

Jana Oehmichen (Germany), Marcus Schuster (Germany), Michael Wolff (Germany)

## Absorptive capacity and incentives

### Abstract

The absorptive capacity of an organization is one of the central elements of innovation and knowledge management. Over the past years it has strongly gained importance in the conceptual and empirical literature. But there are still boundaries and details that are not yet included in the model: the discussion about the objectives of absorptive capacity is usually confined to effectiveness objectives and for the coordination of absorptive capacity authors focus on organizational mechanisms overlooking the motivation of the employees. This paper wants to answer the question whether an incentive system yields a successful regulation of absorptive capacity. We therefore review the concept of absorptive capacity, its different interpretations in business research, its enhancement and points of criticism and derive four objectives conceptually. For the empirical analysis we include the dimension of incentives and investigate its implications on the objectives of absorptive capacity.

**Keywords:** absorptive capacity, innovation, incentives, information, knowledge.

**JEL Classification:** L22, O31.

### Introduction

Knowledge and innovation is one of the essential sources of competitive advantage (Corso et al., 2001). Knowledge is even considered to be the fourth production factor (Kailer and Scheff, 1999) and its importance is increasing ever more because of a fast changing environment and the growing globalization. But as Äschylus realized 2500 years ago it is not the amount of knowledge in general but the right knowledge (Davenport and Prusak, 2000) and its correct implementation and utilization in the firm that leads to competitive success.

A central element of innovation and knowledge management is the absorptive capacity of an organization. This means “the ability of a company to recognize the value of new, external information, assimilate and apply it to commercial ends” (Cohen and Levinthal, 1990). Some work has already been done on the conceptual explanation of this concept, but there have only been a few empirical investigations so far.

Within the empirical papers we could still discover two major gaps concerning the interpretations and enhancements of Cohen’s and Levinthal’s original work from 1990. Firstly, the authors mostly concentrate on the companies’ ability to use the absorbed knowledge and end up seeing innovation as the single objective. This leaves space for more effectiveness objectives to be identified and some efficiency objectives to be developed. Therefore it is the scope of our paper to analyze the four objectives: innovation, the development of a broader knowledge basis, the speed of the information and knowledge process and satisfaction of the employees. Secondly, the coordination of absorptive capacity is usually only investigated from an organizational point of view. But successful coordination also depends on the employees and their

motivation which in turn depends on what the employees expect as a reward or compensation for their work. Therefore we expect a high impact of incentive systems on the objectives of absorptive capacity. The “global hypothesis” of our paper states: “the objectives of absorptive capacity are easier to achieve in combination with a suitable incentive system”. For each of these four objectives we test for the correlation between the objective and the implementation of incentives and find it to be significant in all four cases.

After a literature review on the concept of absorptive capacity, its different interpretations in business research, its enhancement and points of criticism we want to derive the four objectives conceptually and include the dimension of incentives. This represents the basis for our statistical hypotheses. The third chapter describes the underlying data sample and explains the statistical methods. The results of the statistical analysis are presented in chapter four; the last chapter presents the conclusions.

### 1. Literature review

Over the past years the topic of “absorptive capacity” has strongly gained importance in the conceptual and empirical literature. A high number of papers can be found that discuss diverse questions about this construct. In the following chapter we want to give a brief overview of the construct itself and introduce some empirical analyses done on essential specifications and enhancements. We end this chapter with some points of criticism.

The original concept of absorptive capacity goes back to Cohen and Levinthal. According to their original work the absorptive capacity consists of three elements<sup>1</sup> that chronically result from each other: evaluation, assimilation and utilization. To

<sup>1</sup> These elements are sometimes also called components, dimensions or abilities: Lane et al. (2001); Zahra and George (2002); Lane and Lubatkin (1998).

*recognize the value of new, external information* implies the ability to identify relevant information within the total volume of available information. This requires that attention is directed in the right direction (Rocha, 1997) and on sources with a high “hit rate” (Kim, 1997). *Assimilation* stands for the company’s ability to understand the information’s content and process it. The integration of new knowledge sometimes implies re-interpreting existing knowledge or its partial or total elimination (Daghfous, 2004). *Using new information for commercial reasons* means generating product or process innovations from the knowledge<sup>1</sup>.

