefore did not decrease the return quota. On completion of the preliminary analysis structured face-to-face interviews followed in the main step of analysis, which based on a stratified and disproportional sample with subgroups according to company size. The rate of return for this second and main step of the study was 55.6%. After completing both, the pre-liminary and main step of analysis, non-response effects were examined. The analysis (regarding known distributions of variables of the Austrian computer software market such as the type of the organization) revealed no significantly different characteristics between non-respondents and respondents.

COMPANY SIZE DISTRIBUTION

The empirical data showed a strong overbalance of smaller software enterprises in Austria: Micro-enterprises (ME) account for 55.7% of the

Table 1: Company size distribution

Size	employees	turnover (Mio. •)	Independency[1]	No. of companies (rel.)	No. of companies (abs.)
ME	1-9	< 7	< 25%	**55,7%**	1.082
SME	10-249	< 40	< 25%	**32,2%**	625
LE	> 250	> 40		**12,1%**	235
Total				100%	1.941

[1] Capital share in external ownership.

Austrian software organizations. 32.2% can be attributed to SMEs and 12.1% to large enterprises (LE). Classification was performed using data on number of employees, turnover and independency following the definition proposed by the Commission of the European Community (EC, 1996). The applied criteria and the approximated overall number of software enterprises in Austria are presented in Table 1. In Austria the average firm size has declined in line with smaller firms entering the industry. Especially at the end of the 1980's and the early 1990's annual growth rates of over 20% (measured by number of enterprises in Austria) caused the decline of average firm size.

FORMS AND EXTENT OF INTERFIRM CO-OPERATION

Table 2 denotes the different types of co-operations analysed in the empirical survey. The simple exchange of knowledge resources (no. 1) utilized by 52.3 % of the software firms is regarded as co-operation form at the lowest level. Co-operations in sales/distribution undertaken by 59.2 % of the enterprises (no. 2) already reflect a next step towards the highest level of cooperating: The development of long-lasting co-operations between firms at adjacent stages in the value chain (no. 3, e.g. collaborative software development), which is carried out by 49.4 % of the software firms in Austria. Other, unspecified types of co-operation counted up to around 13%. Our first assumption, that collaboration in the context of sales/distribution is the prevalent form of co-operation is supported by the data. But the little differences between the extent of co-operation for each type are surprising, respectively the high rate of collaborative value chains. For the next steps of analysis we have consolidated the types of co-operations into a variable showing the level of co-operation intensity for each enterprise following the order described above. This calculation showed us that 20% of the enterprises do not co-operate with partners, 6.2 % apply knowledge transfer only, 24.5% go to the level of collaborative sales/distribution and may also utilize knowledge transfer with partners, and finally, 49.2 % are engaged in collaborative value chains (and may also co-operate in the two lower graded scenarios).

Table 2 also shows the changes in the co-operation extent from the viewpoint of different firm sizes. It can be seen that the size of an organization has a positive effect on the co-operation, respectively collaboration activities. For the type of collaborative value chains the dependency is highly significant (as shown by the calculation of the Chi-Square statistic with a significance level of 0.003).

FACTORS AFFECTING THE CO-OPERATION INTENSITY

To test the independence of responses between companies with different co-operation intensities, the Kruskal-Wallis H-Test was applied, which is a non-parametric equivalent to one-way ANOVA. It tests whether several independent samples are from the same population, assumes that the underlying variable has a continuous distribution, and requires only an ordinal level of measurement. The strength of a relationship between variables and the co-operation intensity was analyzed by calculating the Spearman rank correlation coefficient, which is used when ordinal scaled variables are involved.

Table 2: Extent of Co-operation and Firm Size

Size/Type of Co-operation in %[1]	Type 1: Simple Knowledge Exchanges	Type 2: Collaborating in Sales/Distribution	Type 3: Collaborative Value Chain	Other Type of Co-operation
ME	47.4	54.6	38.1	10.3
SME	57.1	62.5	60.7	14.3
LE	61.9	71.4	71.4	19.0
All Comp	52.3	59.2	49.2	12.6

[1] Note: Multiple selections were allowed
N = 174 data sets

It was assumed that the following factors have an impact on the amount and type of co-operations taking place (the significant results were summarized in Table 3):

- Size of an Organization
  As already indicated, the size of an organization has an impact on the co-operation intensity. The analysis scheme described above validates this assumption (see Table 3). In general, the co-operation activities get more intense with in large organizations.

