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Bauer, Roland; Köszegi, Sabine T.; Wolkerstorfer, Michaela

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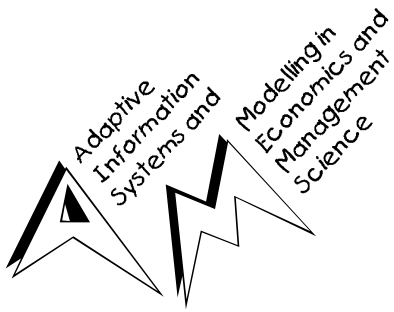

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Roland Bauer
Sabine T. Köszegi
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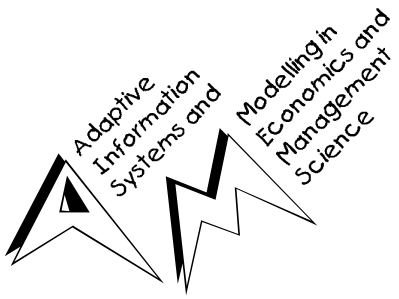

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Measuring the Degree of Virtualization - An Empirical Analysis in two Austrian Industries

Roland Bauer[1], Sabine T. Köszegi[1] and Michaela Wolkerstorfer[2]
[1]*Department of Business Studies, University of Vienna, Austria*
[2]*KPMG Business Consulting, Vienna*
(roland.bauer@univie.ac.at, sabine.koeszegi@univie.ac.at, mwolkerstorfer@kpmg.com)

Abstract

Strategic management literature suggests that especially in young and dynamic industries Virtual Corporations are more likely to emerge, as this type of organization is flexible enough to deal with rapidly changing environments. This paper challenges the proposition that environmental uncertainty and technological change lead to organizational adaptation towards virtual structures. We analyzed companies of two Austrian industries, data processing and engineering, which are characterized by different rates of innovation and environmental uncertainty, and compare their strategic, structural, and process characteristics by measuring their Degree of Virtualization. Results indicate almost no difference in the Degree of Virtualization. From these findings, we draw implications for the theoretical concept of Virtual Corporations as well as for empirical research.

1. Introduction

A Virtual corporation (VC) is a temporary network of independent companies, which collaborate to satisfy customer needs by combining their distinct core competencies [1-4]. Their focus is on the exploitation of short-term market opportunities rather than on establishing long-term business relationships. The literature has developed several explanations for the emergence and evolution of VCs. One proposition of the strategic management literature on VCs is that environmental uncertainty and technological change lead to organizational adaptation towards virtual structures [3, 5]. In this paper, we challenge this proposition and compare strategic, structural, and process characteristics of companies in two Austrian industries, which are characterized by different rates of innovation and uncertainty.

In the next section, we discuss the theoretical background of our study. In the third section, we formulate our research question and present our empirical analysis. In the fourth section, we explore reasons for our findings and address issues for further research.

2. Theoretical Background

Researchers take either a *procedural* or a *structural perspective* on virtual organization. While some authors see virtual organization as a meta-organizational concept, i.e. as a *process* [6-9], others define a virtual organization as an organizational form with specific structural characteristics [1-3, 10-14]. These different views lead to diverging explanations for the emergence of VCs. In our literature review, we identified three different research streams (paradigms), which provide alternative explanations for the emergence and evolution of VCs. Apart from the procedural vs. structural approach we can distinguish between evolutionary path models vs. strategic management models, and external vs. internal drivers for the evolution of VCs (see Table 1):

Table 1. Explanation models of VCs

Research Stream	Models	Process vs. Structure	Path Dependent vs. Strategic Choice	Internal vs. External Drivers
Pragmatic View	Management Trends	Both	Both	Both
Technology	Evolutionary Path Models	Process	Path Dependent	Internal
Organization/ Economic Theory	Contingency Models	Structure	Strategic Choice	External
	Resource-based-Models	Structure	Strategic Choice	Internal
	Transaction-cost-Models	Structure	Strategic Choice	External

The first research stream provides a *pragmatic* approach to explain the *evolution* of VCs.

Similar to organizational life-cycle models, the evolution of VCs is explained by the inherent logic of organizational development. Some scholars suggest that VCs are evolving out of different management trends like Lean Management, Business Process Reengineering, Total Quality Management, Outsourcing, or Supply Chain Management [1, 14-16]. While previous research has shown that in the past, there has been a continuous oscillation between decentralized and centralized organizational structures [18, 19], Krystek at al. suggest that VCs are a synthesis of both decentralized and centralized organizational structures. The emergence of VCs is seen as the result of an unavoidable evolution towards flexible structures [17]. However, this research stream, which we call the "pragmatic approach" is mainly descriptive and relies on heuristics and the analysis of case studies. Its research methodology lacks theoretical foundation in organization theory. Nevertheless, it provides interesting examples and case studies of VCs.

