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HOW DO ICT FIRMS REACT TO CONVERGENCE? AN ANALYSIS OF DIVERSIFICATION STRATEGIES

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Abstract

Convergence represents a dominant force in the evolution of the ICT industry. Under convergence, the identification and analysis of strategies to efficiently leverage firm resources and to configure firm cooperations represents a challenging task. Diversification is considered a central firm strategy with regard to convergence. Former research has mainly focused on the phenomenon of ICT convergence per se. In this article, we analyse how ICT firms react to convergence. Network analysis techniques are applied to assess the degree to which ICT market segments are exposed to convergence. Based on this assessment, we evaluate firm diversification strategies under convergence with a focus on diversification objectives and firm performance. The data analysis provides two major implications. Firstly, convergence creates synergy potentials for diversifying ICT firms. Secondly, diversification does not generally allow ICT firms, which are exposed to convergence, a more efficient application of resources. Even though the term convergence is often cited in ICT research, empirical analyses addressing ICT convergence and firm strategies are rather scarce. This work provides such an analysis by applying a novel research approach based on network analysis.

Keywords: Business strategy, Business network(s), Performance, Synergy

1 Introduction

The information and communication technology (ICT) industry is subject to strong dynamics. Industry evolution is influenced by product and process innovations (Utterback and Abernathy 1975). Technology and product innovations regularly lead to discontinuities, which potentially render strategic firm resources useless (Henderson and Clark 1990). Industry convergence is a special type of industry evolution, which effects formerly unrelated industries in parallel and leads to an alignment of the industries' target markets (Yoffie 1996, Katz 1996). Industry convergence is a widely acknowledged phenomenon, particularly with respect to the ICT industry (Farber and Baran 1977, Collis et al. 1997). In spite of the maturity of this phenomenon in research, the continuous strategic alignment to dynamics in the ICT industry, which are caused by convergence processes, remains a challenging issue for ICT firms.

A current example for the importance of convergence strategies for ICT firms is related to the diffusion of smart-phone applications. A multitude of such applications represent substitutes for traditional products and services such as telephony, messaging, car navigation, gaming, and digital cameras. Incumbent service providers, which are threatened by these offers, react in different ways: some develop smartphone applications themselves and break up their vertical integrated business model. As an example, the car navigation service provider TomTom, which traditionally offers navigation devices, now provides a navigation app for the iPhone. Others leverage their established distribution channels by entering into strategic coalitions with smartphone providers, such as AT&T with Apple, and try to secure revenues for their traditional services. A third strategy is to diversify products in order to stay competitive. The gaming console provider Nintendo for example included Internet browsing features, a camera, and multiple software applications into its product Nintendo DS.

It is a challenge for practitioners and researchers to identify and analyse effective strategies which guarantee a sustainable competitive advantage under convergence effects. The strategic placement in ICT firm networks for a joint service provisioning, standards setting, and resource development (Gulati et al. 1990) determines the competitive position of firms. Here, convergence researchers highlight two contrasting strategies: diversification and concentration (Katz 1996, Gambardella and Torrisi 1998, Pennings and Puranam 2001). Diversification under convergence potentially allows the realization of synergies (Gambardella and Torrisi 1998). Concentration is associated with high resource efficiency (Katz 1996).

Empirical research on ICT convergence focuses mainly on the phenomenon of convergence per se and scarcely addresses convergence related firm strategies and objectives. To fill this gap, this research studies diversification strategies. We analyse whether diversification represents a widely pursued strategy to address convergence. Moreover, the objectives of diversification are analysed and implications regarding the performance of diversification under convergence are drawn.

2 ICT Convergence and Firm Diversification

2.1 Convergence in ICT

Technology innovations potentially have an impact on the consistency of industries by altering the internal competitive landscape and the external industry boundaries (Porter 1985). If such innovations form substantial production resources for formerly unrelated industries, one speaks of technology convergence (Rosenberg 1963). We distinguish between the convergence of technologies and the convergence of industries: if products from different industries are becoming substitutes or bundles in a single product, these industries increasingly address identical markets. This process is referred to as industry convergence (Yoffie 1996, Katz 1996). Stieglitz (2003) emphasizes the inequality of these

two concepts: technology convergence does not inevitably lead to industry convergence. This is shown by Gambardella and Torrisi (1998) in a study on the electronics industry. Greenstein (1997) distinguishes between two forms of convergence: convergence in substitutes occurs if consumers perceive products from distinct industries as interchangeable. Convergence in complements manifests itself in a super-additive value, a bundling of products proposes to consumers.