A couple of interpretations of this concept can be found in literature. Within the conceptual or case study based papers the investigation of the dependence between the absorptive capacity feedback loop and the environment from van den Bosch et al. and the interpretation of absorptive capacity as the ability to learn and to solve problems from Kim are probably the most popular ones.

The idea of van den Bosch and his colleagues is that the development of absorptive capacity implies a feedback loop and that the degree of efficiency of this feedback loop depends on the environment. The authors investigate three dimensions of absorptive capacity: its efficiency, its extent and its flexibility. The environment is considered as a dichotomy variable – it is either stable or turbulent. They recognize that in a stable environment a high efficiency of absorptive capacity is required, whereas a turbulent environment requires a higher extent and flexibility (van den Bosch et al., 1999). The work of Kim is a good example of the *emphasis of single content components* on absorptive capacity. His interpretation of absorptive capacity as the ability to learn and solve problems is based on the case of Hyundai Motor Company. His idea includes the understanding of new knowledge and the ability to copy innovations of other firms in order to create knowledge for own innovations (Kim, 1998).

In addition, we were able to identify four empirical papers relevant for our topic: Lane and Lubatkin define relative absorptive capacity as the ability of a company to learn from another company. To investigate this ability they follow the same process as Cohen and Levinthal: knowledge recognition, assimilation and utilization. Recognizing the knowledge of another company depends on the own endowment of basic and specialized knowledge. Assimilation becomes easier with a more analogue process of knowledge development. If this process

can not be observed directly they recommend observing the company’s compensation policy or the organizational structure. The ability to use the knowledge commercially strongly depends on how aware the company is of the challenges of the other company (Lane and Lubatkin, 1998). Mowery and Oxley examine the role of national innovation systems in the inward transfer of technology that has underpinned the transformation of the Japanese and other East Asian economies since 1945. From their point of view the absorptive capacity is the company’s portfolio of abilities that are required to understand and use externally acquired technological knowledge. On one hand, this results in a generalization since there is no differentiation in knowledge acquisition and assimilation any more. On the other hand, it focuses on only technological knowledge (Mowery and Oxley, 1995). Heeley investigates the impact of absorptive capacity on a firm’s sales growth and research productivity. For him the utilization of knowledge results in the technical abilities of the company. But from his point of view absorptive capacity is more than the simple identification of technological knowledge but also the process of acquisition and assimilation (Heeley, 1997). Liao and his colleagues even enhance this understanding by interpreting the portfolio of technological abilities as the organization’s ability to respond to environmental changes. They examine the relationship between firm absorptive capacity and organizational responsiveness in the context of growth-oriented small and medium-sized enterprises (Liao et al., 2003).

The overview of interpretations and enhancements mirrors the broad acceptance of the concept. But there are still boundaries and details that are not yet included in the model which lead to the following points of criticism. Firstly, the discussion about the objectives of absorptive capacity is usually confined to effectiveness objectives. This is a needless narrowing of the perspective. Including efficiency objectives would further complete the concept. And secondly, the organizational scope for design to coordinate absorptive capacity is only one side of the coin. But the motivation of the employees who actually implement the ideas depends on which results and rewards they expect to earn for their work (Daft, 2006; Porter et al., 1975). This results in the open-ended question of whether an incentive system yields a successful regulation of absorptive capacity. We want to answer this question in the following chapter.

## 2. Motivation and hypothesis development

To build our model as a basis for the hypotheses we want to reconsider incentives as an important lever for the company’s absorptive capacity. As we al-

<sup>1</sup> Whereas product innovation focuses on the improvement of existing products or the development of new products and services, process innovation results in organizational adaptation with an indirect effect on the company’s performance (Christensen and Lundvall, 2004).

ready explained the motivation and engagement with which an employee fulfils his tasks generally depends on which results and rewards he expects (Daft, 2006; Porter et al., 1975). Now the question arises as to whether incentives can be used to control the absorptive capacity<sup>1</sup>. Out of this conviction that there must be a connection between incentives and absorptive capacity we can develop the statistical hypothesis. The general idea that has to be supported statistically states that “the objectives of absorptive capacity are easier to achieve in combination with a suitable incentive system”. This is called the “global hypothesis”.

