

# **Sensing Environmental Changes**

## **Working Paper**

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### **INTRODUCTION**

As the world is changing at an increasing speed, the adaptability of companies is becoming more and more essential for their success. The fast-moving business environment includes constant changes in consumer needs, technological innovations, and changing competitor activities. This constantly changing business environment raises the question of the sustainability of companies' competitive advantages. Some authors have studied the appearance of Schumpeterian hypercompetition, which implies that the increasing dynamism of the markets makes maintenance of the competitive position difficult (McNamara, Valler, & Devers, 2003; Wiggins & Ruefli, 2005). For instance, Wiggins and Ruefli (2005) found that the average time span for which companies are able to sustain their competitive advantages has decreased over time. Many once successful firms were found to struggle or fail as their environments changed because they were unable to adapt successfully to these changes (Harreld, O'Reilly III, & Tushman, 2007). More than ever before, companies today need to know how to handle their resources in order to exploit opportunities or neutralize threats that arise from changes in their competitive environment (Hansen, Perry, & Reese, 2004; Kor & Leblebici, 2005; Lavie, 2006). Resources and competences have to be flexible and should be regarded more as "events" and not as "assets"(Von Krogh & Roos, 1996), which would in turn make renewability and evolution easier to realize (Dierickx & Cool, 1989). Consequently, the constant development of existing

resources, knowledge, and competences under adequate consideration of market developments becomes a central task for strategic renewal.

In recent years, research on strategic management focused on the framework of dynamic capabilities as a central concept of sustained competitive advantage (Ambrosini & Bowman, 2009; Helfat & Peteraf, 2009; Helfat et al., 2007; Teece, 2007; Teece, Pisano, & Shuen, 1997). However, research on dynamic capabilities has not delivered very specific answers for explaining the sources of enterprise-level competitive advantage over time. Even though research in the last four years has made progress with the development of a clear and complete picture of dynamic capabilities, this concept is still lacking clarity (Di Stefano, Peteraf, & Verona, 2010, 2014; Helfat & Winter, 2011; Li & Liu, 2014). Many empirical studies in this field tend to be tautological and vague, making it difficult to capture and measure these capabilities (Kraatz & Zaja, 2001; Danneels, 2008). Alongside Barreto (2010) and Ambrosini and Bowman (2009), who claimed that the concept of “dynamic capabilities” is lacking “...a clear and adequate definition of the main construct” (Barreto, 2010: 275) and that “...these capabilities have been poorly specified” (Ambrosini & Bowman, 2009: 37), authors such as Di Stefano et al. (2014) and Helfat and Winter (2011) have made similar critiques. Researchers need to choose how to operationalize not only the aggregate construct (dynamic capability) but also the dimensions-related constructs, such as sensing (Barreto, 2010). This could be achieved through field research, which would allow researchers to address the micro-process question of how companies practice dynamic capabilities. For this purpose, a strategy-as-practice lens concerned with what companies do could be employed (Ambrosini & Bowman, 2009; Jarzabkowski, Balogun, & Seidl, 2007; Johnson, Melin, & Whittington, 2003; Pablo, Reay, Dewald, & Casebeer, 2007).

Teece (2007) separates dynamic capabilities into the capacity (1) to sense opportunities and threats, (2) to seize opportunities or manage threats, and (3) to enhance, combine, protect,

and, when necessary, reconfigure the business enterprise's assets. By focusing on the components of sensing and their effects on a potential sensing success, this study delivers measurable effects of different sensing activities and is therefore a next step in solving the "secret" behind dynamic capabilities.

We include changes in competition, customer preferences, and technology in the concept of environmental dynamism (Baum & Wally, 2003; Jaworski & Kohli, 1993; Miller & Friesen, 1983). Different environmental dynamics raise different challenges for enterprises and therefore also affect dynamic capabilities. Studies examining the effects of different environmental dynamics on dynamic capabilities have shown inconsistent results (Drnevich & Kriauciunas, 2011, Pavlou & El Sawy, 2006). For these reasons, we integrate environmental dynamism in our model.

To better understand the microfoundations of the dynamic capabilities, we examine sensing activities and their effects on the sensing success under different environmental dynamics by surveying top managers from 346 companies located in Germany. The findings reveal that it is not the sourcing of market information but the method and intensity of gathering and analyzing that drives both the sensing success as well as the capability to sense opportunities and threats. These effects are mainly visible under high environmental dynamism.

## **THEORETICAL BACKGROUND**

### **Dynamic Capabilities and its Dimensions**

As mentioned above, the dynamic capabilities framework tries to provide answers for handling changes in the business environment. Teece, who, along with Pisano, was one of the first authors to examine the concept of dynamic capabilities (Teece & Pisano, 1994), describes the ambition of this framework as "*...nothing less than to explain the sources of enterprise-level*

*competitive advantage over time...*” (Teece, 2007: 1320). Based on this framework, Teece (2007) provides a composition of the critical capabilities (sensing, seizing, managing threats, and reconfiguring) companies need to successfully handle environmental dynamics. This activity-based understanding of dynamic capabilities is now reflected in some empirical research (e.g., Ettlie & Pavlou, 2006; Kindström, Kowalkowski, & Sandberg, 2012).

The relevance and need for a dynamic approach incorporated in the dynamic capabilities has become more and more manifested in research and management practice. Day identified “a real and expanding gap between the demands of markets and the ability of firms to address the complexity and velocity of change in their markets” (Day, 2011: 194), which can only be handled by adaptive capabilities that fit the new market reality. Thereby, he takes the same line as other researchers who conclude that resources are insufficient because competition between companies usually erodes the value of resources over time. Literature and studies on dynamic capabilities addressed this critique; however, they failed by remaining to some extent superficial and thereby missed the exact analysis of dimension-related constructs (Ambrosini & Bowman, 2009; Barreto, 2010; Danneels, 2008; Di Stefano et al., 2014). The present study tries to clarify the concept of dynamic capabilities by operationalizing and measuring the sensing dimension in high and low dynamic environments.

### **Dynamic Capabilities and their Sensing Activities**

A meta-analysis by Barreto (2010) and the review article of Eriksson (2014) show that although some empirical studies focus on the investigation of the sensing capability, most studies stay rather superficial and don’t operationalize the sensing construct or break it down into a measurable model with concrete activities.