More than 30 years ago, Farber and Baran (1977) perceived technology convergence in the computing industry and the telecommunications industry driven by the complementary application of computing and data transport capacities. As a consequence to technology convergence, several authors described the convergence of the following industries into a single ICT industry: hardware (components and equipment), software, telecommunications, and media (Collis et al. 1997, Yoffie 1996). Katz (1996) discussed the several strategic implications of ICT convergence: convergence stimulates competition in ICT. As a reaction, firms either diversify or establish coalitions and focus on core activities. This leads to a horizontal structuring of the ICT industry with competition taking place on the component rather than on the system level. The bundling of complementary products increases the potential for product differentiation. Additionally, convergence increases the importance of network effects and standards, because the competitive advantage of firm coalitions is significantly dependent on the extend to which cooperation partners aggregate components in integrated service offerings. Several authors highlight three courses of action, which are central for the strategic management with regard to industry convergence: diversification, concentration and cooperation (Katz 1996, Gambardella and Torrisi 1998, Pennings and Puranam 2001). Through diversification, firms leverage resources, which become valuable to a different industry, by extending their field of action to this industry (Gambardella and Torrisi 1998). Through coalitions, ICT firms provide shared access to resources, which are required to address markets of convergent industries or collectively establish such resources (Basole 2009, Duysters and Hagedoorn 1998).

The analysis of empirical studies on ICT convergence and firm strategies (Table 1) shows that many authors do not distinguish between ICT convergence and convergence related firm strategies. The studies mostly use data on patents for the operationalization of technological convergence. As a measure for industry convergence, all authors utilize data on mergers, acquisitions, and strategic collaborations. The degree and breadth of merging, acquisition, and collaboration activities of firms is set equal to the degree of industry convergence. The studies largely ignore, that concentration on core markets also represents a possible firm strategy to confront an increase of competition due to convergence. Moreover, these approaches do not cover diversification, which is based on internal resources rather than on mergers and acquisitions

Some authors compare technology and industry convergence and mostly show that a broad technology base does not necessarily imply firm diversification on the market layer. Former studies generate heterogeneous results with respect to the presence of industry convergence. Pennings and Puranam (2001), Palmberg and Matikainen (2006) and Khansa and Liginlal (2009) provide evidence for industry convergence while Basole (2009) does not clearly identify this phenomenon and Duysters and Hagedoorn (1998) even produce contrary findings. Three studies carry out longitudinal studies and perform regressions with Herfindahl indexes of patent and M&A activities as independent variables. Pennings and Puranam (2001), Khansa and Liginlal (2009), as well as Basole (2009) apply network analysis and use network metrics such as the node cohesiveness and centrality to evaluate convergence in the ICT industry.