In the following we will derive the main objectives of absorptive capacity: innovation, the development of a broader knowledge basis, the speed of the information and knowledge process, satisfaction of the employees. On this basis we can complete the single statistic hypotheses.

**2.1. Innovation.** According to Cohen and Levinthal the absorptive capacity is critical to a company’s innovative capabilities (Cohen and Levinthal, 1990). So innovation is one of the objectives that is achieved with absorptive capacity. Though the authors do not give a concrete definition of the term innovation it can be interpreted as the willingness, ability and possibility of social systems to develop marketable processes, products and services. But how to measure innovation? It is clearly not an absolute value and must always be considered within its environment. In a very static environment for example a low degree of innovation is less a disadvantage for the business success then it is in a dynamic setting (Slater and Narver, 1994; Corso et al., 2001). The easiest way of evaluating innovation is to measure the concrete output of its implementation<sup>2</sup>. During our survey we used three questions as proxies for innovation: we asked for the relative change in processes, products and services during the past, enhancements in these areas as well as totally new developments.

The hypothesis that we will test in the next chapter is the following:

*H1: The more intensive the operation of an incentive system, the more innovation is observable in the company.*

**2.2. Development of a broader knowledge basis.** Beside the innovation, absorptive capacity is aimed at the development of a broader knowledge basis, since a diverse knowledge background is essential for an organisation’s learning process. “It increases the pros-

pect that incoming information will relate to what is already known” (Cohen and Levinthal, 1990). If the increase of innovation is considered to be the main objective, the development of a broader knowledge base is one of the most important side objectives, since the knowledge gained in one period serves as prior knowledge for the innovation process of the next period. As opposed to innovation which is usually measured at the end of the process the development of knowledge can be found and measured in nearly every process step. Questions for the knowledge advances in the past, the enhancement of existing ideas and the development of totally new ideas should clarify if a company develops a broader knowledge basis.

Therefore we can formulate the second hypothesis:

*H2: The more intensive the operation of an incentive system, the better the development of a broader knowledge basis.*

**2.3. Speed of the information and knowledge process.** Another side objective of innovation is to have the knowledge available at the right time. Generally this results in two contradictory restrictions concerning the speed. On the one hand a high processing speed is required to bring the innovation to market in time (Dodgson, 1991), which can be ensured by the cross-function absorptive capacity (Cohen and Levinthal, 1990). On the other hand the individual absorptive capacity requires a specific intensity of the examination with the circumstances and this can be expected to be higher if there is more time available, so if the process of acquiring knowledge is slower (Herriott et al., 1985; March, 1991). This dilemma can be solved by the suggestibility of the respective parameter. While the required speed to bring innovations to market is exogenous (Tidd, 2001) the speed of the individual learning process is to some extent controllable. This results in the dominance of the external perspective – the increase in the speed of information – over the internal perspective of giving individuals as much time as possible to process information. For this reason the high speed of the information and knowledge process is another objective of the absorptive capacity. We covered this topic in our survey, for example with questions about the reaction time.

This results in the third hypothesis:

*H3: The more intensive the operation of an incentive system, the faster the information and knowledge process.*

**2.4. Satisfaction of the employees.** Another way of testifying to the success of the absorptive capacity is to analyze the employees’ satisfaction with the information and knowledge system of their company. In a company with a working absorptive capacity we expect the employees to be more satisfied. Thus the employees’ satisfaction is our fourth and last objective.

<sup>1</sup> We desist from generally introducing incentive systems and refer the interested reader to the literature; e.g. Lawler (1971; 1973), Vroom (1964).

<sup>2</sup> One way of measuring this is to consider expenses for research and development, the number of patents or the number of new products announced (Tidd, 2001).

As an approximation we asked our interview partners if they judge the whole process of knowledge generation and the single process steps of evaluation, assimilation and utilization to be powerful.

Therefore we can complete the set of hypotheses:

*H4: The more intensive the operation of an incentive system, the higher the employees' satisfaction with the information and knowledge system.*

**3. Sample selection, data and methods**

This section will answer two questions: where does the data comez from and what needs to be done with the data to analyze our hypotheses.

The data were generated from a survey. To ensure that the results are representative and that the results can be generalized we had to take into account the various industries and business process steps. For this reason we had to choose the sample such that the industries and business process steps are first relevant to the economy or the organization and secondly represent the variance of the basic population.