According to Teece (2007), sensing of risks and opportunities serves as an important component for sustainable competitive advantage since the success of companies mainly depends

on the detection and development of opportunities and risks (Teece, 2007). Protogerou, Caloghirou, and Lioukas (2011) also view the capability to sense environmental challenges as being “of utmost importance” as it provides the firm with a market relevant decision-making basis and thereby enables the company “to reconfigure certain capabilities before they become core rigidities” (Protogerou et al., 2011: 620). Pavlou and El Sawy (2011) regard this part of the dynamic capabilities as the identifying and interpreting capability of market developments. The ability to search for and identify opportunities or threats in the business environment is a relevant topic in many management research fields (e.g., strategic management, marketing, entrepreneurship). The dynamic capabilities framework merged many activities from these fields under the sensing concept. Sensing, however, is not just a conglomerate of activities from different research fields; it also includes the dynamic perspective on the company and its environment (Barreto, 2010; Teece, 2007). In view of this, sensing could be regarded primarily as a business environment’s information gathering and interpreting activity with the goal of identifying opportunities or threats (Barreto, 2010; Teece, 2007; Schreyögg & Kliech-Eberl, 2007). Being able to identify, for example, a new business opportunity, means first of all knowing if any business opportunity exists. This can only happen when the company gets the information about this new business opportunity and is able afterwards to assess the importance of this information. To do this, the environmental information sources have to be tapped and their output needs to be effectively analyzed. This leads to our model, which classifies the sensing activities into “environmental sourcing” and the “environmental gathering and analysis mode”. This categorization is derived from Aguilar (1967) and Daft and Weick (1984). The main difference in our model (see Figure 1) is that we do not distinguish between scanning and interpreting as sensing activities but between sourcing and the method of gathering and interpreting market information. This addresses more recent research findings that argue that sources and the method

of gathering and analysis are the key ingredients for effective scanning of the environment and, in turn, sensing opportunities and threats (Maier, Rainer, & Snyder, 1997; May, Stewart, & Sweo, 2000; Thomas, Clark, & Gioia, 1993).

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Insert Figure 1 about here  
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In examining our understanding of sensing, we bring together different sources of market information (Foss, Lyngsie, & Zahra, 2013; Harmancioglu, Grinstein, & Goldman, 2010; Jaworski & Kohli, 1993; Matsuno, Mentzer, & Rentz, 2000; Wang, Ellinger, & Wu, 2013) on an organizational level. By comparing our sensing activities with the MARKOR or MO intelligence generation activities, we find that those scales do not address the overall methods of analyzing market information (e.g., systematic scanning approach, pragmatic scanning approach, scanning intensity) (Jaworski & Kohli, 1993; Matsuno et al., 2000). Finally, by bringing the sources from the intelligence generation MO-construct from Matsuno et al. (2000) together with the scanning and interpretation approaches from Aguilar (1967) and Daft and Weick (1984) and adapting this to the dynamic capabilities framework, we deliver a new, extended version of environmental scanning, namely sensing.

In earlier research, parts of the sensing activities in the form of environmental scanning activities and their causal effects on constructs such as adaptability (e.g., Fey & Denison, 2003; Goll & Rasheed, 1997; Nadler, 1998; Senge, 1990) or market orientation (e.g., Matsuno et al., 2000; Narver, Slater, & MacLachlan, 2004) have been examined and confirmed. Since many authors such as Barney (1995), Teece (2007) or Ginsberg and Venkatraman (1995) agree that an adaptive company is one that recognizes market trends, identifies the threats and opportunities within a market, and adjusts to new environment conditions, we derived thereon the hypotheses in our model. In our work, sensing performance is determined as “exploiting environmental

opportunities and neutralizing environmental threats” (Barney, 1995: 50), which is the basis for companies’ adaptability as well as the basis for a company’s sustainable competitive advantage (Barney, 1991, 1995; Porter, 1980; Teece, 2007) because when no opportunities or threats are identified, the company would not even know that there is a necessity to adapt. The division of the sensing activities into “environmental sourcing” and “environmental gathering and analysis mode” is provided in the hypotheses blocks.

### **Sensing and Environmental Dynamism**

Research also suggests the inclusion of the moderating variable environmental dynamism in studies on dynamic capabilities (Danneels’s, 2008; Eisenhardt & Martin, 2000; Helfat et al., 2007; Teece et al., 1997). Yet, in his analysis of successful companies from 1870–1960, Chandler (1990) observed that “different environmental conditions ask for different management behaviours.”

Based on the dynamic capabilities concept, the environmental context is not just that of an industry but more a business “ecosystem” including all organizations, institutions, and individuals affecting the company’s business (Teece, 2007). Management research describes environmental dynamism as “the level of environmental predictability manifested in the variance in the rate of market and industry change and the level of uncertainty about forces that are beyond the control of individual businesses” (Baum & Wally, 2003: 1110), which covers more than just a “high-velocity” environment (Eisenhardt, 1989; Judge & Miller, 1991). Therefore, even low-growth industries might be “dynamic” under the condition that the low growth rate variance is high (Baum & Wally, 2003). By applying this understanding of environmental dynamism, organizations in a high dynamic environment need to handle high uncertainty and therefore are more confronted with the necessity of adapting their resource base and reacting on developments in the business environment (Eisenhardt & Martin, 2000). By contrast, companies operating in

low dynamic environments have to respond to changing environmental conditions only occasionally. Nevertheless, occasionally does not mean that there is no need to handle environmental dynamics in low dynamic environments. Hence, for this purpose the investigation of both environmental circumstances is recommended.

The great majority of dynamic capabilities studies tested the effects of industry dynamism while our inquiry considers the whole business environment as a moderating variable, which is a further contribution to research. This approach is strongly recommended by authors such as Teece (2007) and Baum and Wally (2003) because industry borders are difficult to determine and do not cover the whole picture of the relevant business environment.

In addition, based on our literature review, research might be enriched by our investigation of environmental effects on sensing, since these aspects have not been investigated so far.

## **HYPOTHESES**

The above-mentioned deficits were reasons to expect that substantiating and operationalizing the sensing concept to its specific activities and furthermore considering different environmental conditions will lead us to new insights for science and management practice. This approach delivers a more tangible sensing capability and thereby illuminates the still “abstract” dynamic capability framework.

With reference to Teece (2007) and Schreyögg and Kliech-Eberl (2007), we use sensing in the sense of scanning and analyzing a company’s external environment to glimpse potential opportunities or threats for building a basis for seizing those opportunities or managing emerging threats. A conceptual model has been set up on sensing and consists of sensing activities on the one side and sensing performance resulting in business performance on the other (see Figure 1).

## **Environmental Sourcing and Sensing Performance**

In our study, environmental sourcing is defined as the tapping of internal and external information sources for gathering relevant information about the business environment or environmental changes. Kohli, Jaworski, and Kumar (1993) already mentioned most of these sources (customer, end user, competition, networks, media and internal research) in their MARKOR scale. Matsuno et al. (2000) further added macro-economic elements and suppliers as relevant sources. Both Kohli et al. (1993) and Matsuno et al. (2000) concluded positive causal relationships between these sources and the market orientation of a company and, as mentioned earlier (theoretical background), we could derive a sensing performance effect based on a market orientation effect (Barney, 1995; Ginsberg & Venkatraman, 1995; Teece, 2007) The literature on dynamic capabilities further brought institutions and complementors into play to capture a more complete set of the facets of environmental sourcing, as explicated by theory (Teece, 2007).