Author	Research Focus	Operationali-zation of Convergence	Operationali-zation of Firm Strategies	Type and Method of Analysis	Results
Duysters and Hagedoorn (1998)	- effect of technological convergence on computer and telecommunications equipment companies	- sectoral distribution of patents - sectoral distribution of alliances		- longitudinal - linear regression (dependent variable: time)	- no evidence of convergence effect
Gambardella and Torrisi (1998)	- relation of technological with industry convergence in electronics industry	- ratio of technology to downstream diversification as an indicator for convergence	- number of patents per firm and sector - number of acquisitions, subsidiaries, and collaborative agreements per firm and sector	- longitudinal - correlation and comparison of Herfindahl indexes - OLSQ regressions to analyse diversification - performance relation	- evidence of technological convergence in electronics industry - no evidence of industry convergence
von Tunzelmann (1999)	- convergence as initiator of corporate change	- sectoral distribution of patents per industry - effects of corporate changes on patent Herindahl indexes		- longitudinal - regressions of Herfindahl indexes from distribution of patent fields per industry (dependent variable: time)	- no evidence of technological convergence
Pennings and Puranam (2001)	- impact of industry convergence in the digital imaging industry	- number of mergers and acquisitions - number of strategic alliances		- longitudinal - firm relation network analysis (clique, component membership, degree centrality and density)	- growing market overlap in imaging industries
Palmberg and Matikainen (2006)	- internal and external diversification in Finnish telecom industry	- sectoral distribution of patents per industry - sectoral distribution of R&D partners per industry		- longitudinal - comparison of Herfindahl indexes of patents and R&D alliances per industry	- internal stronger than external diversification - increase in the breadth of external diversification
Khansa and Liginlal (2009)	- impact of ICT convergence on information security industry	- inter-sector M&A activities		- longitudinal - cohesiveness of M&A network	- increasing convergence in ICT
Basole (2009)	- analysis of interfirm relations in a converging mobile ecosystem	- firm relationships (alliance, partnership, JV, buyer/supplier/customer)		- cross-sectional - comparison of network metrics of current and emerging industry segments	- no clear evidence for ecosystem convergence

Table 1. Overview on Empirical Studies on ICT Convergence and Firm Strategies

2.2 Firm Diversification- Strategies and Objectives

Firm diversification represents a focal issue in strategic management. Its impact on firm performance has been subject to extensive research (Penrose 1959, Gort 1962, Ansoff 1965, Rumelt 1974, Berry 1975, Porter 1985). Authors have addressed multiple levels of diversification including the diversification of customer segments, geographic regions, products, and tangible and intangible resources. Following Ansoff (1965), we consider a firm to be diversified if it offers heterogeneous products (Ansoff 1965, pg. 132).

The objectives of diversification depend on its type, which is determined by the customers addressed and the resources applied. *Horizontal diversification* refers to the offering of heterogeneous products over identical distribution channels. In *concentric diversification*, firms leverage the relatedness of production resources. A major objective for horizontal and concentric diversification is to realize synergies through the application of shared resources and capabilities. Synergies are rooted in the interrelationships among business units (Porter 1985, pp 317 - 363) and result in a market position, in which the overall market capabilities of a firm are superior to the mere sum of its capabilities in sub-segments (Ansoff 1965, pg. 65). *Vertical diversification* describes the situation in which a firm offers products from successional production stages of a single production chain. Vertical diversification is subsumed under vertical integration. Its objective is to gain a dominant position in value networks through the control of successional production stages (Perry 1989). *Conglomerate diversification* refers to the offering of heterogeneous products which are unrelated in the customers addressed as well as in the resources applied. Its main objective is the diversification of overall business risk (Amit and Livnat 1988). Albeit being subject to research for decades, the nature of the relationship between diversification and performance remains an open research issue. Studies on this relationship yield inconsistent and partly contradictory results (Palich et al. 2000).

The role of ICT in diversification research is twofold: ICT has been considered as a source of synergy (Tanriverdi 2006, Tanriverdi and Chi-Hyon 2008). Moreover, ICT is analysed as a moderator on diversification performance (Ravichandran et al. 2009).

2.3 ICT Convergence Strategies - Research Objectives and Hypotheses

Former research has already addressed the issues of ICT convergence and firm strategies but lacks the ability to measure industry convergence and related firm strategies independently. The objective of this article is to study diversification as a strategic reaction to industry convergence in ICT. As we do not explicitly study technological convergence, convergence is always to be understood in the sense of industry convergence for the rest of this article, unless stated otherwise. For the analysis, we adopt a state oriented rather than a process oriented definition of convergence and diversification: convergence (diversification) refers to the state of being converged (diversified).

