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THE IMPACT OF IT ON COMPETITIVE ADVANTAGE:
A MICROECONOMIC APPROACH
TO MAKING THE RESOURCE-BASED VIEW EXPLICIT

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Abstract

How can an organization establish an efficient IS resource? Over the years, the resource-based view (RBV) has provided important insights into the value creation by IT. Unfortunately, large parts of the literature suffer from broad and ambiguous constructs that are problematic to validate and difficult to concretely apply. Furthermore, the transmission from IT resources on one side to competitive advantage on the other is not yet sufficiently understood. Goal of this paper is to clarify some of the often used constructs and build a framework for the transmission from the endowment with resources to the achievement of competitive advantage.

In this paper, we aim to contribute to this research strand in two ways. First, a model incorporating many isolated findings from the RBV is developed. Reflecting the need for a process view as proposed by large parts of the alignment and strategic management literature, this is integrated into a single process framework of analysis. Second, by augmenting a microeconomic production function incorporating organizational routines the transmission from IT resource to better business process performance is explicated, allowing simultaneous parameter sensitivity analysis and contributing to making the RBV applicable and open for empirical research.

Keywords: Resource-based View, Capabilities, Routine, Production Function.

1 INTRODUCTION

Information systems are crucial in many industries. IT is used to deliver services, create products, coordinate activities along the value chain and form the foundation of strategic alliances. But despite its key role as ubiquitous enabler, there is still a virulent lack of frameworks to both explain the profit impact of IT and to guide firms in exploiting the IT resource as a source of sustainable competitive advantage (SCA). While on an abstract level findings of the RBV are very instructive, concrete managerial implications for daily business, organizational structures within a firm, and especially the relationship between IT and business units are far less clear (Barney et al. 2001, p. 628). In this paper, we clarify some basic constructs of the RBV to show the transmission from single resource to potential competitive advantage. In order to contribute to making the findings of the resource based literature more applicable, the complex and often vague constructs used in the RBV are clarified. Furthermore, we advance one step further than most parts of the literature and propose a concrete microeconomic model to describe the transformation process within the firm combining IT and business resources.

Drawing from the literature we incorporate findings from different research strands on the RBV (section 2). Based on this, the particular role of the basic concepts capabilities and routines is critically discussed (section 3). These are then incorporated into an analytical model (section 4). It turns out that analytically modelling the connection between the IT resource and some performance measures helps to clarify interdependencies. Furthermore, the explication contributes to making the important findings of the RBV and alignment literature more relevant for practical applications (section 5).

2 LITERATURE REVIEW

While many studies have found evidence of an effective use of IT resulting in superior performance, there are also cases where high investment in IT is not or negatively correlated with performance. These inconsistent findings are partly rooted in the incomplete understanding of IT resources and their impact on firm performance. Of the many studies trying to relate IT investment and performance, most analyze single IT components linking them to organizational performance. Moreover, many contributions support the importance of aligning IT and business strategies (Broadbent et al. 1993; Henderson et al. 1993; Kearns et al. 2001). Still, the actual transformation linking IT to performance is not clearly understood (Bharadwaj 2000). In this paper, IT is considered within a business process which is defined as "the specific ordering of work activities across time and space, with a beginning, an end, and clearly identified inputs and outputs" (Melville et al. 2004). The rationale is that a firm comprising several business processes may excel in some, be average or worse in others leading to some net effect at firm level. According to Makadok (2001) resource-based analysis can be separated into two perspectives: the resource-picking perspective and the capability-building perspective which are briefly described in the following.

2.1 IT resources under resource-picking perspective

The resource-picking perspective focuses on the selection of single components and classes of resources to achieve a competitive advantage, for example by use of a particular software system or technical IT skills. Therefore, specific resources are investigated and then related to performance. The definitions for resources are rather broad, making theory of factor demand or portfolio theories special cases of the RBV (Wernerfelt 1984, p. 171). Melville et al. (2004, p. 294f.) partly following Mata et al. (1995) specify IT resources as the technological IT resource (IT infrastructure and business applications) and human IT resource, both consisting of technical and managerial knowledge. According to Barney (1991, p. 105 ff.), a resource has to be valuable, rare, non-imitable, and non-substitutable to provide the basis for a SCA.