- Strategic target of increasing turn over
  We assumed that the strategic target "of increasing turn over", respectively its priority as defined by the management of the software enterprise, has a positive influence on the co-operation intensity. This assumption was supported by the data (see Table 3).

- Expenses on research and development
  During the interviews, managers had to assess the amount spent each year on research and development. Our assumption concern ing a possible relationship with the co-operation intensity was not supported by the data analysis.
- IT position vacancies
  The IT man power shortage could be a good reason for companies to co-operate as a means to overcome this industry specific weakness. In our study, the company had to assess its IT job vacancies. The data showed that a high number of vacancies have a positive influence on the amount and intensity of co-operations taking place (see Table 3).
- Internal success factors
  We were interested in a possible dependency between co-operat ing activities and certain internal success factors of the organisation, respectively organizational strengths and weak nesses. A well organised firm structure (success factor 1) may have a positive influence on co-operation activities. On the other hand, knowledge exchange and collaborative software develop ment may increase the know-how embedded in company (success factor 2), respectively foster employee qualification (success factor 3), or improve access to new technologies (success factor 4). Improved capabilities should lead to better product quality (success factor 5). These inquired endogenous success factors had to be rated by managers of Austrian software companies on a scale from 5 (very positive) to 1 (very negative) as perceived in their own organisation. The data analysis followed the same pattern as described before and showed that almost every analysed criterion seems to be dependent on the co-operation intensity and many show correlations with high significances (see Table 3). The perceived situation regarding employee qualification and access to new technologies improves with the co-operation intensity of an organisation. Taking a closer look at the 3 types of co-operations recorded, we see that product quality seems to be positively influenced by knowledge exchanges between enter prises.

To examine the effect demonstrated by the six criteria as a whole a multiple discriminant analysis (MDA) was undertaken using the statistical software package SPSS. The primary objectives of MDA are to understand group differences and to predict the likelihood that an entity (respectively an organization) will belong to a particular group (in this article characterized by the intensity of its co-operations) based on several scaled independent variables (Hair, Anderson, Tatham, & Black, 1998). For the application of MDA the sample was divided randomly into two sub-samples, one used for estimation of the discriminant functions (analysis sample) and another for validation purposes

Table 3: ***Identified discriminating characteristics by Kruskal-Wallis H-Test and Spearman Rank Correlation Coefficients***

No.	Variable	Independence: Significance (H-Test)	Correlation Coefficient (Spearman)	Significance (Spearman)
1	Size of Organisation	0.008	0.246	0.001
2	Strategic Goal: Increasing turn-over	0.072	0.183	0.016
3	IT job vacancies	0.019	0.242	0.002
4	Internal success factor: Employee qualification	0.077	0.193	0.011
5	Internal success factor: Access to new technologies	0.006	0.209	0.006
6	Internal success factor: organisational structure	0.024	-	not significant
7	Internal success factor: product quality	0.064	-	not significant

N = 174 data sets

(holdout sample). This method of validating the functions is referred to as the split-sample or cross-validation approach (Green & Carrol, 1978; Perreault, Behrman, & G.M., 1979).

The results of MDA show that using these seven factors in a simultaneous estimation approach, 51.6% of all cases in the analysis sample could be correctly attributed the correct level of co-operation intensity, while 51.4% of all cases in the holdout sample could be correctly classified. The calculated discriminant functions are statistically significant (p=0.04), as measured by the chi-square statistic, and the first function accounts for 65.7%, the second for 25.8% of the variance explained by the three calculated discriminant functions. This also affirms the significance of the seven variables for classifying a company's co-operation activities.

In order to measure the value of the predictive accuracies presented above relative to chance, the proportional chance criterion was used. The proportional chance criterion should be used when group sizes are unequal and the researcher wishes to correctly identify members of all the groups (Hair et al., 1998). The formula for this criterion is

$$C_{PRO} = \sum_{i=1}^{n} p_i^2$$

where

$p_i =$ proportion of enterprises in group i.

$n =$ number of groups (here 4)

Using our group sizes (see section "Forms and Extent of Interfirm Co-operation"), the proportional chance criterion is 0.346. Comparing this chance criterion with the prediction accuracies presented shows that they are acceptable.