Whereas former researchers do not distinguish between convergence and firm diversification, this relationship is subject to analysis in this work. On the one hand, firm diversification is used for measuring convergence. On the other, concentration and cooperation are acknowledged as alternative firm reactions to convergence. Hence, the following hypothesis is called into question: *firms, which are directly exposed to ICT convergence, exhibit a higher degree of diversification than firms without such an exposure (H1).* As implied by Gambardella and Torrisi (1998), convergence can be regarded as an enabler of related diversification. Technology convergence broadens the applicability of resources in formerly unrelated industries. Firms, which own such resources, can therefore potentially realize synergies through diversification: *the degree of convergence, an ICT firm is exposed to, has a positive influence on the synergy potential of diversification (H2).* Lang and Stulz (1994) argue that diversified firms have the option to distribute excess resources over multiple divisions whereas single product firms can only use external markets. As a firm often has better information about its markets than external investors, an internal resource allocation potentially yields advantages over external

markets. For this reason, a potential motivation for convergence related diversification is to reach a higher efficiency in the utilization of excess resources: *firms which diversify are able to realize higher allocation efficiency under the exposure to ICT convergence than firms which pursue a concentration strategy (H3).*

3 Empirical Analyses

The data base used in this work was retrieved by selecting all firms from Thomson ONE Banker, which were active in at least one ICT related market segment in 2009, and consists of 7832 firms. For each firm, an entry contains up to eight four-digit SIC codes, which classify market segments.

Sub-Industry	Description	Examples	Market Segments (SIC Codes)
Hardware Components	production of material and components required to produce hardware equipment	-semiconductors -wire products	3671, 3672, 3674, 3675, 3676, 3677, 3678, 3679, 3691, 3692, 3694, 3695, 3699
Hardware Equipment	production of communication terminals and network infrastructure components	-computers -mobile phones -routers	3571, 3572, 3575, 3577, 3578, 3579, 3651, 3652, 3661, 3663, 3669
Software	development of software and Internet applications and value adding tasks such as training and systems design	-computer programming services -information retrieval services	7370, 7371, 7372, 7373, 7374, 7375, 7376, 7377, 7378, 7379, 7382
Telecommu-nications	provisioning of telecommunication services, network operation and management	-PSTN and GSM telephony -DSL Internet access	4812, 4813, 4822, 4899
Media	production and management of text, graphical and multimedia content	-publishing of newspapers -advertising services -motion picture production	2711, 2721, 2731, 2741, 4832, 4833, 4841, 7311, 7312, 7313, 7319, 7812, 7819, 7822, 7829

Table 2. Definition of ICT Sub-Industries

Montgomery (1982) discussed the disadvantages of this classification scheme for diversification analyses, which are mainly due to the assumption of equidistances between SIC classes. The classification has been established based on production and market oriented differentiation criteria, which are subject to change over time. This is particularly valid for the ICT industry, in which technological production resources and markets are constantly further developed. For this reason, ICT products from the five sub-industries hardware components, hardware equipment, software, telecommunications, and media are not clearly allocated into groups at the three or two digit level. Therefore, the SIC is not adequate for the analysis of ICT sub-industry diversification. To address this flaw, we manually grouped ICT related SIC codes into five sub-industries (Table 2). In order to guarantee the completeness and validity of the SIC selection and classification, the results were verified by three industry experts. The ICT sub-industry classification serves as a basis for the analysis of firm strategies addressing ICT convergence as presented in the subsequent subsection.

3.1 Betweenness as an Indicator for Convergence in the Network of ICT Market Segments

For the identification of convergence, we study the network consisting of ICT market segments and segment associations. An association describes the relatedness of the input factors and the customer markets of the two segments and is calculated with the following measure:

$$z(a,b) = |A \cap B| / |A \cup B|.$$

A (B) represents the group of firms, which is active in the SIC segment a (b). z(a,b) describes the share, which is active in both segments, of the firms, which are active in either segment. The concept of ICT market segment relatedness bases on the theory of within-industry diversification, which explains diversification through the relatedness of resources required for production and of customer markets addressed (Li and Greenwood 2004, Tanriverdi and Lee 2008).

The SIC associations serve as a basis for the identification of convergence. The SIC codes as nodes and their associations as weighted edges form an undirected weighted network (Opsahl et al. 2010). This network resembles a value network (Pil and Holweg 2006) in which each market segment represents a value activity which is marketed externally.