A resource is of **value** if it allows a firm to develop strategies that improve efficiency and effectiveness which means that the firm must be able to exploit opportunities or neutralize threats (Porter 1985). The second attribute is **rarity**. When a resource is broadly distributed and available, other firms are able to also plan and implement value-creating strategies. Value and rarity are conditions for first-mover advantages, too. In order to sustain competitive advantage these attributes are not sufficient. Other firms may not obtain these resources, but imitate them. A cause for **inimitability** can be unique historical conditions (locations, values and believes, etc.) (Mata et al. 1995, p. 492). Causal ambiguity is another cause describing the insufficient understanding of the link between resources and SCA thus making it hard to imitate. The fourth attribute of a resource is **non-substitutability** which means that there is no equivalent a competitor can appropriate. A fifth attribute, extending Barney's set, is **immobility**. Mobility refers to the possibility to transfer a resource (Dierickx and Cool 1989; Grant 2002, Mata et al. 1995). If a resource is mobile other firms can acquire the resource and scarcity rents cannot be earned (Peteraf 1993). One example of IT resources in the resource-picking perspective are *single information systems* considered to lead to a competitive advantage for the firms implementing them. Mata et al. (1995, p. 488) and Clemons and Row (1991, p. 276) describe some of these systems in detail. WalMart could reduce its inventory costs with the adoption of a purchase/inventory/distribution system and General Electric could differentiate its service support by the introduction of an answer centre. Also, *technical IT skills* can be defined as know-how for development and operation of IT applications (Mata et al. 1995, p. 498, Ross et al. 1996). IT skills enhanced with considerable experience e.g. in very large and complex IT projects are rarer and building them up takes time. On the other hand these resources, considered as single human beings, are mobile and can be acquired by a competitor for example in the form of technical consulting. *Managerial IT skills* "include management's ability to conceive of, develop, and exploit IT applications to support and enhance other business functions" (Mata et al. 1995, p. 498, Ross et al. 1996). Understanding the business needs, working together with functional managers to develop a solution, coordinating IT activities in order to support functional managers, and anticipating future IT needs are listed, among others, as examples of this sort of skill.

2.2 IT resources under capability-building perspective

The capability-building perspective builds upon the availability of valuable resources and examines how the productivity of these resources can be enhanced (Makadok 2001). Grant (1991, p. 119f.) points out that resources are inputs into the production process but mostly do not create value on their own. Resources must work together in order to create **organizational capabilities** referring to the ability to team resources. These capabilities can then implement competitive advantages (Barney 2001, p. 647). According to Amit and Schoemaker (1993, p. 359) capabilities "refer to a firm's capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end." Correspondingly, Day (1994) defines capabilities as "complex bundles of skills and accumulated knowledge, exercised through organizational processes that enable firms to coordinate activities and make use of their assets." He also provides a scheme to categorize capabilities into three classes common to all businesses. First, *inside-out capabilities* respond to market requirements and opportunities and tend to be internally focussed (e.g. transformation activities, logistics). Second, the externally oriented *outside-in capabilities* enable the firm to anticipate requirements and create relationships with market participants outside the firm. Third, *spanning capabilities* integrate the two other categories. Examples are new product development and price setting which need the integration of inside-out and outside-in capabilities. According to Day capabilities are based on organizational processes which in turn can be identified as routines (Nelson and Winter 1982). The effect of IT capabilities was underpinned by a study presented by Bharadwaj (2000) finding a superior IT capability associated with significantly higher profit ratios. A basic element of organizational capabilities is organizational routines referring to "regular and predictable patterns of activity" (Grant 1991, p. 122). The concept of organizational routines "represent the skills of an organization", and was introduced by Nelson and Winter (1982, p. 124, p. 14). Implied in this concept is the motivation and socialization of the members of the organization directed to reach the cooperation and commitment of the members leading to smoothly functioning routines. As capabilities are based upon the combination of resources, they are generally more complex than resources and more difficult to imitate (Grant 1991, p. 124).

3 DEVELOPMENT OF A CONCEPTUAL FRAMEWORK

Many models were developed to explain how resources and capabilities can have an effect on the achievement of a competitive advantage (Soh and Markus 1995). Some draw a connection between a well-designed IT and its use which in turn leads to some effect on performance. Other models describe the way from investment in IT via the creation of IT assets to performance. Recently, Melville et al. (2004) have provided a model of IT business value generation with a focus on environmental factors (trading partners, industry characteristics, and country characteristics). They also point out that impacts of IT occur through intermediate business processes including the interaction with non-IT resources. They combine IT- and business resources into a business process which in turn produces a performance parameter. Despite all these singular models, a more complete framework is still lacking that considers not only the environment but also the way IT resources are acquired, built into the firm's processes and in turn effect the environment. As can be seen from the literature review, definitions are rather broad, and the connections between constructs seem to be unclear and ambiguous. In the following we first clarify the basic term "capability" and in turn the underlying concept of "routines". Based on this, a framework is developed showing the value chain within a firm from an RBV perspective.