Table 1 shows the industries covering an essential part of the German economy<sup>1</sup>. The observed business process is strongly geared to Porter's value chain which is widely accepted by the scientific community<sup>2</sup>.

Table 1. Industries interviewed

Industries	
- Automobile (incl. suppliers)	- Finance
- Construction/Construction material	- IT/Telecommunication
- Chemicals/Pharmaceutical	- Consumer goods
- Services	- Manufacturing
- Energy/Raw materials	- Transportation and logistics

We generated the data via a standardized written interview for the following three reasons: the sample had to be large enough to produce statistically significant, representative and generalizable results. The interview should require as little time as possible of the interview partners, since nearly all of them are members of the companies' management structures and have a restricted timeframe anyway. And since the results of the interviews should be comparable we used statements in our questionnaire which only had to be evaluated by the interview partners. This procedure results in discreet and polytome variables<sup>3</sup>.

We used an uneven scale to identify answers of protest, supposedly irrelevant questions and diffidence of

the interview partners. Possible evaluations ranged from 1 ("I do not agree at all") to 7 ("I totally agree")<sup>4</sup>.

We sent 2000 questionnaires with 151 variables of which 17 were of interest for our research topic<sup>5</sup>. With 133 interview partners answering we achieved a response rate of seven percent. Figure 1 shows the successful interviews sorted by industries; Figure 2 – the sorting by business process steps. As we expected, not everybody answered every question<sup>6</sup>. To deal with the missing data we applied elimination and the mean imputation method<sup>7</sup>.

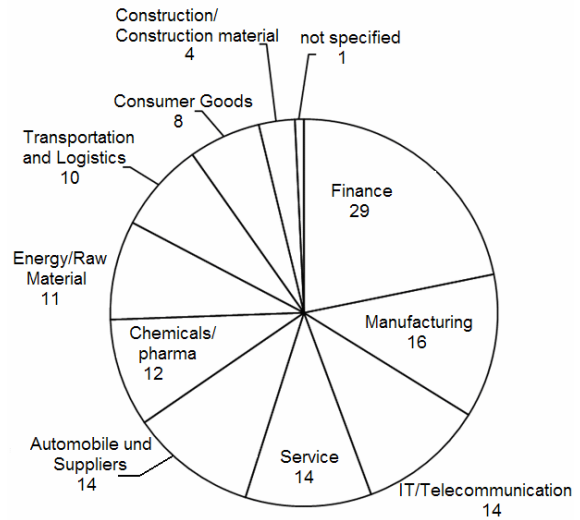


Fig. 1. Participants by industries



Fig. 2. Participants by functional areas

In a next step we conducted an exploratory factor analysis<sup>1</sup>. Factor analysis is a collective term for the

<sup>1</sup> Compare <http://www.ihk.de> (Industriereport 2004/2005).

<sup>2</sup> See Porter (1998): the essential parts of a company's value chain are procurement, production, marketing, sales, research and development, controlling and strategic management.

<sup>3</sup> To ensure that the manner of answering is not influenced by diction we only used statements with less than 20 words and avoided absolute formulations like "always" and "all" or restrictive formulations like "nearly" or "almost" (Payne, 1994).

<sup>4</sup> Dawes discovers that five and seven-point scales result in nearly the same mean scores when they are rescaled (Dawes, 2008).

<sup>5</sup> The whole questionnaire and the important variables can be requested from the authors.

<sup>6</sup> Possible reasons are a lack of comprehension or accidentally overlooking. In socio-scientific research projects 10% of the data missing is usual (Kim and Curry, 1977).

<sup>7</sup> Before applying the elimination method we tested for the MCAR (Missing Completely at Random) attribute. The insignificance in Little's MCAR test implies that the MCAR attribute can not be rejected. We are aware of delimited explanatory power of this statistical reverse but the application of this method is still better than totally ignoring these problems (Little and Rubin, 1987).