CO-OPERATION AND BUSINESS PERFORMANCE

In this section we have attempted to describe the relation between co-operation intensity and higher performance.

First, we analyzed six variables, which the company had to assess concerning the passed and expected future success of their businesses measured by software profits, turnover and number of employees in their software department. With these variables we have conducted the same analysis as presented above. Beginning with the Kruskal-Wallis Test, it showed that every growth figure apart from the expected future growth of software profits had a significantly different distribution depending on the observed co-operation intensity. The Spearman rank correlation coefficients (all significant at least on the 0.05 level) revealed that the extent of co-operations in a software firm correlates positively with these growth figures. Thus, high performers show in general a better past and predict a better future business development.

Second, we used the ratio turn-over per employee and the indicated capital resources, respectively the net equity capital situation as perceived by the interviewed managers in the analysis. While the productivity ratio showed no dependency, the similar relationship to above was revealed for the equity capital situation. Firms with sound equity capital resources are more often engaged in inter-enterprise collaborations.

CONCLUSION

The data analysis has shown that the Austrian software companies are widely integrating their operations with external business partners. Almost every second organization is already exploiting joint activities with business partners at various stages of their value-chains.

We have also shown that a number of assumptions concerning possible influencing factors on the level of co-operation intensity were supported by our analysis. Each of the stated factors viewed separately has a positive influence on the amount of co-operations taking place, e.g. the company size or the level of IT staff recruitment problems. Co-operating companies also seem to have better access to new technologies. Evidence was found to support the view that a higher level of co-operation intensity leads to better business performance. Co-operations even up to the level of collaborative value chains seem to be a sound basis for software companies to sustain in their very dynamic and competitive business environment. Software firms are shaping the nature of their relationship from simple knowledge exchanges towards productive collaborative software development to fully exploit the potential benefits indicated in this paper. Due to the highly globalizes nature of the software industry the findings can also be very informative for other geographical areas, esp. for other European countries.

REFERENCES

Alavi, M. (1993). An assessment of electronic meeting systems in a corporate setting. *Information & Management, 25*(4), 175-182.

DTI. (2001). *Building the Knowledge Driven Economy*. Retrieved 22.08.2001, 2001, from http://www.dti.gov.uk/comp/competitive/main.htm

EC. (1996). *Empfehlung der Kommision betreffend die Definition der kleinen und mittleren Unternehmen* (Amtsblatt der Europäischen Gemeinschaften No. L 107/4). Brussels: Commission of the European Community.

EITO. (1999). *European Information Technology Observatory 1999*: European Economic Internet Grouping (EEIG).

EITO. (2000). *European Information Technology Observatory 2000*: European Economic Internet Grouping (EEIG).

EITO. (2003). *European Information Technology Observatory 2003*: European Economic Internet Grouping (EEIG).

Green, P. E., & Carrol, J. D. (1978). *Mathematical Tools for Applied Multivariate Analysis*. New York: Academic Press.

Grover, V., & Vaswani, P. (2000). Partnerships in the U.S. Telecommunication Industry. *Communications of the ACM, 43*(2), 81-89.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate Data Analysis* (5th ed.). London: Prentice Hall.

Keeble, D. (1996). *Small Firms, Innovation and Regional Development in Britain in the 1990s* (Working Papers from ESRC Centre for Business Research): ESRC Centre for Business Research.

Kraemer, K. L., & King, J. L. (1988). Computer-Based Systems for Cooperative Work and Group Decision Making. *ACM Computing Surveys, 20*(2).

Mendelson, H. (2000). Organizational Architecture and Success in the Information Technology Industry. *Management Science, 46*, 513-529.

Naisbitt, J. (1995). *Global Paradox*. New York: Avon Books.

Nowak, M. J., & Grantham, C. E. (2000). The virtual incubator: managing human capital in the software industry. *Research Policy, 29*, 125-134.

Perreault, W. D., Behrman, D. N., & G.M., A. (1979). Alternative Approaches for Interpretation of Multiple Discriminant Analysis in Marketing Research. *Journal of Business Research, 7*, 151-173.

Poltrock, S. E., & Engelbeck, G. (1999). Requirements for a virtual collocation environment. *Information and Software Technology, 41*(6), 331-339.

Vickery, G. (1999, January). Business and industry policies for knowledge-based economies. *OECD observer*.