3.1 Capabilities

Some definitions regarding capabilities identify them as organizational processes (e.g. Eisenhardt and Martin 2000, Wade and Hulland 2004, Ravichandran and Lertwongsatien 2002) while others focus on their content and characteristics (e.g. Grant 1991, Barney 2001, Day 1994, Teece at al. 1997). Apart from that, these research perspectives use the term "capabilities" as an ensemble of underlying constructs. As an example and starting point we take the definition of Amit and Schoemaker (1993, p. 35). In their definition capabilities "refer to a firm's capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end" where the desired end can be interpreted as the generation of competitive advantage (Barney 2001, p. 647). Eisenhardt and Martin (2000, p. 1107) extend this somewhat static view by introducing the notion of dynamic capabilities as a means to integrate, reconfigure, add, and release resources. The term "dynamic" in this respect refers to achieving new forms of competitive advantage fitting to changing environments (Teece et al. 1997, p. 515). Capabilities as described above can be seen as "complex bundles of skills and accumulated knowledge, exercised through organizational processes that enable firms to coordinate activities and make use of their assets" (Day 1994, p. 38). Capabilities in this sense are built up by information-based firm-specific processes, developing over time and based on information-exchange through the human capital of a firm (Amit and Schoemaker 1993, p. 35). A set of specific and identifiable processes are also central for the notion of dynamic capabilities (Eisenhardt and Martin 2000, p. 1107). Thus, organizational processes are central for the creation and activation of capabilities. The term *process* is often used to refer to explicit structures while there are implicit actions as well. Galunic and Rodan (1998) call them tacitly-held and explicitly-held routines to address the fact that routines can contain tacit knowledge and also explicit knowledge. Accordingly, Ravichandran and Lertwongsatien (2002, p. 579) identify IS capabilities as the routines within the IS department that enable it to deliver IT services to the firm. Correspondingly, routines can be seen as enabler of a learning process leading to continuously improving capabilities (Andreu and Ciborra 1996, p. 115). Thus, organizational processes are central for capabilities – either capabilities are identified with such processes (see Eisenhardt and Martin 2000), or they are necessary to build up and activate capabilities (see Amit and Schoemaker 1993). Summarizing the discussion above "capabilities" can be differentiated into three components common to many studies regarding this subject.

3. The third component are processes to exchange information, processes of implicating and explicating knowledge which is necessary to activate skills and knowledge and to act upon the assets (Amit and Schoemaker 1993) which can be identified with the term “routines” (Nelson and Winter 1982).

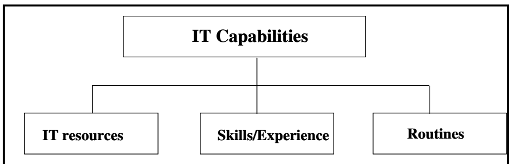

Figure 1. *Capabilities*

A capability in the sense of the discussion above is a meta-construct incorporating other concepts used in the RBV. In the following we subsume the second component of capabilities under resource (like the first) in the sense of the resource-picking perspective (i.e. managerial and technical skills). The third component (processes) are elaborated in more detail in the following section using the term “routines” according to Galunic and Rodan (1998) to point out that also tacit processes are incorporated.

3.2 Routines

The concept of routines is an important building block for the concept of capabilities and also a basic mechanism for value transformation. “The competitive advantage of firms lies with its managerial and organizational processes, shaped by its (specific) asset position, and the paths available to it. By managerial and organizational processes we refer to the way things are done in the firm, or what might be referred to as its routines, or patterns of current practice and learning” (Teece et al. 1997, p. 518). Organizational routines refer to “regular and predictable patterns of activity which are made up of a sequence of coordinated actions by individuals” (Grant 1991, p. 122) and “represent the skills of an organization“, incorporating tacit knowledge acquired by learning and unconscious coordination as introduced by Nelson and Winter (1982, p. 14 / p. 124, Andreu and Ciborra 1996). As Galunic and Rodan (1998, p. 1199) put it, individuals interacting frequently come to share a common meaning by developing a common language and symbols improving the exchange of knowledge. An example of routines at work is a simple practice of Japanese firms called quality circle. It took years to imitate it in the U.S. and Europe with similar success. The problem was the needed cooperation and the attitude of the employees codified in routines (Grant 1991, p.127).

Routines as used here are formal and informal processes based on the interaction between human agents. By these interactions knowledge is transferred and attitudes are formed which in turn leads not only to an adaptation of the knowledge base of a human agent but may also lead to an adaptation of behaviour and attitudes. These adaptations can facilitate the information flow. At the same time, smoothly functioning routines come at the price of inertia in rapid changing environments since routines per se are a stable element. In volatile environments, new firms can have an advantage over incumbents through faster learning as they are less committed to routines (Grant 1991) and thus less constrained by the organizational system of which they are part (Galunic and Rodan 1998, p. 1199).

3.3 Developing the framework

Following Makadok (2001, p. 389) capabilities improve the productivity of other resources of a firm which implies that the resources controlled by the firm provide a basis for productivity enhancement. The prerequisite is the successful acquisition of valuable resources. Without valuable resources the basis for the deployment of resources is inferior and a capability has no impact. Thus, there is a need to select valuable resources (resource-picking perspective). The first step in the acquisition of valuable resources is the selection of factors from factor markets in order to create Ricardian rents which were investigated by Barney (1986) and Peteraf (1993). The idea is that firms endowed with superior factors and resources are better positioned in competition and are able to earn rents (Peteraf, 1993, p. 180). Once selected factors are under control of the firm but need not necessarily be added to the resource base. According to Teece et al. (1997, p. 516) factors are undifferentiated inputs because they lack a firm-specific-component. An example is potentially valuable raw marketing data that is not adapted to the firm's needs. Thus, factors have to be made available to the firm's processes. The third step is to combine resources into a business process. Resource configurations are the basis for competitive advantage (Eisenhardt and Martin 2000, p. 1106) and form a business process as the place where the transformation from inputs to outputs occurs.