In order to study the consistency of this network, traditional network analysis techniques are applied (Freeman 1979). The betweenness centraliy of a node describes the degree to which it lies on the shortest paths of the flows between all other nodes (Opsahl et al. 2010). It allocates high values to nodes, which lie on connection paths between two weakly connected network components. In market segment networks, a sub-industry is a cluster of segments, which are characterized by a strong segment relatedness (Li and Greenwood 2004). Convergence leads to a connecting of two sub-industries. A special importance is attached to the segments on the bridge between the two convergent sub-industries: products within these segments are directly or indirectly subject to substitutive or complementary product convergence. From this follows that segments which are subject to convergence are characterized by a high betweenness centrality. Under the assumption, that the ICT industry is not subject to divergence, the betweenness centrality signals the degree of convergence, a segment is exposed to.

3.2 Analyses of ICT Firm Strategies

3.2.1 ICT Convergence and Firm Diversification (H1)

This section is dedicated to the testing of the relationship between convergence and firm diversification (H1). In order to operationalize the degree to which a firm is exposed to convergence effects, we utilize the betweenness centrality of market segments and define the betweenness centrality of a firm as the maximum betweenness centrality of a firm's market segments.

For the operationalization of diversification, multiple measures have been proposed: Gort (1962, pg. 26) counts the industries a firm is active in. We use three such counting measures differentiating industries at the sub-industry level as explained above (see Table 2), at the SIC2, and at the SIC4 level. Jacquemin and Berry (1979) introduce an entropy measure formulating total diversification as a weighted average of intra-sector diversification plus inter-sector diversification. Caves et al. (1980, pg. 199) introduce a measure which differentiates between diversification at the SIC1, SIC2, and SIC3 level, and allocate stronger weights to higher diversification levels. Jacquemin and Berry (1979) and Caves et al. (1980) propose to weight the products or sectors by the sales ratio in order to take into account the relative importance of the products to a firm. As this data is not available for the firms included in our analysis, we did not introduce such weights. Although this limits the explanatory power of the diversification measures, the measures do provide insights into product related firm activities. As such, they allow quantitative statements about the heterogeneity of diversification strategies, especially with regard to the issue of ICT sub-industry diversification.

In order to study the relationship between convergence and diversification we took the firm betweenness centrality as the single independent variable and carried out five OLSQ regressions with the different diversification measures as single dependent variable. The diversification measures basing on the 4- or 2-digit SICs and the firm betweenness centrality measure are weakly related measures, because they are both derived from firms' market segment integration behaviour. In contrast, the number of sub-industries is not derived from market segment integration and exhibits the highest R-value. Therefore, the results do not indicate a high measure-relatedness. The results show

that firm betweenness centrality indeed has a positive impact on firm diversification. This suggests that firms which are exposed to convergence diversify stronger than firms without such an exposure. The regression of the sub-industry diversification yields the most significant result compared to the regressions of the other diversification measures. A possible explanation is that the intra-class relatedness and the inter-class differences are stronger for the sub-industry classification defined above (Table 2) than for the SIC at the 2-digit level.

Independent Variable		Mean	Std.				
Firm Betweenness Centrality		149.162	119.513				
Information about Dependent Variable			Regression Analysis				
Dependent Variable	Mean	Std.	R^2	F[b]	Beta	T[c]	Durbin-Watson
Number of Sub-Industries	1.256	0.514	.077	654.672*	.278	25.587*	1.950
Number of 4-digit SICs	3.140	1.919	.037	300.966*	.192	17.348*	1.781
Number of 2-digit SICs	2.407	1.650	.005	40.981*	.072	6.402*	1.776
Caves et al. (1980)	0.796	0.595	.017	133.873*	.130	11.570*	1.840
Jacquemin & Berry (1979)	2.375	2.051	.049	405.300*	.222	20.132*	1.807
[a]number of observations: 7832, [b]overall fit, [c]regressant, *p<.001							

Table 3. Firm Diversification and Firm Betweenness Centrality - OLSQ Regressions[a]