reduction of large data sets with the objective of recognizing and describing structures that the data set encloses. These structure variables – in the following called factors – can be created via linear combination of the original variables (Tabachnick and Fidell, 2006). In order to verify that the variables are applicable for a factor analysis we examined the Kaiser-Meyer-Olkin criteria (measure of sampling adequacy, MSA) and the total variance explained (TVE) (Hair et al., 1998). To reduce the data set we used the principal component analysis which focuses on whether and how well we can bundle the variables loaded on a factor (Meyers et al., 2005). The statistical criteria that were helpful in finding the right number of factors were the Kaiser variables (Kim and Mueller, 1978) and the Scree Test (Kline, 1993). For rotation we used the Varimax-rotation as the most common method for orthogonal rotation (Kline, 1993). With Cronbach's alpha and the item-to-total-correlation we tested the reliability of the factors and with the total variance explained (TVE) and the level of factor loading their validity (Homburg and Giering, 1998; Hair et al., 1998). Finally the factor values were calculated as summated scales<sup>2</sup>.

The correlation analysis is the best instrument to analyze bivariate linear connections, their significance, strength and direction (Tabachnick and Fidell, 2006). The correlations coefficient is usually calculated via the product-moment-correlation according to Pearson<sup>3</sup>. One precondition for this method is the normal distribution of the variables. This could be assumed in a data set with  $n = 104$ , but nevertheless we verified the normal distribution with the Kolmogorov-Smirnov test (Hair et al., 1998).

#### 4. Empirical results

In this chapter we will present all the results of our statistical analysis. We will explain comprehensive outcomes of the data evaluation before we focus on the tests of the hypothesis and the interpretation of their results.

**4.1. Results of the factor analysis.** First we separate our sample of 17 variables into 2 modules: incentives and objectives. These modules are tested separately for their suitability for a factor analysis: 4 variables represent the incentives and 13 the objectives. Table 2 shows the outcomes of the total analysis of requirements for the factor analysis. As we see the conditions for the MSA values and the total variance explained are fulfilled.

Table 2. Overview of requirements for factor analysis

Overview of requirements for factor analysis			
	Incentives	Objectives	Total
Original number of variables	4	13	17
MSA values of the variables < 0.5	./.	./.	./.
Number of variables for factor analysis	4	13	17
MSA values of the correlation matrix > 0.5	0.842	0.828	./.
Total Variance Explained > 50 %	81.3%	69.4%	./.
Number of factors	1	3	4
Exclusion of factors without meaning as regards content	./.	./.	./.
Number of factors	1	3	4

Table 3. Results of reliability and validity test for factor analysis.

Results of reliability and validity test for factor analysis			
Factors	No Variables	Cronbach's $\alpha$	TVE
Incentive system	4	0.923	0.813
Satisfaction	4	0.869	0.720
Total effectiveness <sup>4</sup>	5	0.867	0.653
Process speed	4	0.835	0.672

The factor analysis yields four factors which are presented in Table 3 together with the results of their reliability and validity tests. As required, Cronbach's alpha and the total variance explained are always greater than 0.5. The level of factor loading is always greater than 0.4. Due to these

results an adjustment in respect of the item-to-total correlation is not necessary.

<sup>1</sup> We want to avoid redundancies by measuring the same attribute with several variables. For this reason we bundle the relevant variables into a few superior factors representing the instruments and objectives of absorptive capacity introduced in Chapter 2.

<sup>2</sup> For advantages of the summated scales method compared to estimating the factor values via regression or surrogate variables see Hair et al. (1998).

<sup>3</sup> This coefficient is often called the Bravais-Pearson-correlation coefficient (Kotz et al., 2006).

<sup>4</sup> We separated the factor total effectiveness confirmation into innovation and development of a broader knowledge basis according to the theoretical derivation in Chapter 2. The test for reliability and validity allows this separation (Cronbach's  $\alpha$  0.789 and 0.836 and TVE 0.703 and 0.862).

The factor values are calculated as summated scales. These values aggregating the information of the original variables embody the basis for the following analyses.

**4.1. Results of the correlation analyses.** The bivariate analysis of correlation between the incentive factor and the objective factors will give us an answer on the significance of the hypothesis. The Kolmogorov-Smirnov test which is necessary since the Pearson correlation coefficient requires normal distribution is positive for all factors. Table 4 shows the correlation coefficients and the significances.