The mechanisms to extract factors from the environment, add them to the resource base, and combine them within a business process are organizational processes identified as routines. These routines can be categorized using the scheme of Day (1994) into internally oriented routines like transformation processes, externally-oriented routines like managing external relationships, and spanning routines providing for the link between externally- and internally oriented routines by spanning organizational boundaries within a domain (here: IT or business) and across domains like IS/business relationships. To interact with the environment and to select factors from factor markets externally-oriented routines are needed. To make this usable for the firm spanning processes must be in place to transfer the externally acquired factors to the resource base. Employing internally-oriented processes the resource base is used to find resource configurations to build up business processes which in turn produce outputs for the market. The discussed steps and the enabling routines are depicted in figure 2. In order to keep this figure simple accumulating and learning processes are indicated with double arrows. For example, the combination of resources within a business process leads to new uses and configurations which in turn are available within a changed the resource base. This resembles learning processes embedded in the routines depicted as block schemes (see Andreu and Ciborra 1996).

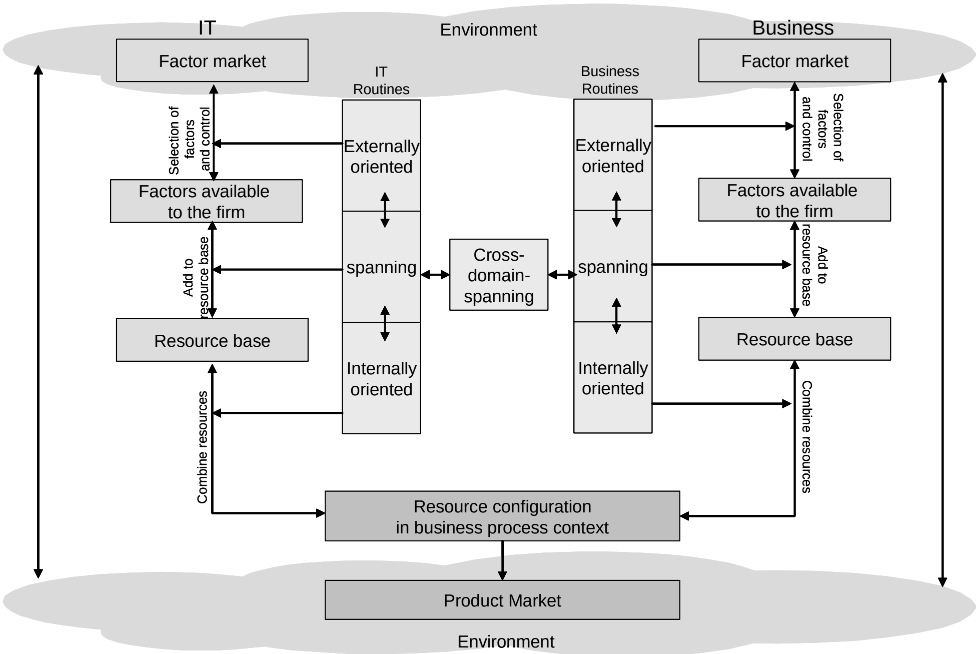

Figure 2. RBV framework: complementary IT and business domains

The discussion above can be applied for either type of resources. Differentiating resources into IT and business resources results in the dichotomy often found in IS literature. For example, Melville et al. (2004, p. 293) link ”IT Resources” and ”Complementary Organizational Resources” to ”Business Processes”. Although intuitively convincing, in some respect the basic idea of complementarity has to be further elaborated. According to Milgrom and Roberts (1995, p. 181) complementarity means that “the marginal returns to one variable are increasing in the levels of the other variables”. Adopted for IT and business, a higher level of IT will lead to an increase of the marginal returns of business activities. Obviously, this simple relationship does not work if “more IT” is interpreted as more spending. Complementarity between IT and business can only be achieved if processes are in place leading to alignment. Otherwise, (more) IT will not have a positive effect on business. This finding is supported by Devaraj and Kohli (2003) pointing at the importance of the actual usage of IT within the business. Correspondingly, Brynjolfsson and Hitt (2003) found that the productivity of computerization is significantly enhanced in the long term by complementary investments into organization redesign, for example. The detected time lag between investment in IT and a reasonable effect on productivity also corresponds with learning processes when implementing IT, changing business processes, etc. (Andreu and Ciborra 1996). This effect is consistent with a finding regarding complementarity: increasing one variable might not impact output if the complementary variable is not increased at the same time (Milgrom and Roberts 1995, p. 182). Adapted to the IT business environment this finding implies that it is not sufficient to increase IT resources but also to activate business resources. This gives a link to the notion of alignment bringing both domains together in order to achieve a fit (Henderson and Venkatraman 1993). Using the scheme of Day (1994) spanning processes like IS/business partnerships can be identified as processes working across domains and leading to a fit between the domains.