*Value chain partners and sensing performance.* Kohli et al. (1993) and Matsuno et al. (2000) already found that customer exchange, end user exchange, and supplier exchange lead to a higher market orientation. Based on this generated knowledge and the improved understanding of such value chain partners, new business opportunities or business risks such as new customer preferences could be identified, which indicates a higher sensing performance (Harmancioglu, Grinstein, & Goldman, 2010; Hurmelinna-Laukkanen, 2012). We therefore expect that:

*Hypothesis H1a. Customer exchange is positively associated with a company's sensing performance.*

*Hypothesis H1b. End user exchange is positively associated with a company's sensing performance.*

*Hypothesis H1c. Supplier exchange is positively associated with a company's sensing performance.*

***Complementors and sensing performance.*** According to Teece (2007), considerably less attention has been paid to another relevant market participant for exchange: the provider of complementary goods. Since many companies are exposed to these dependencies, a regular exchange with these “partners” might be useful. Simple changes in complementary goods could instantly make related products redundant unless product adaptations are made. Furthermore, a complementary goods provider might deliver information about changes in the market. This information might help companies to better identify new developments in their business environment, which indicates a higher sensing performance (Teece, 2007). Hence:

*Hypothesis H1d. Complementor exchange is positively associated with a company’s sensing performance.*

***Competitors and sensing performance.*** Though the assessment of customer needs plays a central role in scanning the environment (Kohli & Jaworski, 1990), companies that are focusing too strongly on these needs might disregard competitors’ actions and their effect on customer preferences (Day & Wensley, 1983). Porter also (1980) points out the importance of considering the competition for being able to anticipate competitors’ actions. Since Kohli and Jaworski (1990) as well as Matsuno et al. (2000) confirm in their research that there is a higher market orientation when competition is observed regularly, we assume that this competitor orientation also leads to a higher sensing capability.

Based on our literature review, we also found it relevant to include the effect of competition exchange in our model. Researchers’ views vary on whether there is a positive or negative relationship between competition exchange and sensing performance because cooperation with competition carries a certain conflict potential. On the one side, contact to the competition could enhance organization-wide know-how and thereby might help to identify opportunities and threats (Hurmelinna-Laukkanen, 2012; Jung-Erceg, Pandza, Armbruster, &

Dreher, 2007). On the other side, information about developments on the market such as emerging new customer segments or new regulations might lead to a competitive advantage and may result in competitors being reluctant to pass on this information. This in turn might lead to a protective behavior between competitors that questions the value of the exchanged information (Hurmelinna-Laukkanen, 2012). Since companies do not wish to disclose sensitive success-related information but would like to get that information from the competition, we assume that companies engaging in a strong competition exchange might fail in recognizing relevant market developments and therefore might decrease their sensing performance

Following the above mentioned arguments, we suggest:

*Hypothesis H1e. Competition focus is positively associated with a company's sensing performance.*

*Hypothesis H1f. Competitor exchange is negatively associated with a company's sensing performance.*

***External networking, impersonal sourcing and sensing performance.*** As Hitt, Ireland, Camp and Sexton (2001) observe, external network contacts could be particularly rich sources of information on the environment. The most common professional network platforms are business clubs and industry associations, which are covered by our variable “external network exchange.” Networks create ongoing social contact and dialog, which could provide the latest information on market developments (Hitt et al., 2001) and therefore increase an organization's sensing performance.

Impersonal sourcing including media, such as newspapers, trade publications and magazines, seems to be an obvious external information source used by many companies. Hills and Shrader (1998), however, found that successful entrepreneurs focus primarily on personal contacts and not on classical media usage because personal sources provide richer information

than written sources (Daft & Lengel, 1986; Holland, Stead & Leibrock, 1976). Based on this, one could derive that media sourcing does not deliver much valuable information concerning opportunities or threats in the business environment and might therefore even deteriorate a company's sensing performance.

In line with the above mentioned reasons, we might conclude:

*Hypothesis H1g. External networking is positively associated with a company's sensing performance.*

*Hypothesis H1h. Impersonal sourcing is negatively associated with a company's sensing performance.*

***Institutions and sensing performance.*** Clusters such as the Silicon Valley Cluster illustrate how effective collaboration between research institutions and the surrounding companies works. These days, not only the IT companies but also other industries such as the automobile industry have discovered the value of institutional relationships. The great majority of institutional cooperations are made with universities. These relationships represent a knowledge source for small and large companies (Lorenzoni & Lipparini, 1999; Jung-Erceg et al., 2007). In contrast to competitors or suppliers, universities tend to share their knowledge because of the scientific ethos of their experts. Since there is no need to feel skeptical about a potential important information loss because of competitive advantages, companies and universities make more of an effort to participate actively in such partnerships (Fey & Birkinshaw, 2005; Möller & Rajala, 2007). The above-mentioned reasons demonstrate that the exchange with research institutions could bring competitive edge due to a noticeable lead in knowledge. Ellonen, Wikström and Jantunen (2009) note in their qualitative study that companies that work closely with universities possess a good sensing performance.

According to Teece (2007), supporting institutional structures have a major impact on the market since they may support innovation and thereby influence the competition. Further the knowledge and assets of supporting institutions could be integrated into new value-added combinations and thereby can shape the market (Teece, 2007). Therefore, supporting institutions might play a relevant role in market analysis and in discovering opportunities or threats.

Based on these arguments, we assume:

*Hypothesis H1i. Research institution exchange is positively associated with a company's sensing performance.*

*Hypothesis H1j. Supporting institution exchange is positively associated with a company's sensing performance.*

***Internal sourcing and sensing performance.*** People within the company could be valuable information sources in the business environment. Particular individuals who are in direct contact to external constituents, such as purchasing managers, public relations directors or customer service employees, may be relevant for this purpose (Rosenkopf & Nerkar, 2001). Matsuno et al. (2000) also attach great importance to internal sources for keeping track on external developments, which might also drive a company's sensing performance. Hence:

*Hypothesis H1k. Internal sourcing is positively associated with a company's sensing performance.*

### **Environmental Gathering & Analysis Mode and Sensing Performance**

Environmental information needs to be gathered and then analyzed to sense specific changes in the environment (Teece, 2007; Thomas, Clark, & Gioia, 1993). Information gathering is defined as “the process through which an organization obtains information from internal and external sources” and information interpretation is “the process through which organizations

make sense of new information that they have acquired...” (Flores, Zheng, Rau, & Thomas, 2012: 643).

***The intensity and systematics of gathering and analysis and sensing performance.*** In gathering and interpreting upcoming external events or developments, individuals within a company don't have much leeway when analyzing the information. According to Daft and Weick (1984), these activities are aggregated in an organizational method of gathering and analyzing environmental information because an organization's culture, structure, and processes don't leave much room for individual actions (Daft & Weick, 1984). By acknowledging the relevance of gathering and analyzing environmental information, companies need to raise the question of how to gather and analyze. Diverse authors differentiate these activities with the success factors intensity (Aguilar, 1967; Anderson & Nichols, 2007; Daft, Sormunen, & Parks, 1988; Farh, Hoffman, & Hegarty, 1984), systematics (Aguilar, 1967; Fahey & King, 1977), and pragmatics (Aguilar, 1967; Flores et al., 2012). As a result, these factors might also increase the sensing performance of firms:

*Hypothesis H2a. The intensity of gathering and analyzing environmental information is positively associated with a company's sensing performance.*

*Hypothesis H2b. The systematic method of gathering and analyzing environmental information is positively associated with a company's sensing performance.*

*Hypothesis H2c. The pragmatic method of gathering and analyzing environmental information is positively associated with a company's sensing performance.*

***Macroeconomic attention and sensing performance.*** Matsuno et al. (2000) claim that the MARKOR scale from Kohli et al. (1993) needs to be expanded with macroeconomic elements such as social and cultural trends or new regulatories because such factors are relevant drivers in the market and provide a more holistic picture of the environment. Therefore, Matsuno et al.