The second research stream approaches VCs from a *technological perspective* [6, 20-24]. Here, information and communication technology (ICT) is seen as the driving force underlying the evolution of VCs. ICT reduces transaction costs considerably and enables firms to transfer processes of the value chain to external cooperation partners. In this paradigm, evolutionary path models are suggested to explain different stages of development from a non-virtual to a virtual corporation [20]. Although some case studies demonstrate that organizations exhibit various grades of virtualization, scholars so far have not explained convincingly why organizations should follow the suggested path of development. For example, Wüthrich et.al. show that especially in the service industry, where the whole value adding process can be digitized, VCs emerge without previously following any evolutionary path [14]. Moreover, Mertens et.al. suggest that especially small and medium sized companies directly implement virtual structures as they lack the size and ability for externalization [22].

The third research stream explains the *emergence* of VCs by applying organizational theories such as contingency, resource-based, and transaction-cost theory. Scholars of this research stream suggest that VCs do not follow an evolutionary path but are established in one discrete step. Organizations face new environmental challenges like market globalization, individualized customer needs, and shorter product and technology life cycles [3, 25]. According to contingency theory, these external conditions require firms to become more flexible [1], to focus on their core competencies [26], and to optimize their value chain [27]. By implementing virtual structures, the management reacts to these external conditions to improve the fit between context and organizational structure [10, 17]. According to the resource based view [28, 29], core competencies are important building blocks for VCs. The value adding process must be configured and coordinated according to emerging opportunities [5]. This rapid adoption is not possible if the entire process is contained within one large firm. The flexible and dynamic combination of core competencies of several firms to unique value chains gives participating firms the opportunity to achieve competitive advantages by virtually increasing their resource and know how endowment [4, 13]. Hence, managerial capabilities in identifying market opportunities as well as in selecting appropriate cooperation partners have a strategic impact on firm survival [12, 13]. Another important characteristic of VCs is the replacement of institutionalized management structures by more marked-based coordination mechanisms, such as trust [30], self-organization and standardization [31], as well as the implementation of ICT [4] to reduce setup costs [32], communications costs [3], and monitoring costs [33].

Scholars of this research stream view VCs from a structural perspective and suggest a variety of structural characteristics [2, 22]:

- VCs consist of *independent* companies.
- Collaborators contribute *core competencies.*
- The collaboration is *temporary* to optimize value creation and exploit short-term market opportunities.
- Collaborative arrangements exhibit a *low degree of formalization* and hierarchical integration.
- Collaborators share *one identity*, through shared goals and one mission.
- *ICT* and *trust* enable flexible coordination of the value adding process.

An organization displaying these characteristics can be clearly distinguished from other cooperative arrangements, like strategic alliances, joint ventures, etc. [13]. However, empirical research shows that corporations rarely exhibit all the characteristics of this ideal VC

[22]. Scholz [10] therefore suggests, to replace the binary classification, virtual vs. non-virtual, by the concept of *gradual virtualization*, which interprets virtual structures as a continuum. That is, the more characteristics of an ideal VC a firm exhibits, the higher is its *Degree of Virtualization (DV)*. As a result, every organization is characterized by a specific DV on a continuum between a non-virtual corporation and an ideal VC. However, the integration of the different dimensions into a single measure, the DV, is problematic. So far, empirical analyses either compare characteristics separately [22], or weigh characteristics equally and build an additive scale [33, 34]. It is important to point out that, contrarily to the first two research streams, the concept of gradual virtualization is not suggesting an evolutionary path from a non-virtual to a virtual corporation. The concept of gradual virtualization only suggests that some organizations are "more virtual" than others. Thus, it allows to classify and to compare organizations or industries according to their adoption of virtual structures.

In summary, we can extract two distinct attempts to explain the emergence of VC, the *evolutionary perspective,* and the *strategic management perspective* (see also overview in Table 1). The first perspective proposes evolutionary path models for the emergence of VCs. The evolution is either driven by ICT, by an inherent logic of modern management concepts, or as a synthesis between historical trends of decentralization and centralization. Evolutionary models propose a general movement towards virtual structures and managerial choice is reduced to the internal restructuring measures necessary to implement them.