The general idea of figure 2 can be depicted as follows: Factors are chosen from the factor market and brought into the firm using externally-oriented routines. Available factors are added to the resource base employing spanning routines bridging organizational boundaries. Resources are combined within a transformation process which is the business process with the help of internally-oriented routines. The products and services produced by the business process get exposed at the market. On the market profits can be earned in return to superior resource combination within the firm moderated by environmental factors (Melville et al. 2004). The market interactions effect the firm’s environment. In turn, these effects can be extracted in form of market data, competition reaction, etc. from the environment by the externally-oriented routines providing feedback loops. Figure 2 thus depicts a conceptual RBV framework comprising the firm and its environment. The next step of extracting insights from conceptual work and inserting them explicitly into an analytical model is rare in the literature. In contrast, because of the valuable insights provided by the RBV which may enhance the explanatory power of analytical models, we go one step further and propose to explicitly introduce a basic RBV concept (i.e. routines) into a microeconomic model. This allows simultaneous parameter sensitivity analyses and contributes to making the RBV applicable and more open for empirical research. Building on production oriented approaches one part of the conceptual framework which is the transformation process will be modelled in the following section.

4 APPLYING MICROECONOMIC ANALYSIS

The chain from IT to its impact on process performance as depicted in figure 2 comprises several parts including the consideration of the external environment. In order to explicitly model parts of the framework we focus on the resource configurations in a business process context and the routines employed. This is done by building on production oriented approaches and augmenting a production function.

According to Melville et al. (2004, p. 269) “business processes are the activities residing in the black box of microeconomic production theory that transform a set of inputs into outputs.” Correspondingly, for explaining the transformation from inputs to outputs we focus on a business process context and employ a production function. In prior work on studying the IT productivity impact, production functions were used to relate output to several inputs with IT as one of the input factors. In this case, the output is an amount of physical units per period of time; IT, and other inputs generating output, are measured assuming homogeneous in- and outputs. These approaches were augmented by incorporating both quality and heterogeneous inputs and outputs into a production function (Mukhopadhyay et al. 1997). Different output levels in terms of quality are considered using weights for amounts of output produced at certain quality levels. Different input characteristics are considered by engaging corresponding input factors within the function like fraction of raw material with a given index of quality.

Furthermore, production functions were amplified by introducing parameters for quality of management (Mefford 1986), time trends and innovation shifts (Haynes and Thompson 2000), and lagged variables (Brynjolfsson and Hitt 2003), for example. Moreover, especially in the case of service production balance sheet measures for output and inputs (e.g. earning assets, liquid assets) were used instead of physical amounts (Haynes and Thompson 2000).

To examine the transformation process, specific technical interrelationships are mapped to a mathematical interpretation (production function). One of the most often applied production functions is the Cobb-Douglas function. Despite its dispersion, the Cobb-Douglas representation was criticized for several reasons. One reason is the assumption of an elasticity of substitution of 1 which can be very limiting in practice as it has an important effect on the returns and factor shares (Dewan and Min 1997). This has lead to the development of the CES production function which also has a constant elasticity of substitution but allows for values other than 1. Further enhancements are offered by the translog and the CES-Translog function (Dewan and Min 1997). Both are more general forms and can be reduced to the Cobb-Douglas production function, thus incorporating the latter as a special case. Nevertheless, recent studies employed the Cobb-Douglas form because both results were similar to the other function types and estimation was easier due to the simple form (Brynjolfsson and Hitt 2003, Haynes and Thompson 2000). Therefore, for the purpose of this paper a Cobb-Douglas form is chosen. The Cobb-Douglas function represents a neoclassical production function and follows the law of diminishing returns and assumes factor divisibility. The output is the mathematical product of a firm-specific effect (Haynes and Thompson 2000), generally presented as a constant, and several input factors raised to a power which represents production elasticities. The sum of these elasticities indicates the presence of economies of scale. The firm-specific effect codifies *statistical noise*, *exogenous technical progress*, and *organizational factors* like learning effects (Fandel 1994). Mukhopadhyay et al. (1997, p. 1658) state that the experience from their study employing a Cobb-Douglas function "implies that an appreciation of operations management and organizational behaviour is crucial in understanding the role of these control variables".

In the following we will add the consideration of routines as central concept of the RBV framework. The concrete business process employing IT and business resources can be seen as a result of internally-oriented routines. As discussed before, internally-oriented routines concentrate on the transformation process and determine the ordering of activities and the mode of resource deployment including the learning processes involved. Errors in designing the transformation process may result in severe deficiencies during operations. This can be compared to a software development process from which it is known that errors in early phases account for the most severe and costly deficiencies later on. Thus, routines are necessary to achieve complementary effects and impact the achievable output level. Therefore, from an RBV perspective routines must be recognized when implementing a production function. In the following it is shown how routines can be recognized within the firm-specific effect in the sense of an organizational parameter affecting the level of output.