(2000) included these elements in their market orientation framework and deliver thereby a better information base for the recognition of opportunities and threats, which indicates a higher sensing performance. Based on this, we have to assume:

*Hypothesis H2d. Macroeconomic attention is positively associated with a company's sensing performance.*

### **Sensing Performance and Business Performance**

Although Teece (2007) notes that some companies discover opportunities but still fail in their implementation and, consequently, in their performance, the majority of the studies point out that sensing in its various facets has an impact on the performance of the firm (e.g., Daft et al., 1988; Tseng & Lee, 2014; Yang & Liu, 2012). According to these studies, successful companies generate a better understanding of their environment by sensing and are therefore better able to adapt to market changes. By investigating the dynamic capabilities, Tseng and Lee (2014) found that there is a specific link between sensing and organizational performance. According to him and other authors, a company that exhibits a high sensing performance is better able to detect the dynamics in the market, which builds the fundament for any management decision and therefore leads to an effective and efficient responsiveness concerning environmental changes. This in turn results in a good business performance (Tseng & Lee, 2014; Yang & Liu, 2012). Building on this, our hypothesis is:

*Hypothesis H3. Sensing performance is positively associated with a company's business performance.*

### **Environmental Dynamism and Sensing Performance**

High levels of environmental dynamism are accompanied by a strong erosion of competitive advantages and thereby might reduce the relevance of existing operational processes (Winter, 2003). For these reasons, dynamic capabilities might have more significance for

organizations in high dynamic markets, where operational processes need to be adjusted more frequently (Barreto, 2010). Moreover, in low dynamic environments, dynamic capabilities might even lead to inappropriate changes (Teece et al., 1997). Thus, it can be assumed that the higher the environmental dynamism, the stronger the effect of dynamic capabilities. Transferring this to our study, the sensing concept implies that the sensing activities in high dynamic environments have a higher impact on the sensing performance and consequently the business performance than they have in environments with a low dynamism:

*Hypothesis H4a. The higher the level of environmental dynamism, the stronger the impact of sensing activities on sensing performance.*

*Hypothesis H4b. The higher the level of environmental dynamism, the stronger the effect of sensing performance on business performance.*

## **METHODS**

### **Sample Selection and Description**

For our study, we addressed members of the executive board and top management from exporting German companies. Our respondents needed to have the ability to assess sensing activities, environmental dynamics, the firm's sensing, and business performance. Even if top-level managers are not directly executing all sensing activities, they are still in the position of being involved and well informed about such actions since related changes have an impact on company performance. As a result, the data is generated by an informed single source. The persons contacted represent the respective company (Day & Lord, 1988). Research assumes that persons from the top management serve as key informants on this topic. Thereby, we follow the design of earlier studies where companies' top managers served as main informants (e.g., Danneels, 2008).

The sample frame used was the DAFNE company database. In a first step, the sample was narrowed down based on the company size (> 100 employees). Smaller companies have less formal organizational structures, which makes a valid and clear assessment of organization-wide sensing practices quite difficult for the respondents (Foss et al., 2013). Furthermore, we selected only manufacturing industries for our sample, resulting in a final sample of 5,225 companies.

### **Survey Development and Measures**

We developed our questionnaire based on the procedures recommended by Churchill (1979) and Gerbing and Anderson (1988). Through a combination of exploratory qualitative interviews, a review of the sensing literature, and a survey pretest, the examination (method) evolved.

We used existing measures, as far as possible, for the development of the items and scales. Since only a few empirical studies have been conducted directly on the sensing topic as part of the dynamic capabilities framework, we integrated existing items from related research contexts and adapted them to the sensing concept. For details of the measurement items, see Appendix A. All relationships in our model were measured by subjective assessments of the respondents based on a six-point Likert-type scale.

The qualitative interviews were conducted with 10 corporate executives from 10 different German companies operating in different industries and representing different company sizes. Eisenhardt (1989) supports this selection of interviewed companies with contrasting characteristics in order to be able to identify potential differences regarding investigated aspects. The main aim of these interviews was to match the literature-based model with the practical view as well as different industry and company perspectives. The execution of the interviews was derived from typical case study approaches (Yin, 2014), which is supported by many researchers for examining or exploring theory (e.g., Eisenhardt, 1989).

In our case, we do not wish to create case studies; however, we want to use these methods as a professional analysis tool for the verification of our theory. The outcoming results helped us to make the main survey more focused and more practical. By employing this approach, literature-based concepts, constructs, or items, which have been examined under different conditions to those of our investigation (e.g., other regions/countries, specific industries), can thereby be correctly transferred to our study's context. Afterwards, this adapted structured questionnaire was pretested by diverse research experts from the academic field and top managers who were representative for our sample. The experts' remarks have been aligned with the theory and past research outcomes, resulting in a suitable questionnaire.

For our study, the top executives were invited personally per email to answer the questions online. The promised incentive for the participation was a summary of the results. In total, 346 usable questionnaires were returned. In comparing the original sample with the return rate, no relevant non-response bias or incentive effect could be assessed. Additionally, by guaranteeing absolute anonymity, socially desirable response patterns could be prevented.

***Sensing activities measures.*** To examine a company's sensing capability, we focus on the impact of different sensing activities, which were subdivided into "environmental sourcing" and "environmental gathering and analysis mode," on the actual sensing performance of a company. To capture the sourcing activities, we used items from the MO and MARKOR scale (Kohli et al., 1993; Matsuno et al., 2000). For the "environmental gathering and analysis mode," items have been derived from Aguilar's (1967) and Daft and Weick's (1987) concept of environmental scanning. In order to fit the literature's understanding and perspective of sensing, these items were reformulated and adapted (Barreto, 2010; Teece, 2007, 2012). In addition to these empirically proven items, we included further relevant items in the concept of sensing, derived

from suggestions found in research on dynamic capabilities (Ambrosini & Bowman, 2009; Barreto, 2010; Teece, 2007, 2012)

In this survey, the dimension “environmental sourcing” is measured with thirteen items. The first questions, derived from the MARKOR and MO scale, relate to the exchange with the typical known market players (customer, end user, supplier, and competitor). The aspects external network exchange, internal sourcing, and impersonal sourcing have also been derived from Matsuno et al.’s (2000) framework (Questions 8-10). The dynamic capabilities literature and, above all, Teece (2007) suggest also focusing on complementor and institutions as environmental information sources for gaining sustainable competitive advantage over time (Questions 4, 11, 12). The remaining questions on the sensing activities focus on the environmental gathering and analysis mode, which we derived primarily from Aguilar (1967) and Daft and Weick (1987), Kirzner (1973) and Flores et al. (2012). For the scale, we decided to use a six-point Likert-type scale to have respondents commit to one side of the scale in order to get actionable results.

***Business performance measures.*** Following Anand and Ward (2004) and Richard, Devinney, Yip, and Johnson (2009), we used the organization’s outcomes for business performance: market share, sales growth, and profit. We decided to examine the performance development within the last three years as this represents the success of a company better than current year figures. It also allows us to better compare small and large companies with each other. Each aspect of the firm’s business performance was measured as a single-item. Since absolute confidentiality was guaranteed in our survey, we believe that the respondents would give correct answers about their companies’ business situation.

***Environmental dynamism measures.*** Our environmental dynamism construct is measured based on items from Talke and O’Connor’s (2011) and Baum and Wally (2003), who

expanded Kohli and Jaworski's (1990) market dynamism scale with the technology dynamism in order to give a more comprehensive picture of the business environment.