Table 4. Results of the correlation analysis

Results of correlation analysis		
Correlation with incentives	Pearson correlation	Significance (one-sided)
Total Effectiveness	0.237***	0.008
Innovation	0.231***	0.009

Knowledge Development	0.202**	0.020
Process Speed	0.162**	0.050
Satisfaction	0.307***	0.001

Note: The asterisks signal the levels of significance. Three asterisks represent a level of significance of one percent and two asterisks a level of five percent.

Note that we added the factor “total effectiveness” since it includes the two separately and confirmatory calculated factors innovation and development of a broader knowledge basis. Correlation between incentives and the speed of the information and knowledge process and the one between incentives and the development of a knowledge basis are significant to five percent, all the other correlations show a one percent significance.

**4.2. Summarizing results of the hypothesis tests.**

What do these statistical results imply for our hypothesis? Table 5 summarizes the outcomes of the hypothesis testing.

Table 5. Overview of hypothesis test results

Overview of hypothesis test results				
Hypothesis	Description	Level of significance		
		< 0.10	< 0.05	< 0.01
H <sub>1</sub>	The more intensive the operation of an incentive system, the more innovation is observable in the company			X
H <sub>2</sub>	better the development of a broader knowledge basis		X	
H <sub>3</sub>	faster the information and knowledge process		X	
H <sub>4</sub>	higher the employees' satisfaction with the information and knowledge system			X

During the conceptual derivation of the objectives of absorptive capacity we separated innovation and the development of a broader knowledge basis. The factor analysis suggests the assumption that these two objectives share higher common information content than expected. Since for both objectives the correlation with incentives is significantly strong the null hypothesis is rejected. The intensity of the correlation (between 0.20 and 0.24) was expected to be within this range since the two factors innovation and development of a broader knowledge basis depend on many more parameters and can be influenced by many more instruments than only incentives.

The idea that there is a correlation between the speed of the information and knowledge process and incentives can be statistically approved as well – the correlation coefficient is significantly positive. From this it follows that for H3 we can reject the competing null hypothesis.

And we also get significant results for satisfaction: as we expected there is a significant correlation between the satisfaction with the information system and incentives. One could argue that a correlation of 0.3 does not militate in favour of a strong depend-

ence but as for innovation and knowledge development we have to keep in mind that there may be many more factors influencing the employees' satisfaction.

In total our global hypothesis can be seen as approved. We showed that there is a big influence of incentives or the employees' motivation on a company's absorptive capacity. Therefore companies should consider knowledge more as a target variable in constructing their incentive systems. Especially companies in knowledge intensive industries could meditate on special incentive systems for the employees of their knowledge management department.

**Concluding remarks**

The main question of our conceptual and empirical investigation was whether there is any impact of an incentive system on a firm's absorptive capacity. To analyze this empirically we first derived the main objectives of absorptive capacity theoretically. We hereby identified the four objectives of absorptive capacity as innovation, the development of a broader knowledge basis, the speed of the information and knowledge process and the satisfaction of the employees. This theoretical prelimi-

nary consideration was the basis for the statistical hypothesis to test the correlation between incentives and objectives.

The data we used to test the hypothesis were generated via a survey. To ensure that the results are representative and can be generalized we took into account the variety of industries and business process steps. We sent 2000 questionnaires with 151 variables of which 17 were of interest for our research topic and got 133 answers out of which we could use 104 since their degree of completeness was high enough. The correlation analysis was conducted on 5 factors which were first created from the 17 variables via a factor analysis: 4 variables represented the incentives and 13 the objectives. We did not have to reject any of our hypotheses since all the correlations were significant. The correlation coefficients between 0.16 and 0.3 suggest that there are many more factors than incentives by which we could influence the objectives of absorptive capacity.

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In the end we could show the relevance of incentive for all objectives of absorptive capacity, whereas the influence on effectiveness was higher than on effi- ciency. Our global hypothesis is hereby confirmed.

But there are still some open topics: to date we only investigated the correlation between incentives and the objectives of absorptive capacity. This did not include an analysis of the causality which leaves space for further research. One of the reasons why we did not include a causality analysis, a cluster analysis or a confirmatory factor analysis is the rela- tively small and limited sample size. Only bigger samples create the preconditions for these kinds of statistical analysis. And a sample of this kind would permit an analysis separated by functional areas. This could be reasonable since different functional areas in a company require different information and knowl- edge related activities. A separation by company type would additionally allow an analysis of the impact of company type specific incentive systems.

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