3.2.2 Synergy (H2)

In this section, the relationship between firm betweenness centrality and the ability of a firm to realize synergies (H2) is analysed. For this analysis, only firms with a high level of diversification are taken into account. More precisely, we use the number of sub-industries as the diversification measure and select firms which are active in two sub-industries and above. We operationalize diversification synergy (SYN) by the following measures: return on assets (ROA), return on investments (ROI), return on sales (ROS), cost of goods sold to sales (CGS), net income per employee (IPE), and selling general and administrative expenses to sales (SGS). For each synergy measure, we carried out an OLSQ regression with the firm betweenness centrality (CENTR) as the independent variable and the sales (SALES) and 2 digit SIC sector memberships (SICx) as control variables (Table 4). The regressions have the following general form:

$SYN_i = CONST + a_1*CENTR_i + a_2*SALES_i + a_3 * SIC27_i + a_4 * SIC35_i + a_5 * SIC36_i + a_6 * SIC48_i + a_7 * SIC73_i + a_8 * SIC78_i$ where $SICx_i = 1$ if firm i offers a product in the 2 digit sector x and $SICx_i = 0$ otherwise.

Except for the regressions of costs of goods sold to sales and net income per employee, all regressions identify the firm betweenness centrality to be a significant driver of diversification synergy. This implies that diversifying firms, which are strongly exposed to ICT convergence, are able to realize stronger asset and sales specific synergies than diversifying firms, which are not exposed to convergence. The data does not verify a significant employee related productivity increase with convergence neither does it suggest a decrease. The same holds for the positive relationship of convergence and the cost of goods sold to sales.

SYN		ROA	ROI	ROS	CGS	IPE	SGS
R^2		.024	.027	.023	.032	.075	.048
F		3.180**	2.821**	2.978**	4.083***	6.904***	4.402***
No. of Observations		1027	836	1025	1004	691	705
Durbin-Watson		1.963	1.951	2.096	2.096	1.807	1.963
	Beta	.071	.065	.065	.034	.055	-.081
CENTR	T	2.202**	1.832*	2.009**	1.051	1.459	-2.128**
	Beta	.063	.060	.086	-.059	.184	-.079
SALES	T	2.035**	1.746*	2.765***	-1.877*	4.935***	-2.125**
	Beta	.029	-.030	.006	-.027	.006	.119
SIC27	T	.863	-.814	.167	-.807	.158	2.930***
	Beta	.038	.041	-.053	.081	-.071	-.007
SIC35	T	1.065	1.048	-1.485	2.278**	-1.684*	-.160
	Beta	.007	-.009	-.053	.075	-.021	-.071
SIC36	T	.180	-.206	-1.359	1.888*	-.455	-1.561
	Beta	.121	.111	.047	-.021	.132	-.059
SIC48	T	3.296***	2.738*	1.272	-.577	3.072***	-1.360
	Beta	.031	.039	-.017	-.061	.073	.020
SIC73	T	.861	.974	-.468	-1.668*	1.730*	.481
	Beta	-.049	-.065	-.043	.019	-.015	.028
SIC78	T	-1.566	-1.862*	-1.372	.610	-.389	.744
CONST	T	-3.719***	-2.612*	-1.274	20.832***	-.892	8.050
*p<0.1, **p<0.05, ***p<0.01							

Table 4. Diversification Synergy and Firm Betweenness Centrality - OLSQ Regressions

3.2.3 Allocation Efficiency (H3)

In this section, the allocation efficiency of diversifying firms is compared to the allocation efficiency of non-diversifying firms under the exposure to convergence (H3). For this analysis, only firms with a high betweenness centrality (of 216 and above) are taken into account. We perform regressions with the number of sub-industries (DIV) as the independent variable and the sales (SALES) and 2 digit SIC sector memberships (SICx) as control variables (Table 5). Regressions have the following general form:

$ALLO_i = CONST + a_1*DIV_i + a_2*SALES_i + a_3 * SIC27_i + a_4 * SIC35_i + a_5 * SIC36_i + a_6 * SIC48_i + a_7 * SIC73_i + a_8 * SIC78_i$ where $SICx_i = 1$ if firm i offers a product in the 2 digit sector x and $SICx_i = 0$ otherwise.