***Control variables.*** We included the controls firm size and risk taking to ensure that no distortion effects guide the examined relationships. The control variable firm size might have an influence particularly on the sensing performance, since larger organizations might be tendentially more successful in sensing opportunities or risks because of higher slack resources and more specialists such as risk management officers. Company size was further controlled in terms of the business performance because numerous studies state that size can have an impact on an organization's practices because it often stands for organization complexity (e.g. Smith, Collins, & Clark, 2005).

Risk taking was measured as a result of several studies showing that there might be an impact on sensing relations, since companies with a greater readiness to take risks might be able to sense opportunities more easily (Jambulingam, Kathuria & Doucette, 2005).

### **Validity and Reliability Measures**

By performing a principal-axis factor analysis for all exogenous and endogenous variables, we tested the convergent validity of the multi-item constructs. For all items, the standardized factor loadings exceed the recommended minimum value of 0.4 (Ford, MacCallum, & Tait, 1986). In a next step, we conducted a confirmatory factor analysis to finally confirm the validity of our model relations (Jöreskog & Sörbom, 1993).

Cronbach's alpha for all tested constructs is equal or above the recommended minimum level of 0.7 (Nunally & Bernstein, 1994). We further tested the average variances extracted, which should lie above 0.5 (Fornell & Larcker, 1981) or at least above 0.45 (Netemeyer, Bearden, & Sharma, 2003). These criteria could also be confirmed in our model. We compared the average variance extracted with the squared correlation between the constructs to test for

discriminant validity of the multi-item constructs. The average variance extracted for all tested constructs is higher than the squared correlation, except for the constructs “gathering and analysis intensity” and “systematic approach” (Fornell & Larcker, 1981). A Chi-square difference test on the constructs “gathering and analysis intensity” and “systematic approach,” however, resulted in a Chi-square difference value of 38.30, which lies above the required 3.84 (Greenwood & Nikolin, 1996), meaning that both constructs measure different aspects. In total, we can state that reliability and validity of the constructs exist.

By employing a t-test to examine significant differences in the response behavior between early and late respondents, we examined whether a potential non-response bias would exist. The reasons behind this are that the answers given by late respondents tend to be closer to those of non-respondents (Armstrong & Overton, 1977; Jansen, Simsek, & Cao, 2012). T-test results don't show any significant differences between these groups, indicating that non-response bias does not play a role in this study.

### **Data Analysis**

We examined our hypotheses by employing a structural equation modeling with maximum likelihood estimation. First, we analyzed Hypotheses Block 1 (environmental sourcing), Hypotheses Block 2 (environmental gathering & analysis mode), Hypothesis 3 and their subhypotheses using the structural equation modeling (Model I). Then, we verified the Hypotheses 4a and 4b, which focus on the environmental dynamic impact on the sensing relationships using a multi-group causal analysis. To test this moderation effect, we divided our data base with a median split (Arbuckle, 2003; Arbuckle & Wothke, 1999) into a low environmental dynamic and a high environmental dynamic section (Model II). The comparison of structural effects across the environmental dynamic groups requires that an investigation of the measurement invariance across the single group models be conducted.

## RESULTS

By using the following recommended indices, we assessed the fit of data to the hypotheses from Model I and Model II. First, the  $\chi^2$  probability should be above the recommended minimum level of 0.05 (Bagozzi, 1980). Second, the comparative fit index (CFI) should be above or near 0.90 (Barrett, 2007). Third, the cut-off point for the standardized root mean square residual (SRMR) is below 0.08 (Hu & Bentler, 1999). And finally, the root mean square error of approximation (RMSEA) has to be less than 0.08 (Browne & Cudeck, 1993). We did not use the goodness-of-fit index (GFI) and the adjusted goodness-of-fit index (AGFI) because current simulation studies question the usefulness of these criteria (Sharma, Mukherjee, Kumar, & Dillon, 2005). As presented in Table 1, the above-mentioned model-fit-criteria are all met, which means that both analyzed models (see Figures 2, 3a and 3b) are acceptable.

The assessment of the measurement invariance to identify the aspects of inequality for the two environmental dynamic groups held positive results including the differences of the global fit statistics between the restricted and the baseline model/unconstrained model, which have to be smaller than 0.01 (De Jong, Steenkamp, & Fox, 2007). Thus, no limits exist on comparing effects between constructs across the two groups. Further, the  $\chi^2$ -values significantly increase by imposing equality restrictions on structural weights on top of the restrictions according to configural and metric invariance (Bensaou, Coyne, & Venkatraman, 1999). Using a chi-squared difference test, we further confirmed the comparability of the results for high versus low levels of environmental dynamism (Model II). Obviously, environmental dynamics moderates the effects between some of the constructs of the model.

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Insert Table 1 about here  
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In Figure 2 below, the results for the overall sample are reported (Model I), while in Figures 3a and 3b the results for the moderating effect of environmental dynamism on the sensing relationships (Model II) are presented.

As shown in Figure 2, environmental sourcing (H1) has a highly significant effect on the sensing performance. In particular, the exchange with value chain partners (H1a, H1b, H1c) positively drives the sensing performance. While the complementor exchange (H1d), the institutional exchanges (H1i, H1j), the external networking (H1g), and the internal sourcing (H1k) have no significant impact on the sensing performance, competition exchange (H1e), competitor focus (H1f), and impersonal sourcing (H1h) show significant path coefficients to the sensing performance. Although the Hypotheses H1a, H1b and H1c can be confirmed by the data analysis, we expected these relationships to be even stronger.

As hypothesized on the environmental gathering and analysis mode (H2), a high significant strong negative gathering and analysis intensity (H2a) and a strong positive systematic approach (H2b) can be assessed as a predictor for sensing performance.

The sensing performance can further be confirmed as a predictor for business performance (H3).

As many research studies concluded, environmental dynamism has an influence on the sensing relationships (H4a, H4b). A comparison of Figure 3a with Figure 3b shows that in low dynamic environments, the exchange with all value chain partners, including end users and suppliers, plays a significant role in achieving sensing performance while in highly dynamic environments, the sensing performance is primarily predicted by an exchange with the value chain partner customer. Further, in both environments, competition exchange is negatively-related to sensing performance. For the institutional exchange predictors, we found that in a high dynamic environment, research institution exchange is positively related and supporting

institution exchange is negatively related to sensing performance. The environmental moderating effect makes clear that only in high dynamic environments the gathering and analysis intensity, the systematic approach, and the macroeconomic attention are significantly related to sensing performance. Interestingly, the pragmatic approach has the opposite effect on the sensing performance under different environmental dynamics.

The parameter estimates for the control variables show that there is no significant effect of risk taking on the model's relationships; however, the firm size has a significant impact on the model.

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Insert Figures 2, 3a and 3b about here  
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## **DISCUSSION, CONCLUSION, AND LIMITATIONS**

The overall contributions of our study are

(1) it delivers a concrete empirical model for one dimension (sensing) of the dynamic capabilities frame, thereby responding to numerous calls for future research that suggested this abstract concept be broken down into concrete and manageable aspects. To achieve this, we developed measures and constructs to investigate the sensing concept

(2) the integration of different theoretical concepts and research results (strategic management, marketing, entrepreneurship, organizational science) under the heading of sensing and

(3) a large sample support in testing the sensing concept and thereby again responding to numerous requests for future research, emphasizing that more empirical studies should be conducted to better understand dynamic capabilities.