Drawing on Wagner and Weitzel (2005) routines are based on interaction between individuals or organizational units, which can be measured using the strength of tie-argument of Granovetter (1973) who developed the strength of a tie as a dichotomous variable that can be either weak or strong at a given point of time. The interaction is necessary for knowledge transfer between the units which is a prerequisite of cross-domain planning activities. Knowledge to design and develop a complex system resides in different organizational units where strong ties provide the channels for the knowledge flow and increase the probability of sharing information while enhancing the development of a shared understanding (Tiwana et al. 2003). Accordingly, strong and weak ties can be deployed with the parameters s and w which are a measure for the interaction between organizational units. These parameters can be standardized between 0 and 1. Within the depicted scenario (design of a transformation process), more strong ties provide for an increased flow of knowledge. The complexity of such a design as a proxy of knowledge complexity can be formalized using the adapted coefficient KQ (Schrott and Beimborn 2003). KQ is redefined by dividing the design project at stake, measured by degree of complexity (e.g. budget as a proxy), by all design projects carried out within a certain timeframe. KQ takes on values between 0 and 1 with 1 indicating high and 0 no complexity. KQ and the measure of ties are now related to successfully accomplish the project (as complex problem) resulting in p as a probability to successfully complete a project. In this context, p can also be interpreted as factor of alignment as in (Wagner and Weitzel 2005). A *KQ* of 0 (no problem) delivers the highest possible value for *p*, which is unity for all values of s and w. Therefore, *p* is independent of the number of ties. A *KQ* of 1 delivers very low functional values for low *s*, or high *w*, respectively. Here, the complexity is so high that a knowledge transfer with a few strong ties but a lot of weak ties is hardly feasible (Granovetter 1973). The higher *p* the more probable a successful outcome. This depends on the accumulation of know-how and the ability to interexchange knowledge between the organizational units involved. Thus, p represents the effect of routines in the case of knowledge transfer between organizational units which is required in order to leverage IT complementary to business resources.

Considering this effect within a production function, more output will be produced under a given set of input. In microeconomic theory, accumulating effects are also known. The traditional learning curve effects refer to the decrease of costs (or increase of output) depending on the amount of units produced (Lapre et al. 2000). In our case routines within a given problem context (design of a transformation process) in a previous period determine the output levels of the following period. The problem context incorporates a learning perspective in that *p* is high if similar problems occurred in the past and the interactions between the organizational units dealing with that context are strong, thus, resembling learning loops (Andreu and Ciborra 1996). A further difference to traditional learning curve considerations is that *p* does not refer to the amount of output produced in the past which is the outcome of the operative process. Rather, *p* reflects “problem solving capability” in the planning phase of a business process which is identified as a transformation process according to Melville et al. (2004). For that reason it seems inappropriate to apply this parameter to the amount of output produced by the specific process in the past. Rather an Euler function is employed which is common in microeconomic theory when considering technical progress. The production function considering routines and classes of inputs can be augmented as follows:

$$y = \eta e^{\beta p} \prod_{i=1}^{n} r_i^{\alpha_i} \forall i \in 1...n \text{ , } \eta > 0 \text{ and constant; } \beta \geq 1, \ 0 \leq p \leq 1, \ 0 \leq \alpha_i < 1 \text{ and constant}$$

with $r_i = \{1,\dots,l\}$ representing IT resources; $r_i = \{l+1,\dots,m\}$ labor; and $r_i = \{m+1,\dots,n\}$ non IT resources being classes of resources following Mukhopadhyay et al. (1997). η represents the traditional technical progress and statistical noise. p represents the probability of successfully completing the project of designing a transformation process. Parameter β is introduced as a scaling factor because the order of magnitude of the described effect cannot be restricted a priori.

Within a production function the input factors r_i and their amounts used can be measured in the sense of a proxy (Melville et al. 2004) like transactions per second. Furthermore, inputs can be disaggregated as appropriate because the focus is on a business process level (see Mukhopadhyay et al. 1997) considering inputs with different characteristics. This is done by distinguishing between classes of factors and allowing for several factors within each class. Furthermore, following Mukhopadhyay et al. (1997) the output of the production function can be defined incorporating certain quality levels. While employing this approach for a postal service the approach can also work within a banking environment. Let us assume a bank’s credit process, for example. The output of the process can be defined as the number of credits of a certain volume within a given period of time. We further assume that the time for the successful completion of this process for a specific credit is an appreciated quality parameter. Then, credits produced faster will receive a higher weight, i.e. the output of the credit process increases. If errors occur the process cannot be completed successfully and some activities of the credit process must be repeated. The effect will be a reduction of credits per unit of time which means less output. In the latter case the affected credit will take longer to complete and get a lower weight which in turn results in less output. Thus, errors within the process are also recognized by the cycle time. In sum the production function reflects the combination of resources at a business process level allowing for a differentiation of input factors considering quality aspects. Furthermore, the basic concept of routines that is elementary in the RBV is introduced affecting the level of achievable output.

As indicated in this section regarding CES-Translog functions there are limitations according to the chosen functional representation. Beside this there are further limitations considering measurement problems especially in service production (Haynes and Thompson 2000).