Allocation efficiency (ALLO) is operationalized by the following measures: alpha (ALPHA), Tobin's Q (TOQ), return on equity per share (ROE), return on investment (ROI), return on sales (ROS), and return on assets (ROA). The regressions only yield significant results for the efficiency measures Tobin's Q, return on sales and return on assets. Under convergence effects, diversification is generally not found to be more efficient with respect to resource allocation than concentration. The sub-industry diversification has a significant impact on the return on assets. Since this influence is negative, one can deduce that concentration generally allows a more efficient asset allocation than diversification in the presence of convergence effects. This finding puts into question the universality of diversification as a profitable convergence strategy.

ALLO		ALPHA	TOQ	ROE	ROI	ROS	ROA
R^2		.006	.022	.023	.018	.026	.028
F		.673	3.081**	1.572	1.101	1.894*	4.921***
No. of Observations		910	1098	534	480	579	1360
Durbin-Watson		2.092	1.881	1.843	1.825	2.077	2.004
DIV	Beta	-.037	-.005	.126	-.022	.077	-.103
	T	-.782	-.112	1.981**	-.337	1.278	-2.624***
SALES	Beta	-.008	-.023	-.026	.010	.087	.003
	T	-.224	-.748	-.585	.219	2.066**	.121
SIC27	Beta	-.017	.002	-.012	.005	-.002	.048
	T	-.501	.060	-.266	.115	-.041	1.664*
SIC35	Beta	-.043	.037	-.012	.006	.052	.024
	T	-1.174	1.112	-.257	.133	1.195	.804
SIC36	Beta	.038	-.037	-.038	-.053	.012	.099
	T	1.044	-1.154	-.812	-1.062	.269	1.958**
SIC48	Beta	-.012	-.011	.061	.111	.026	.134
	T	-.311	-.307	1.134	2.027**	.511	3.349***
SIC73	Beta	.018	.134	-.089	.014	-.115	.052
	T	.446	3.628***	-1.614	.242	-2.173**	1.108
SIC78	Beta	.014	.021	.016	.020	.033	-.161
	T	.379	.659	.375	.427	.798	-5.637***
CONST	T	.085	3.645***	-.223	.852	-1.109	-.217
*p<0.1, **p<0.05, ***p<0.01							

Table 5. Convergence Related Allocation Efficiency and Diversification - OLSQ Regressions

4 Discussion of Results

The first part of the analysis focuses on diversification as a common strategic firm reaction to convergence. The results (Table 3) indicate that the degree, to which a firm is exposed to ICT convergence, positively influences a firm's tendency towards diversification. There are two explanatory approaches for this relationship. As analysed in Gambardella and Torrisi (1998) and Palmberg and Matikainen (2006), many ICT firms continually expand their technological competencies. This is merely interpreted as a necessity for guaranteeing a sustainable competitive position rather than as a preparation for diversification. Nevertheless, a multi-technology strategy (Granstrand 1998) often represents a necessary condition for the diversification of ICT firms. This is particularly the case for the development of hybrid products, which integrate characteristics of formerly unrelated products. Smartphones are exemplary hybrid products, which comprise of phone, camera, and computer functionalities. Convergence processes such as the creation of hybrid products lead to an increase of the relatedness of the underlying technological resources. Technological diversification enables to offer hybrid products in an integrated fashion. This is particularly attractive if the management of firm networks would require a high coordination effort. A good example of the two polar strategies can be found in the smartphone market: whereas Apple pursues an integration strategy for the production of the iPhone, the Open Handset Alliance, a consortium of 65 firms, jointly developed a competing open source software platform for smartphones. Whereas such an alliance provides the ability to pool resources, a vertical integration strategy potentially allows a more efficient resource development and utilization (Perry 1989, Katz 1996). Another explanation for the convergence related diversification in ICT is related to the degree of the specificity of product market resources, such as technological resources or distribution channels. Traditional markets with highly specific product market resources are characterized by high entry barriers, which represent obstacles for firm diversification. The ICT industry is characterized by a high degree of innovation and market

dynamics, which lowers the specificity of market resources required for market entrance (Henderson and Clark 1990).