### **Sensing Performance and Business Performance**

In terms of our specific results, we found that sensing performance has a strong positive relationship with business performance. This finding supports our argument that the ability to perceive threats and opportunities is a key ingredient for the good financial performance of companies.

### **Sensing Activities and Sensing Performance**

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Insert Table 2 about here  
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Table 2 highlights the effects of the sensing activities on the sensing performance. This is potentially important because prior research did not focus on sensing activities in conjunction with sensing success. Our results suggest that the exchange with the main value chain partners drives the sensing performance of a company. Our results are also in line with those researchers arguing that competition exchange leads to a worse sensing performance. Looking at the impersonal sourcing dimension, our results show another negative relation with the sensing performance, suggesting that Hills and Shrader's (1998) media usage effect on opportunity identification could be expanded to an effect on the whole sensing performance including threats identification.

By comparing environmental sourcing in the two dynamic contexts, several differences emerge. We can assess a missing end user and supplier exchange effect along with a stronger customer exchange effect on the sensing performance in the high dynamic environment. That is, the only value chain partner who plays a significant role in highly dynamic environments is the customer. Consequently, only in low dynamic environments are end users and suppliers able to deliver new business relevant market information and thereby increase a company's sensing performance. Most interesting is the fact that sensing performance is predicted by institutional exchange only in low dynamic environments. Hereby the positive effect from research

institutions' exchanges on sensing performance is evident. In contrast, the explanation of the "supporting institution exchange" impact is not obvious and was not anticipated by us. The results show us only a negative effect of supporting institutional exchange on sensing performance in a highly dynamic environment.

As hypothesized, it is evident that the "*environmental gathering and analysis mode*" has an impact on the sensing performance. However, the fact that its significance is so much stronger compared to different environmental sourcing aspects is quite surprising. Therefore, it can be concluded that not the source but the sensing mode is mainly responsible for the sensing performance of a company.

Surprisingly, and contrary to our hypothesis, we found that companies are less able to sense opportunities and threats using an effortful environmental scanning and interpreting approach. One potential explanation for this unexpected result could be that there is still a difference between trying to identify opportunities and threats and the actual identification of opportunities and threats. Thus, when companies are overcommitted to external information search and analysis, they still may not be able to perceive opportunities and threats. Perhaps the most important insight here is that it is more about making conclusions from the market screening and analysis than about spending time reviewing market data. Our results show that this effect only becomes visible in a high dynamic environment.

In line with our findings on the systematic gathering and analysis approach, companies should focus on a method of systematically scanning the environment in order to stay adaptable over time. Those companies that just accidentally scan the environment or undertake adhoc analyses of environmental events will sooner or later fail. This includes not only a systematic gathering of data from the environment but also a systematic analysis of this data, which is necessary to reach business-relevant conclusions. Nowadays, many companies have a market

intelligence department, which only comes into force at the request of top management. This inhibits a constant monitoring of the environment. Even if companies practice a systematic gathering of market information, they might still fail in interpreting that information on a continuous basis to assess a new opportunity or threat.

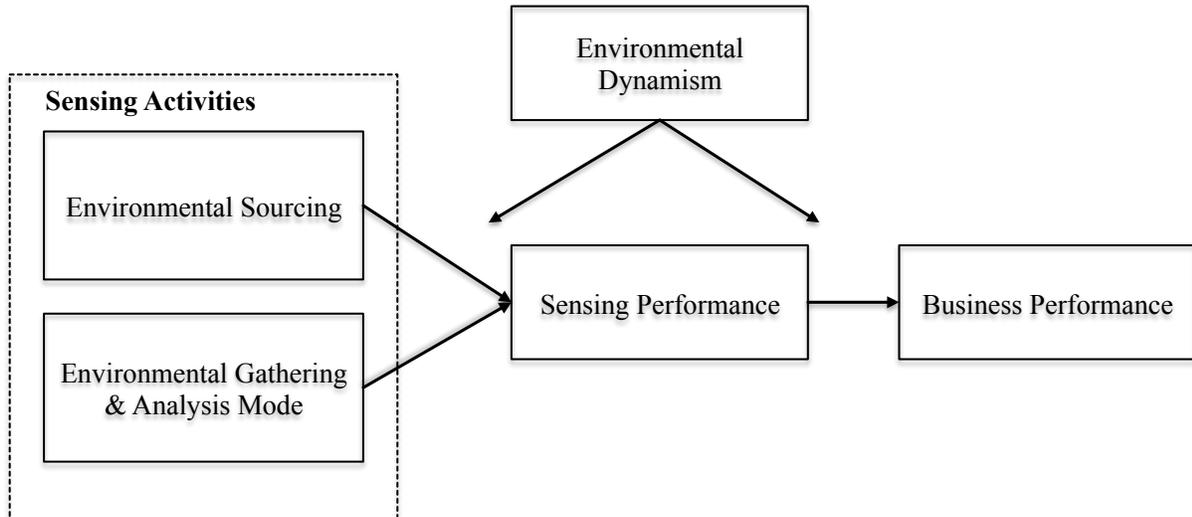
Interestingly, we found no empirical effects for macro economic attention in the overall sample. Only under high environmental dynamics does macro economic attention play a relevant role. Since highly dynamic environments often arise from changes in the macroeconomic environment, macro economic attention seems to be an important success factor there.

While this study provides a lot of new insights, it carries, like all research, some limitations. If one were to study the sensing concept among different nations, in non-manufacturing industries or in companies with less than 100 employees, we might find variations in the relationship between the different sensing activities and sensing performance. This study derived its conclusions for environmental effects on the model from a dichotomous distinction of environmental dynamism. Future studies might want to take a more differentiated approach by analyzing different intensities of environmental dynamism on the sensing relationships. Despite these limitations, we could show and prove what sensing is about and made, thereby, a significant contribution to making dynamic capabilities more tangible.