5 CONCLUSIONS AND FURTHER RESEARCH

5.1 Summary

Methodologically, we used a critical discourse of the RBV identifying basic underlying concepts and developed a conceptual framework. The framework clarifies elementary constructs of the RBV and their interdependencies. Routines were found to be a basic underlying concept in the sense of the RBV and necessary to deploy complementary business and IT resources. The RBV argument chain from IT factors to SCA depends on smoothly functioning routines between IT and business units and within these domains. Interaction between units not only serves to exchange information but also to adapt attitudes over time which is important for developing and implementing IT systems appropriate for the business requirements. In prior research, routines were handled nearly exclusively within conceptual models and examined using case studies. Going one step further than most of the literature we applied production theory to map the transformation part of the framework to a production function. Additionally, we contributed to production oriented approaches by explicitly introducing the concept of routines into a production function using Granovetter's strength-of-tie argument to formalize routines. Thus, the incorporation of quality and of heterogeneous inputs in a traditional production function was discussed and the important concept of organizational routines was explicitly considered. This approach is appropriate as it shows that once clarified the usually quite vague and broad constructs of the RBV can be modelled making explicit functional relationships in a comparatively simple form. The production function introduced explicates the transformation process using the concept of routines in the context of knowledge transfer. To our knowledge the function is the first attempt to explicitly incorporate routines in a production function making variables explicit that are considered to be important in large parts of the literature. Using the algebraic formulation we can therefore identify conditions of successful routines for IT alignment.

5.2 Managerial implications

From a practical point of view, the algebraic function helps to understand the importance of the transformation process from IT to performance. It also indicates that routines are able to increase output levels, thus improving the transformation process. Possibly instructive for managers is that quality aspects and routines can be modelled explicitly making it manageable exhibiting a main lever of a successful transformation process. The proposed model can be used to identify potential for optimization. Once a potential is identified one step in the direction of leveraging the capacity of routines is to construct more formalized interaction, which can be helpful for the setup of routines. First steps are regular meetings, not only at top management level, covering business and IT items. Since obviously this is not sufficient, eventually special organizational units have to be created to foster the information flow. At the service delivery side of IT another managerial recommendation is to internally create service level agreements (SLA). Besides providing the foundation for quality measures of IT services, the process of SLA development itself can be a substantial step towards understanding business necessities and the role of IT and thereby to reduce complexity and mitigate risks.

5.3 Further research

The proposed production function will be used as one component in the next step to build a production model for financial services with special respect to IT capital and sourcing services. The effect of routines on the production of services, especially the learning effects, will be analyzed and empirically tested using case studies in the financial service industry. First results indicate that indeed routines have a positive effect on output level. In this respect, some enhancements are employed and restrictions are relaxed. In the actual model restriction of capacity of a single actor (e.g. organizational unit) and costs associated with a tie within routines are not considered. The stronger the ties the higher the value of p as forecasted by the literature. For the purpose of optimization the next step will be the formulation of a corresponding cost function. Further steps are aimed at applying the model to other contexts like esp. the adaptation to a changing environment and the generation of innovation.

REFERENCES:

Amit, R. and Schoemaker, P.J.H. (1993). Strategic Assets and Organisational Rent, Strategic Management Journal. Vol. 14, Issue 1, 33-46.

Andreu, R. and Ciborra, C. (1996). Organisational learning and core capabilities development: the role of IT. Journal of Strategic Information Systems Vol. 5, 111-127

Barney, J.B. (1991). Firm Resources and Sustained Competitive Advantage. Journal of Management, Vol. 17, No. 1, 99-120.

Barney, J.B. (1986). Strategic Factor Markets:Expectations, Luck and Business Strategy. Management Science, Vol. 32, Issue 10, 1231-1241.

Bharadwaj, A.S. (2000). A Resource based Perspective on Information Technology Capability and Firm Perfomance: An Empirical Investigation. MIS Quarterly, Vol. 24, No 1, 169-195.

Bharadwaj, A.S., Samabmurthy, V. and Zmud, R.W. (1998). IT Capabilities: Theoretical Perspectives and Empirical Operationalization. Proceedings of the 19th ICIS, Helsinki, 378-385.

Broadbent, M. and Weill, P. (1993). Improving business and information strategy alignment: Learning from the banking industry. IBM Systems Journal, Vol. 32, No. 1, 162-179.

Brynjolfsson, E. and Hitt, L.M. (2003). Computing Productivity: Firm-Level Evidence. The Review of Economics and Statistics, Vol. 85, No. 4, 793-808.

Clemons, E.K. and Row, M.C. (1991). Sustaining IT Advantage: The Role of Structural Differences. MIS Quarterly, September, 275-292.

Day, G.S. (1994). Capabilities of Market-Driven Organizations. Journal of Marketing, Oct., 37-52.

Devaraj, S. and Kohli, R.(2003). Performance Impacts of Information Technology: Is Actual Usage the Missing Link?. Management Science, Vol. 49, No. 3, March, 273-289.

Dewan, S. and Min, C. (1997). The Substitution of Information Technology for Other Factors of Production: A Firm Level Analysis. Management Science, December, Vol. 43, No. 12, 1660-1675.

Dierickx, I. and Cool, K. (1989). Asset Stock Accumulation and Sustainability of Competitive Advantage. Management Science, Vol. 35, No. 12, December, 1505-1511.

Eisenhardt, K.M. and Martin, J.A. (2000). Dynamic Capabilities: What Are They?. Strategic Management Journal, Vol. 21, 1105-1121.

Fandel, G. (1994). Produktion I: Produktions- und Kostentheorie. Fourth Edition, Springer-Verlag, Berlin, Heidelberg, New York.