The second perspective acknowledges the strategic choice of management on organizational design. It reflects the controversy of organizational adaptation versus environmental selection [35-38]. While organizational ecology theories suggest that selection of the environment mechanisms lead to survival of the fittest organizations in the population, making – in the most radical interpretation - managerial intervention useless [36], strategic management theories view organizational adaptation as the outcome of a deliberate strategy and organizational design by the management. The strategic management perspective views VCs as a result of both the external context of the firm and the concious managerial actions, which have a direct impact on adaptation and survival of firms.

3. Empirical Analysis

3.1. Research Question

The purpose of this paper is to challenge the proposition offered by the strategic management perspective that environmental uncertainty and technological change push organizations to adopt virtual structures. Our intention *is not* to challenge the fundamental models on organizational change offered by contingency or evolutionary theories. Instead, we want to investigate empirically, whether strategic management models of VCs provide an appropriate explanation for the emergence of this organizational form.

Consequently, by adopting the concept of gradual virtualization suggested by Scholz [10], we formulate the following hypothesis:

H_1: *Companies in industries characterized by environmental and technological uncertainty will exhibit a higher Degree of Virtualization than companies of industries with lower uncertainty.*

In contrast to strategic management models, evolutionary models propose a uniform trend towards virtual structures within all industries. Testing this hypothesis would require a longitudinal study of several industries. However, we claim that, even if there is a general movement towards virtual structures, VCs will still emerge faster in highly uncertain environments. Hence, by using a cross-sectional analysis of industries, we are able to test our hypothesis.

We base our empirical analysis on the concept of industry life cycle suggested by Porter [39] and Little [40]. We use the stages of industry life cycles to classify industries according to their environmental characteristics and the resulting strategic implications. Both Porter and Little distinguish between four different stages in the life cycle of an industry, i.e. emergence, growth, maturity, and decline. The first two stages are characterized by a fast growth of revenue, the latter by stagnation or decline. Emerging and growing industries are characterized by technological and strategic uncertainty, high initial but rapidly declining costs, a high percentage of spin-offs and newly founded organizations, and a short time horizon [39]. Important strategic factors for competitive advantage in growing industries are technology, innovation potential, flexibility, and venture capital. Mature or declining industries are characterized by increased competition and concentration of market shares, increasing importance of

costs and customer service as well as increasing power of customers [39]. Critical factors for competitive advantage in such industries are costs, market share, efficient production technology, and a control system.

Hence, the environment of industries in the first two stages of life cycle displays exactly those characteristics which were suggested as driving forces for the adoption of virtual structures, whereas the environment of industries in the third and fourth stage of industry life cycle does not require highly flexible organizational structures. However, we do not suggest that organizations "de-virtualize" in the later stages of the industry life cycle. We rather claim that, because of the temporary character of VCs, they evolve (and disappear) more often in the first two stages than in the latter two. Thus we expect a higher DV in industries in the first two stages of life cycle.

3.2. Sample

We used the results of the "Community Innovation Survey II - Technology & Innovation" conducted 1997 by the Austrian Institute for Economic Research (Wirtschaftsforschungsinstitut - WIFO) as a basis for the selection of industries. This survey collected data from a sample of 1003 companies of Austrian service industries (39.08 % response rate) on technology and innovation [41]:

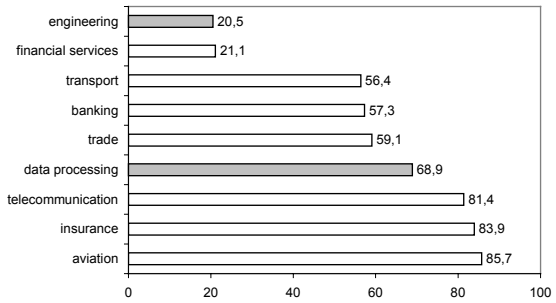

Figure 1. Percentage of innovators

The figure above shows the percentage of companies which either offered a technologically new or significantly improved service to customers, or improved significantly their processes of service production in the period of 1994-1996.

For our empirical analysis, we selected the following two industries:

a) **Data Processing**: this industry comprises companies providing data processing or data-base services for third companies and companies which develop software.
b) **Engineering**: this industry comprises architects and engineering offices, which provide construction and planning services as well as technological expertise.