The analysis of convergence related synergy effects in diversification (Table 4, H2) reveals significant asset specific synergies. In contrast, employee related synergies are not identified. From this it follows that quantifiable ICT specific assets play a more important role as sources of synergies in convergence related diversification than the intangible knowledge of ICT experts in the company. This conclusion must nevertheless be put into perspective, because financial reports do not provide an accurate basis for a distinguished analysis of employee related firm capabilities. In addition to asset synergies, the analysis also reveals synergies in the organizational and management related capabilities: the ratio of selling, general, and administrative expense to sales decreases significantly with an increase of firm betweenness centrality. This suggests, that convergence in ICT yields a high synergy potential with respect to operational expenses, which are not directly allocated to a specific ICT product such as marketing and engineering expenses. This is in contrast to the product specific expenses, which are not subject to convergence related synergies as expressed by the measure cost of goods sold to sales.

The comparison of the allocation efficiency of diversifying and non-diversifying firms under convergence (H3) only provides a significant result with regard to return on assets: the degree of diversification is found to have a negative influence. Regarding the other measures for allocation efficiency, mixed but insignificant results are generated. This implies that diversification is in many cases not the most efficient strategy for a firm's application of ICT resources in convergent markets. Here, the focus on core markets and the formation of coalitions, in which a joint access to shared resources is provided, represent alternatives with similar or better prospects of success. Through coalitions, the synergy potential of ICT convergence can potentially be realized more efficiently than through diversification. As suggested by the formation of cooperative firm networks in ICT (Katz 1996, Basole 2009), the benefits of a resource pooling often outweigh the coordination costs in ICT coalitions.

5 Conclusion

The motivation for this research was the identification and discussion of convergence specific firm strategies. It was successfully shown, that diversification indeed represents a strategy often adopted by ICT firms. ICT Convergence opens up various potentials: on the ICT asset, as well as on operational ICT management layer, the exposure to convergence allows diversifying firms to realize stronger synergies. This implies that firms continually must analyse their technological resources and their operational processes with regard to changed synergy potential. We were able to show that the degree of "convergedness" of sub-industries influences the value of resources and capabilities of diversified firms in market segments on the bridge between these sub-industries. Dependent on the degree of industry dynamics, this value is subject to change over time. Nevertheless, the analyses also suggested that diversification is not generally superior to alternative convergence strategies. Having identified a new synergy potential, firms therefore must carefully consider the consequences of diversification as opposed to cooperation and concentration strategies.

As a main difference to prior research, the presented approach allows to differentiate between industry convergence and firm strategies. The identification of convergence based on network characteristics allows to distinguish strategies under convergence and to further analyse them. As such, this approach represents a novel method for analysing convergence. Following prior research on ICT diversification (Khansa and Liginlal 2009, Basole 2009) network analysis is applied to study the network of market segments in the ICT industry. The authors newly introduce the application of measures to analyse weighted networks (Opsahl et al. 2010). Node betweenness centrality is used as a measure for sub-industry convergence in the ICT industry. In doing so, we assume that sub-industries are characterized by strong market segment relatedness. We adopt a purely state oriented view on convergence and are not able to capture industry dynamics. However, the stationary convergence measure quantifies the degree to which a market segment bridges the divide between sub-industries and as such describes the

degree to which a market segment is exposed to sub-industry convergence. The inclusion of longitudinal data could strengthen the results and further allow the identification of sub-industry specific differences.

In diversification research, the identification of synergies represents a widely discussed research issue (Palich et al. 2000). A main achievement of this study is the identification of such synergies in the context of ICT convergence. Moreover, even though the term convergence is often cited in ICT research, there is a research gap regarding the relationship of convergence and firm strategies in ICT, which has been addressed in this article.

This research focused on ICT specific markets and did not take into account the firms' activities in other markets. Even though this limits the explanatory power of the results received, it allowed the deduction of ICT specific conclusions. The formation of strategic coalitions represents a second alternative convergence strategy discussed by many researchers. The analysis of such coalitions would potentially yield complementary results. Another follow-on research issue addresses the determinates of a successful diversification under convergence. Diversification success is potentially influenced by characteristics of the specific sub-industries (such as resource similarities) or firm specific attributes (such as its absorptive capacity).

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