Galunic, D.C. and Rodan, S. (1998). Resource Recombinations in the Firm: Knowledge Structures and the Potential for Schumpeterian Innovation. Strategic Management Journal, Vol. 19, No. 12, December, 1193-1201.

Granovetter, M.S. (1973). The Strength of Weak Ties. American Journal of Sociology, Vol. 78, No. 6, May, 1360-1380.

Grant, R.M. (2002). Contemporary Strategy Analysis: Concepts, Techniques, Applications. Fourth Edition, Blackwell Publishers Ltd., Oxford.

Grant, R.M. (1991). The Resource-based theory of Competitive Advantage: Implications for Strategy Formulation. California Management Review, 114-135.
Haynes, M. and Thompson, S. (2000). The Productivity Impact of IT Deployment: An Empirical Evaluation of ATM Introduction. Oxford Bulletin of Economics and Statistics, Vol. 62, No. 5, 607-619.
Henderson, J.C. and Venkatraman, N. (1993). Strategic alignment: Leveraging information technology for transforming organizations. IBM Systems Journal, Vol. 32, No. 1, 4-16.
Kearns, G.S. and Lederer, A.L. (2001). Strategic IT Alignment: A Model for Competitive Advantage. Proceedings of the 22nd ICIS, Barcelona, 1-12.
Keen, P.G.W. (1991). Shaping the Future: Business Design through IT. Harvard Business School Press, Boston.
Lapre, M.A., Mukherjee, A.S. and Wassenhove, L.N. van (2000). Behind the Learning Curve: Linking Learning Activities to Waste Reduction. Management Science, Vol. 46, No. 5, May, 597-611.
Makadok, R. (2001). Toward a Synthesis of the Resource-Based and Dynamic-Capability Views of Rent Creation. Strategic Management Journal, 22, 387-401.
Mata, F.J., Fuerst, W.L., and Barney, J.B. (1995). Information Technology and Sustained Competitive Advantage: A Resource Based Analysis. MIS Quarterly, December, 487-505.
Mefford, R.N. (1986). Introducing Management into the Production Function. The Review of Economics and Statistics, Vol. 68, No. 1, 96-104.
Melville, N., Kraemer, K. and Gurbaxani, V. (2004). Information Technology and Organizational Performance: An Integrative Model of IT Business Value. MIS Quarterly 28, No. 2, June, 283-322.
Milgrom, R. and Roberts, J. (1995). Complementarities and fit: Strategy, structure, and organizational change in manufacturing. Journal of Accounting and Economics, Vol. 19, Issue 2-3, 179-208.
Mukhopadhyay, T., Rajiv, S., and Srinivasan, K. (1997). Information Technology Impact on Process Output and Quality. Management Science, Vol. 43, Issue 12, 1645-1659.
Nelson, R.B. and Winter, S.G. (1982). An evolutionary theory of economic change. The Belknap Press of Harvard University Press, Cambridge.
Peteraf, M.A. (1993). The cornerstones of competitive Advantage: A Resource-Based View. Strategic Management Journal, Vol. 14, Issue 3, March, 179-191.
Porter, M.E. (1985). Competitive Advantage. The Free Press., New York.
Ravichandran, T. and Lertwongsatien, C. (2002). Impact of Information Systems Resources and Capabilities on Firm Performance: A Resource-Based Perspective. Proc. of the 23rd ICIS, 577-582.
Ross, J.W., Beath, C.M., and Goodhue, D.L. (1996). Develop Long-Term Competitiveness through IT Assets. MIT Sloan Management Review, Fall, 31-42.
Rumelt, R.P. (1984). Towards a Strategic Theory of the Firm. In: Lamb, R.B. (ed.), Competitive Strategic Management. Prentice-Hall Inc., Englewood Cliffs, 556-570.
Schrott, G. and Beimborn, D. (2003). Informal Knowledge Networks: Toward a Community-Engineering Framework. Proceedings of the 24th ICIS, Seattle, 1-7.
Soh, C. and Markus, M.L. (1995). How IT Creates Business Value: A Process Theory Synthesis. Proceedings of the 16th ICIS, 29-41.
Teece, D.J., Pisano, G. and Shuen, A. (1997). Dynamic Capabilities and Strategic Management. Strategic Management Journal, Vol. 18, No. 7, August; 509-533.
Tiwana; A.; Bharadwaj, A., and Sambamurthy, V. (2003). The Antecedents of Information Systems Development Capability in Firms: A Knowledge Integration Perspective. Proceedings of the 24th ICIS, Seattle, 246-258.
Wade, M. and Hulland, J. (2004). Review: The Resource-Based View and Information Systems Research: Review, Extension, and Suggestions for Future Research. MIS Quarterly, Vol. 28, No. 1, March, 107-142.
Wagner, H.-T. and Weitzel, T. (2005). Modeling the impact of alignment routines on IT performance: an approach to making the resource based view explicit. Proc. of the 38th HICSS, Kona, USA, 1-10.
Wernerfelt, B. (1984). A Resource based View of the Firm. Strategic Management Journal, Vol. 5, Issue 2, June, 171-180.