The selection of these industries is based on several reasons: in addition to the significant difference in the innovation rate (see Figure 1) there is also a significant difference in market development. Between 1982 and 1997, the net value creation of the data processing industry in Austria increased by 400 % whereas during the same period net value creation of the engineering industry increased only by 100 % [41]. Other important characteristics, such as the average number of employees and human resource costs are similar in both industries [41]. Furthermore, both industries offer knowledge intensive services, and, most important, cooperation with other companies is relatively common in both industries. 48.9 % of the companies in the data processing industry regularly cooperate with others. Collaboration in the engineering industry is - traditionally - very high (81.5 %) [41]. The similarity of the industries with regard to products (knowledge-intensive services), collaborative arrangements, as well as size of companies and employee structures allows for an analysis of the influence of technological and environmental uncertainty on the adoption of virtual structures.

300 companies (150 in each industry) were selected randomly from the Community Innovation Survey II sample. We followed a key-informant approach to data collection, viewing managing directors as the most qualified to provide valid responses to organization-level questions [42]. The questionnaire was thus sent to company managing directors. A covering letter accompanying the questionnaire explained that it was essential that the respondent be a member of the top management team, that the data was processed anonymously, and that confidence was assured. The respondents were allowed a time period of four weeks to fill in and return the questionnaire. With this procedure, we received a return rate of 23,33 % (70 questionnaires) which is above expected response rates for mailed, unsolicited surveys [43]. However, information about non-responders and tests of non-response biases cannot be provided. 45 % of the returned questionnaires came from the data processing industry and 55 % belong to the engineering indus-

try. Because of missing data, 3 questionnaires were not processed further.

On average, the engineering companies of our sample have 12 employees (median=6). 59.5 % have 1-10 employees, and 40.5 % have between 11 and 100 employees. There were no companies in the sample with more than 100 employees. Companies of the data processing industry have an average number of employees of 63 (median=15). 44.8 % have between 1 and 10 employees, 48.3 between 11 and 100 employees and 6.9 % have more than 101 employees. Apart from the few large companies in the data processing industry, the size of companies in both industries of our sample is similar. 86.5 % of all respondents collaborate on a regular basis with other companies or persons. Only 6.5 % do not regularly cooperate with other companies. The average number of cooperation partners is 2.7 in the data processing industry and 3.2 in the engineering industry.

3.3. Measurement and Construct Validation

The questionnaire used in this analysis consists of two sets of items. The first set of items was developed for this study with reference to Porter [39] and Little [40] and comprises questions about market structure as well as goals and strategies. The second set of items measures the DV and was developed and validated by Bauer and Köszegi [34] in an earlier study on gradual virtualization in the consulting industry in Austria and Germany. Similar approaches to measure the DV can be found in [11, 22, 46, 47].

Stage of industry life cycle

Despite the careful prior selection of the industries, we wanted to test whether the companies perceive themselves to be in a different stage of the life cycle. We asked several questions about characteristics of the market and the industry. Results of ANOVA (entering industry as a factor), an exploratory factor analysis of items, as well as Cronbach alpha values for reliability are displayed in the following table:

Table 2. Market structure

Items (translated): Which of the following characteristics describe your market/industry? (Likert: 1 = not at all; 5 = true)	Factor I+ (α=.74)	Factor II+ (α=.51)	ANOVA F
The market grows.	.891		49.699**
The market stagnates. #	.748		27.915**
Market development is positive.	.819		29.713**
The number of products & services is increasing steadily.	.510		8.320**
Technology is especially important for product development.	.459		7.023*
The market is dominated by a few competitors. #		.742	0.265
The number of competitors will increase in the future.		.707	1.130
Access to market is open and unrestricted.		.635	7.104*

reversed items
+ KMO = .613, Rotation: Varimax, cut-off value = .45; 42.67% of total variance explained
**p<.01, *p<.05

In the ANOVA analysis, 6 out of 8 items revealed significant differences between industries. The factor analysis with Varimax Rotation estimated two factors when applying the Scree Test Criterion and Percentage of Variance Criterion (above 5 %). Items with factor loadings below .45 were omitted. Separate factor analysis in each industry revealed almost identical factor distribution and loadings. Factor I contains items regarding market growth and dynamic. Factor II includes items describing market density and competition. Cronbach α values indicate good reliability (α=.74) for factor I *Market Growth and Dynamics* and low reliability (α=.51) for the factor II *Market Density and Competition* which is below the acceptance level [44].