# FIGURES

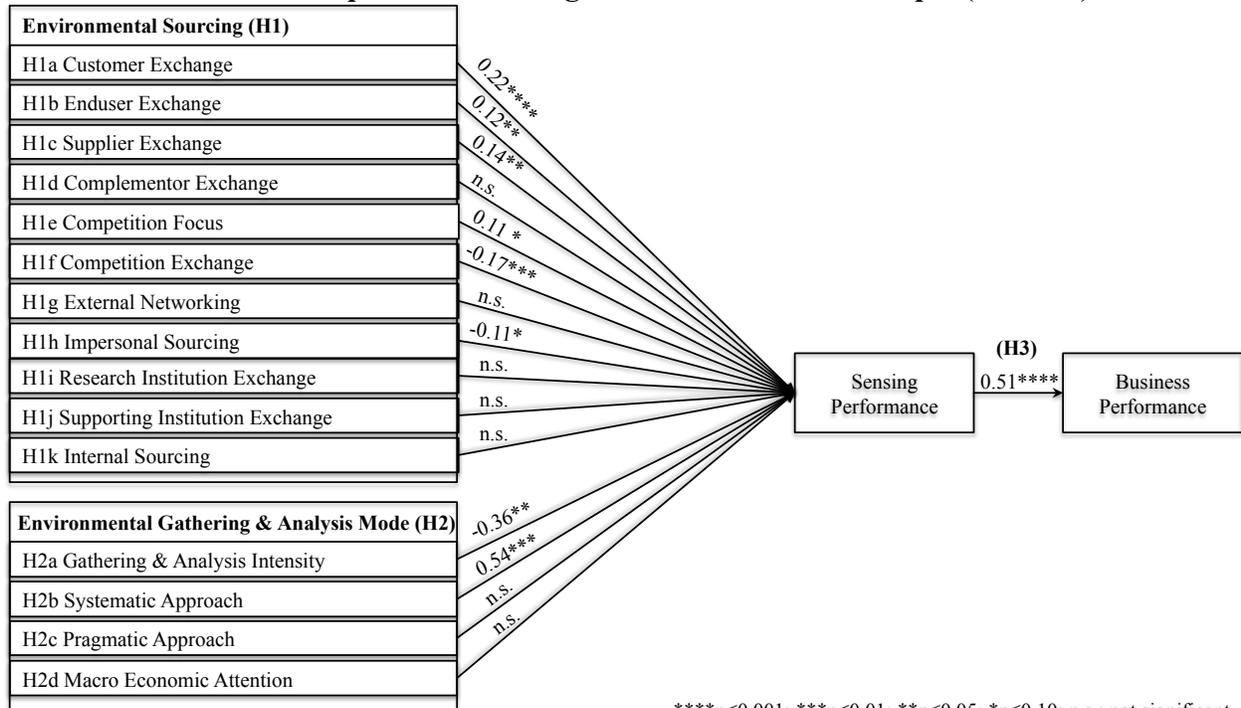
## FIGURE 1

### Concept of the Study



## FIGURE 2

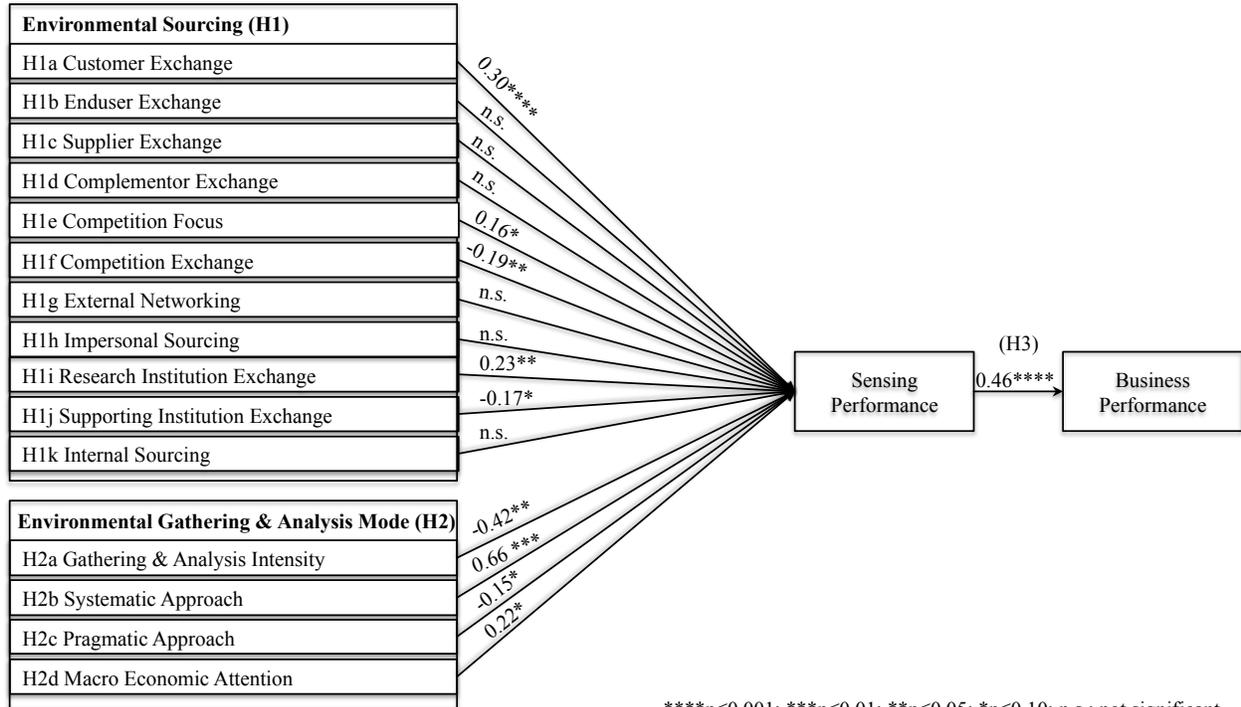
### Structural Equation Modeling Results for Overall Sample (Model I)



\*\*\*p<0.001; \*\*p<0.01; \*p<0.05; \*p<0.10; n.s.: not significant

**FIGURE 3a**

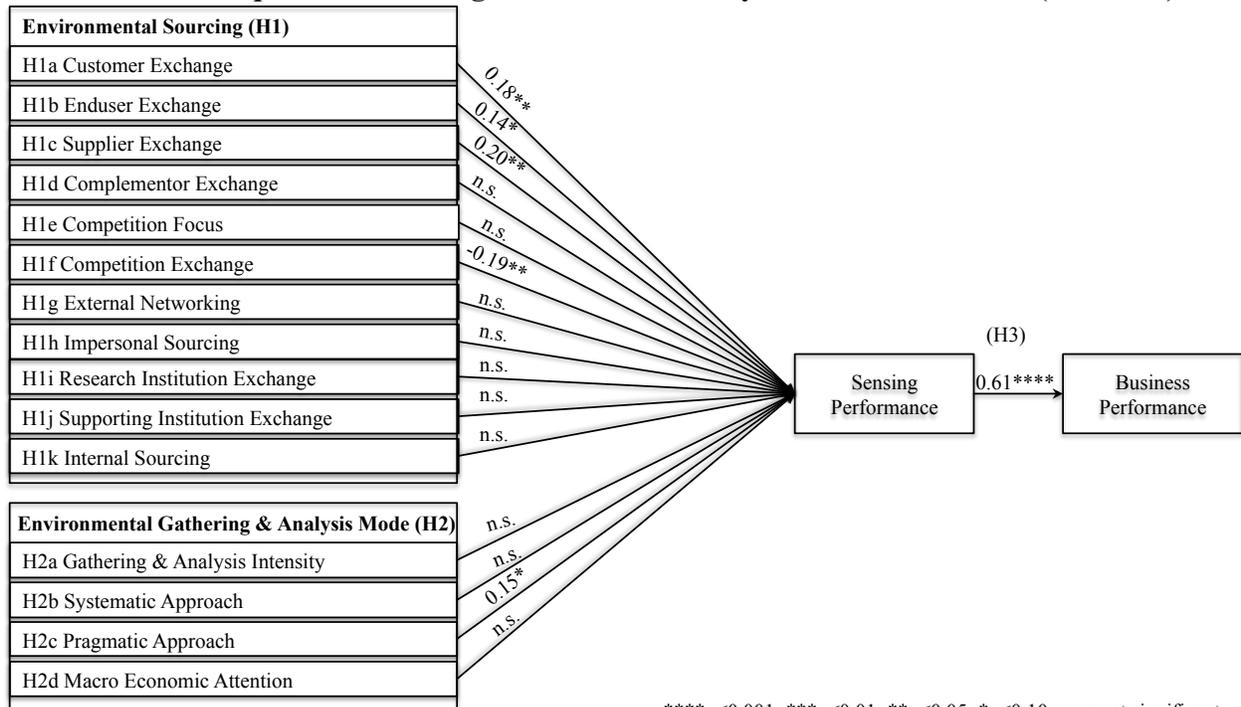
**Structural Equation Modeling Results for High Dynamic Environment (Model II)**