Using linear regression we calculated factor values for the factor *Market Growth and Dynamic* and built quartiles (1= not dynamic; 4=highly dynamic). To analyze differences between the data processing and engineering industry we cross-tabulated the quartiles of the factor values from the factor *Market Growth and Dynamic* with industry. The following graph shows the results:

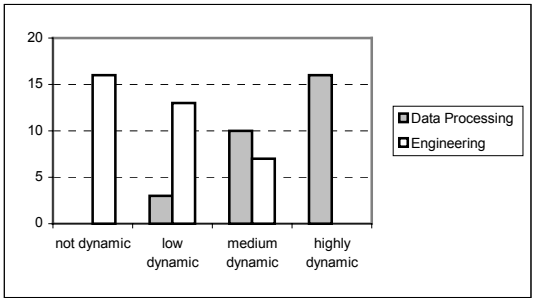

Figure 2. Market growth & dynamics

Companies of the data processing industries perceive market growth and dynamics higher than companies of the engineering industry. A χ^2-test confirms highly significant differences of the two industries in this factor ($p < .001$).

In addition to this analysis, we investigated critical success factors and strategies (according to Porter [39] and Little [40]). Table 3 shows the results of an exploratory factor analysis over 16 items which were used to measure critical success factors in the industry.

The Srceeplot Criterion as well as the Percentage of Variance Criterion (> 5 %) suggested the extraction of 4 factors. Separate fac-

tor analyses for each industry led to similar results. Cronbach alpha values are satisfying for all factors. Items comprised in the first factor describe the importance of *Innovation* and items of the second factor can be summarized under the concept of *Flexibility*. Items of the third factor describe the relationship between companies and their customers and are therefore named *Customer Relation Management (CRM)*. The last factor comprises items concerning cost orientation as well as the need for fast reaction when market opportunities appear. Although this item could also be grouped into the factor *Flexibility,* it also measures competitive pressure and therefore fits into the last factor, which we name *Cost Orientation*.

Table 3. Decisive factors for success in industry

Items (translated) How important are the following statements for the success of your company? (Likert scale: 1 not at all; 5 very important)	1 α= .72	2 α= .62	3 α= .63	4 α= .64
Product life cycles of our products and services are becoming constantly shorter.	.764			
Knowledge we use today is obsolete tomorrow.	.722			
Development and use of new technology is decisive.	.621			
It is important to offer innovative products even if production costs are higher.	.596		.449	
It is important to react immediately to new trends.	.478	.464		
When entering into new markets, fast actions are more important than careful consideration of pros and cons.		.808		
Fast decisions are more important than thorough planning.		.755		
Marketing know how is very important.		.523		
The time between product idea and its introduction into the market has to be minimized.		.416		.404
Our services are customized.			.746	
Our customers can influence service production at any stage.			.674	
Expectations and needs of our customers are changing often.			.600	
Professional customer complaint management is important for good customer relations.			.575	
Minimizing costs is more important than minimizing order processing time.				.766
Competition is focussed more on costs than on innovative products.				.762
Opportunities in the market need to be realized immediately				.574

KMO= .583; Rotation: Varimax, cut-off value = .45; 55.75 % of total variance explained

An ANOVA analysis on factor values obtained through the regression method revealed significant differences between the data processing and the engineering industry in two out of the four factors. *Innovation* is significantly more important in the data processing industry ($F=7.398$, $p < .01$) whereas *Cost Orientation* is significantly more important in the engineering industry ($F=17.090$, $p < .001$). There are no differences in the remaining two factors, *Flexibility* and *CRM*.

Based on these analyses on market description and critical success factors as well as on the findings of Dachs et al. [41] on innovation we conclude that the data processing industry is characterized by market growth and high dynamic as well as a high innovation rate. Furthermore, innovation seems to be a decisive factor for success. The engineering industry is characterized by more competition, rather pessimistic evaluation of market growth, a lower innovation rate and cost orientation seems to be a decisive factor for success in the market. Thus, data processing is indeed in an earlier phase of the life cycle than engineering.

Degree of Virtualization

The objects of investigation in an analysis of VCs are hybrid organizational forms. Hence, to measure the DV, not only characteristics of collaborators (such as core competence focus, etc.) but mainly their inter-organizational relationships must be considered. Considerable problems for measurement are caused by the temporary nature of VCs, as well as the vagueness and fluidity of its borders. Facing these methodological difficulties we propose to measure the DV by analyzing characteristics of one collaborator and his relationships to other collaborators of the network [34]. Although with this procedure we can neither analyze network measures like closeness, centrality or reciprocity of directional relations, nor explain longitudinal evolution of VCs within an industry, it should be sufficient to measure cross sectional differences in form and quality of collaborative relationships between industries.

Based on the definition of a Virtual Corporation, the following strategic, structural, and procedural dimensions are used to measure the DV:

a) **Strategy - Focus on core competence and virtual value creation.** Items in this dimension measure the company's focus on its own core competencies, the degree of outsourcing activities, and the degree of virtual sourcing for product/service production.
b) **Structure - Characteristics of collaborative relationships.** Items in this dimension measure how often companies cooperate with others, the degree of formalization, duration of cooperative arrangements, as well as mutual dependence within the cooperation.
c) **Process - Coordination of Value Creation.** In this dimension we measure which information and communication tools are implemented to coordinate value creation within the cooperation, as well as qualitative meas-

ures of the relationship such as trust and fairness.

We performed a factor analysis for all items (except items regarding ICT-tools which were analyzed separately). The Screeplot Criterion as well as the Percentage of Variance Criterion (> 5%) suggested the extraction of 5 factors. A separate factor analysis for both industries revealed again similar results. Due to the relatively small sample size compared to the high number of items, we selected only items, which had high loadings (above .50) only on one factor. The final item allocation is presented in Table 4. Cronbach alpha values indicate high reliability for the first three factors and are sufficient for factors 4 and 5. The first factor comprises items, which can be summarized under the construct *Fairness*. Items of the second factor describe the appearance of the cooperation towards the customer and are labeled *Virtual Identity*. Items comprised in the third factor are summarized under the construct of *Formalization*. The fourth factor measures the degree of *Virtual Sourcing*, i.e. modularized service production. The last three items of the fifth factor measure the companies' focus on *Core Competencies*.

The extracted factor structure is similar to the one found by Bauer and Köszegi [34]. There, the concepts of trust and fairness, which are integrated in our study in one factor, were separated into two factors. Additionally, Bauer and Köszegi [34] suggested the factors "integration" and "general characteristics of the cooperation" which are comprised into one factor *Virtual Identity* in our study. *Formalization*, *Virtual Sourcin*g (Virtual Value Creation) and *Core Competencies* are almost identical in both studies.

Table 4. Degree of virtualization

Item (translated): (5-point Likert scales) α-values	Components .83	.80	.82	.67	.66
We are committed to cooperation principles, even if it is disadvantageous for us.	.874				
We are committed to oral agreements, even if it is disadvantageous for us.	.862				
We are committed to written agreements, even if it is disadvantageous for us.	.846				
In our co-operations we have an atmosphere of honesty, openness and trust.	.565			.427	
We always try to consider the interests of all the collaborating partners.	.539				
All collaboration partners participate in decision making processes.	.511			.443	
The cooperation offers the customer a complete product/service solution.		.872			
The cooperation acts with one face towards the customer.		.798			
There is only one contact person for the customer in the cooperation.		.756			
There is a central coordination unit, which coordinates the tasks within the cooperation (e.g. Network Broker).		.640			
The cooperation has its own logo.		.629			
We have detailed written contracts with our cooperation partners. #		.831			
We only have oral agreements with cooperation partners.		.799			
Generally, the extent of contractual agreements is high. #		.794			
We cooperate without contractual agreements.		.775			
All collaborating partners have equal rights within the cooperation.			.737		
We need our collaboration partners to produce the products/services in due time and quality.			.711		
Our product/service is the result of the different inputs (core competencies) of the collaborating partners			.579		
We control services and products our partners deliver.	.309		.566		
Our strengths differentiate us from our competitors.					.868
It is difficult to imitate our strengths for our competitors.			.369		.700
It is important to concentrate on one's own core competencies.	.368				.641

KMO = .590; Rotation: Varimax, cut-off value = .50; 63,42 % of total Variance explained
# reversed items

In addition to these 5 factors, we calculated an *ICT* factor, i.e. the implementation and use of ICT-tools (email, Internet, intranet, video conferencing, newsgroups, GroupWare, EDI, and the access to shared data bases), by using an additive scale over all ICT items, measured on 5-point Likert scales.

3.4. Results

The basic question of our empirical analysis focused on differences in the DV between industries characterized by different rates of innovation and environmental uncertainty. To test this hypothesis, we calculated factor values using additive scales for the factors derived from the factor analyses and entered them as dependent variables into an ANOVA analysis with industry as the independent variable (company size was controlled in a separate analysis and turned out to be not significant). Results show no significant difference in the dimensions *Core Competence* focus ($F = 1.982$, $p = .164$) and *Virtual Sourcing* ($F = 3.0590$, $p = .085$), although the engineering industry had a slightly higher mean in *Virtual Sourcing*. There is also no significant difference in the factors *Virtual Identity* ($F = 0.5153$, $p = .475$) and *Formalization* ($F = 0.158$, $p = .692$) between the two industries. Only the factor *Fairness* is significantly higher in the engineering industry as compared to the data processing industry ($F = 4.225$, $p < .044$) and finally, *ICT* implementation and use is significantly higher in the data processing industry ($F = 18.0490$, $p < .001$).