\*\*\*\*p<0.001; \*\*\*p<0.01; \*\*p<0.05; \*p<0.10; n.s.: not significant

**FIGURE 3b**

**Structural Equation Modeling Results for Low Dynamic Environment (Model II)**



\*\*\*\*p<0.001; \*\*\*p<0.01; \*\*p<0.05; \*p<0.10; n.s.: not significant

## TABLES

### TABLE 1

<b>Model Statistics</b>						
<b>Model</b>	<b>CFI</b>	<b>SRMR</b>	<b>RMSEA</b>	<b>Chi<sup>2</sup></b>	<b>d.f.</b>	<b>Normed Chi<sup>2</sup></b>
Model I: Overall Sample	0.91	0.06	0.05	699	368	1.9
Model II: Subsamples	0.89	0.07	0.03	1.165	736	1.6

### TABLE 2

<b>Sensing Activities Effects on Sensing Performance</b>			
<b>Sensing Activities</b>	<b>Overall</b>	<b>High Dynamism</b>	<b>Low Dynamism</b>
Customer Exchange	+	+	+
Enduser Exchange	+	n.s.	-
Supplier Exchange	+	n.s.	+
Competition Focus	+	+	n.s.
Competition Exchange	-	-	-
Impersonal Sourcing	-	n.s.	n.s.
Research Institution Exchange	n.s.	+	n.s.
Supporting Institution Exchange	n.s.	-	n.s.
Gathering and Analysis Intensity	-	-	n.s.
Systematic Approach	+	+	n.s.
Pragmatic Approach	n.s.	-	+
Macroeconomic Attention	n.s.	+	n.s.

„+“ significant positive effect; „-“ significant negative effect; „n.s.“ not significant  
 All effects are significant at  $p \leq 0.10$

## APPENDIX A

### Variables and Sources

<b>ENVIRONMENTAL SOURCING</b>
<p><b><i>Customer Exchange</i></b>                      How often, compared to your competitors, does your company meet direct customers to figure out what products or services could be of value to them in the future? (Matsuno et al., 2000)</p>
<p><b><i>Enduser Exchange</i></b>                      How often, compared to your competitors, does your company meet end user sto figure out what products or services could be of value to them in the future? (Matsuno et al., 2000)</p>
<p><b><i>Supplier Exchange</i></b>                      In our company, we exchange with suppliers very often about market developments and their plans and activities (Matsuno et al., 2000)</p>
<p><b><i>Complementor Exchange</i></b>                      In our company, we exchange with providers of complementary goods very often about market developments and their plans and activities (Matsuno et al., 2000)</p>

<p><b>Competition Focus</b>  We constantly benchmark ourselves against our competitors.  We have extensive information about our competition.  (Flores et al., 2012; Matsuno et al., 2000; Teece, 2007)</p>
<p><b>Competition Exchange</b>  In our company, we exchange with competitors very often about market developments and their plans and activities (Matsuno et al., 2000; Teece, 2007)</p>
<p><b>External Networking</b>  To what extent do employees of your company actively participate in business networks?  How strongly is your company engaged in associations?  (Matsuno et al., 2000; Teece, 2007)</p>
<p><b>Impersonal Sourcing</b>  To what extent does your company use media for being better able to estimate market developments?  (Baron, 2006)</p>
<p><b>Research Institution Exchange</b>  In our company, we exchange information with universities or other research institutions very often about market developments and their plans and activities (Teece, 2007)</p>
<p><b>Supporting Institution Exchange</b>  In our company, we exchange information with supporting insitutions very often about market developments and their plans and activities (Teece, 2007)</p>
<p><b>Internal Sourcing</b>  We operate very intensively in internal market research (Matsuno et al., 2000)</p>
<p><b>ENVIRONMENTAL GATHERING &amp; ANALYSIS MODE</b></p>
<p><b>Gathering and Analysis Intensity</b>  We take a lot of time for gathering and analyzing market information  If something is not clear, we analyze it again.  Before we make a decision in our company due to market changes, we need to conduct extensive research and analysis  (Kirzner, 1973; Teece, 2007)</p>
<p><b>Systematic Approach</b>  To what extent does your company undertake a concentrated search for changes in the market environment  In our company, market information is gathered and analyzed according to a clear structured approach  The gathering and analysis of market information happens continuously  In our company, new relevant information always leads to a reconsideration of our own decisions  (Aguilar, 1967; Flores et al., 2012)</p>
<p><b>Pragmatic Approach</b>  I would describe our analysis methods as being very pragmatic  (Aguilar, 1967; Flores et al., 2012)</p>
<p><b>Macro Economic Attention</b>  In our company, we have regular meetings to discuss general macro-economic information (e.g., interest rates, exchange rates, GDP, industry growth rates, inflation rates) and their effect on our company  In our company, we have regular meetings to discuss the regulatory framework and its effect on our company  In our company, we have regular meetings to discuss political developments (e.g., intergovernmental initiatives, governmental fiscal planning) and their effect on our company  In our company, we have regular meetings to discuss general social trends (e.g., environmenal consciousness, emerging lifestyles) and their effect on our company  In our company, we have regular meetings to discuss demographical trends (e.g., ageing society) and their effect on our company  (Matsuno et al. 2000)</p>
<p><b>ENDOGENOUS VARIABLES</b></p>
<p><b>Sensing Performance</b>  As soon as an opportunity for our company arose from market changes, we were always the first in the last three years to recognize this opportunity.  As soon as a threat to our company arose from market changes, we were always the first in the last three years to recognize this threat.</p>

In comparison to our competition, we recognized far less opportunities in the last three years (R) (Kohli et al. 1990, Matsuno et al. 2000, Teece 2007)
<b>Business Performance</b> How would you evaluate the development of your company in comparison to your main competitors in terms of sales revenue growth? How would you evaluate the development of your company in comparison to your main competitors in terms of market share? How would you evaluate the development of your company in comparison to your main competitors in terms of profitability? (Anand & Ward, 2004; Richard et al. 2009)
<b>MODERATING VARIABLE</b>
<b>Environmental Dynamism</b> Our company needs to change its products or services frequently to be able to keep pace with the competition Products or services quickly become obsolete in our market Technology changes faster in our market than in other markets Customer needs differ strongly between the different customer segments in our market (Baum & Wally, 2003; Miller & Friesen, 1983; Talke & O'Connor, 2011)
<b>CONTROL VARIABLES</b>
<b>Firm Size</b> What is the number of persons currently employed at your company? (Smith, Collins & Clark, 2005; Weber & Kabst, 2004)
<b>Risk Taking</b> In our company, we have an overproportional tendency to take risks (Jambulingam, Kathuria, & Doucette, 2005)

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