These results lead to a rejection of our hypothesis. Only two out of six factors were significantly different. Moreover, the higher degree of fairness in the engineering industry is contrary to the prediction. Given the tradition of

collaboration in this industry, it is not surprising that a culture of trust and fairness has been developed among cooperating partners. The significantly higher use of new ICT in the data processing industry is also not surprising, as ICT belongs to the core competence of this industry.

4. Discussion

In this empirical study, we tested the proposition that dynamic environments and innovation lead to the adoption of virtual structures. Previous literature used case studies to demonstrate this tendency. Here, we took a different approach and tried to measure differences in the DV of industries which are characterized by a different degree of innovation and environmental dynamics using quantitative analyses of a larger sample of firms. The results suggest that there is only a minimal difference in the adoption of virtual structures. We have two explanations for these findings. One is self-critical and the alternative explanation is rather provoking.

The self-critical explanation is that our approach to measure the DV is not appropriate. The question is: How can the characteristics of a short-lived organization with fluid and vague borders be measured, if it vanishes even before one has the chance to take a closer look at it? Following the literature [11, 14, 19, 33, 46], we used the characteristics of an ideal VC as a reference for measuring the DV. However, in contrast to previous research, we did not concentrate our empirical analysis on entire virtual corporations or networks but on single companies (potential nodes in a VC) and their relationships to cooperation partners. We hypothesized that this procedure allows us to infer to which extent virtual structures exist in a network, and to extend this measurement to the whole industry. However, this approach has some drawbacks. First of all, we do not observe VCs directly but only - in the best case - parts of them. According to social systems research [48], one could argue that characteristics of a network are better explained by its relationships than by its nodes, as this focus should lead to a holistic perspective of a network. By concentrating only on one node and its relationships, we are possibly neglecting that firms could be part of different networks. Additionally, we are not able to determine the borders of a network.

Furthermore, a cross sectional approach of analysis does not allow to analyze emergence or evolution of VCs over time. Such an analysis would need to be based on longitudinal studies where the historical context of the companies as well as their environments are integrated in the research model [36]. Lewin and Volberda [36] developed a sophisticated framework for research on strategy and new organizational forms by formulating minimum requirements for empirical research. Nevertheless, the translation of these requirements into methods and pragmatic procedures is still unresolved.

Another important requirement for future research is that we need to be more precise in the conceptual foundation of characteristics of VC and root them in theoretical concepts to develop more valid and reliable measures of constructs. In this study, we rely on self-reported measures of characteristics of collaborative relationships in a relatively small sample (67 observations), which causes problems for generalization of results. More objective indicators need to be developed and tested in larger samples. Miles et al. [49] give examples for such indicators in their research on industry variety and performance. However, our results regarding the industry life cycle stage were in line with the findings of the highly reliable survey of Dachs and Leo [41], which suggests that results of this study are at least to some extent reliable. The construct validations through factor analysis and Cronbach alpha analysis of the dimensions of a VC were satisfying and allow, at least for our sample, the conclusion that there are almost no differences in the DV between the industries we analyzed, given the concurrent conception of VCs.

This leads us to the alternative and provocative explanation of our results: the current conception of Virtual Corporations is not appropriate. As already mentioned in the introduction, the theoretical foundation of the concept of Virtual Corporations is weak. Although there were numerous book publications on VCs, and many case presentations in research reports and articles, only few of them are also published in academic journals (see EJOV at www.virtual-organization.net). It seems that we do not know much more about the Virtual Corporation than Byrne said almost 10 years ago in his famous article in Business Week [1]. In the heading of this article, Byrne asks: "*[Virtual Corporation -] Just another management fad - or a vision of the future*?" and research has not been able to

provide a satisfying answer to this question so far. Did anybody observe this ideal Virtual Corporation - this temporary network of competitors, suppliers, and customers exploiting short-term opportunities, and vanishing once the need evaporates? The literature came up with quasi-evolutionary models ("quasi" because of the missing link to evolutionary models in organization theory) and models of the DV which undermine the original concept and circumvent puzzles and contradictions the concept encompasses.

The results of our empirical analysis demonstrate major weaknesses in the concept of VC. For example, one of the important characteristics of VC is mutual trust between collaborators. When we examine industries which traditionally have a high degree of collaborative arrangements, like the engineering industry, we observe - not surprisingly - high levels of mutual trust and fairness. Additionally, we observe some other "virtual" characteristics such as configuration of projects according to customer needs, the formation of a cooperative arrangement for single projects, which disband after completion of the project, handshake quality of oral agreements and so forth. The source of high trust and fairness can also be seen in the tradition in these industries rather than the (theoretical) need for flexible arrangements. Another basic characteristic of VCs is the use of ICT. Again - not surprisingly - we observe higher ICT use in ICT industries. These examples demonstrate the problem of segmenting the characteristics of a VC into extremely diverse factors (technology, social aspects, resources etc.), as the problem of re-aggregation into a holistic picture is unresolved. Moreover, the assumption that all characteristics of VCs are equally important is questionable. However, the differentiation between structural, procedural, and strategic characteristics, as suggested in this analysis, at least allows us to distinguish between different approaches to virtualization.

Apart from the basic concept of VCs, there are several key questions concerning the evolution of VCs. According to the contingency argument underlying the strategic management perspective, virtual structures are indispensable for organizational survival in dynamic environments. However, it is not clear why specifically VCs, and no other organizational design, should be the best reaction to environmental changes [12]. Levinthal [50] for example has shown that organizational adaptation is path and history-dependent, resulting in different organizational forms even if the firms' context is identical. On the other hand, evolutionary path models of VCs view the environment as an exogenous variable, neglecting the possible influences of firms on their environment. This view contradicts the recent literature on the evolution of new organizational forms, which stresses the co-evolution of firms and their environment [35-37].

With regard to the resource based theory, it has to be questioned whether the mere combination of core competencies will really lead to synergies. Currently, there is no evidence which core competencies are best combined in which situations, how they can be identified, or how synergies can be ensured [12]. It is also doubtful whether sustainable competitive advantages based on combined core competencies and know-how can be achieved in a virtual context. For instance, one goal of VC is to equalize heterogeneous resource endowments among firms and to improve resource mobility among partners in order to overcome their own limitations [10, 27]. This leads to a paradoxical situation: By equalizing the sources of resource based competitive advantages [29], the basis for sustaining them is lost and could lead to exploitation by competitors [51]. Moreover, while focusing on their core competencies, firms are losing competencies in other areas and are increasing the dependence among partners as well as the danger of being replaced within the network by competitors.

In contrast to the theoretical concept, empirical evidence points to a need for intensified inter-organizational coordination to guarantee success of alliances and collaborations [52]. Thus some authors propose a strategic core competence management for VCs [53], a pool of possible cooperation partners [31, 54], the formation of VCs inside strategic networks [55], or the institutionalization of a network broker [22]. However, all these ideas are in conflict with the goal of lowering transaction costs, which requires the absence of an institutionalized management function and a focus on short-term arrangements.

Although transaction cost theory is widely used and accepted in the strategic network literature its application to VC leads to another paradox: According to the transaction cost argument given above, the extensive use of ICT lowers transaction costs. While it is quite obvi-

ous that communication costs decrease and that the quality of communication can be improved by ICT, other costs may stay the same or even increase. For instance, the usage of ICT still does not impede opportunistic behavior. Additionally, as the investment in ICT is highly specific, monitoring costs may even further increase [56]. Therefore, it cannot be generally assumed that all different types of transaction costs can be lowered by ICT. The net effect remains unclear.

Despite the attempts to obtain a real picture of a virtual phenomenon, we must acknowledge that the theory of VC lacks an underlying framework. This impedes conceptualization for empirical research, as the object of investigation remains largely unclear. To aggravate the situation, VCs are by definition a temporary organizational form. This makes the object of investigation even more vague and long term studies – as demanded in literature [35, 36, 38, 50] – are impossible as the organizations disband after some time. Although case studies presented so far may provide valuable insights as starting point for academic discussions and for deriving new organizational theories, their generalization to the entire population is quite limited [57]. New empirical methods, measuring instruments, general accepted theoretical frameworks, and concepts for research need to be developed to improve our overall understanding of VCs.

In summary, it is questionable whether the concept of VC as a new organizational form is appropriate. We refer to the discussion between scholars taking either a procedural or a structural perspective on virtual organization. It could be more fruitful to view virtual organization as meta-organizational concept. The procedural perspective acknowledges that the DV is not limited to specific industries, contexts or firms as suggested by the structural perspective. Instead, virtual organizing is an ICT-enabled meta-management principle for goal-oriented enterprises.

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