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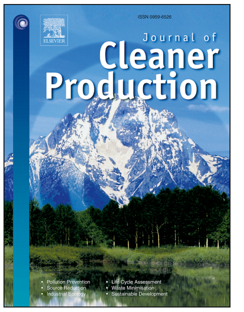


Linking energy-related strategic flexibility and energy efficiency – The mediating role of management control systems choice

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# LINKING ENERGY-RELATED STRATEGIC FLEXIBILITY AND ENERGY EFFICIENCY – THE MEDIATING ROLE OF MANAGEMENT CONTROL SYSTEMS CHOICE


**ABSTRACT**

For many industrial companies a rising tension between efficiency considerations on the one hand and the promotion of strategic flexibility on the other is visible within the last years. Various studies in different contexts have confirmed that management control can mitigate the tradeoff between efficiency and flexibility to a considerable extent, but no research in this regard was conducted in the field of energy management so far. Based on data of 236 German manufacturing companies this paper empirically examines the impact of energy-related strategic flexibility of firms on the design of their management control system (MCS) and their corresponding energy efficiency. Using structural equation modeling, we examine primary data that captures the energy-related strategic flexibility as well as the design of management control elements and longitudinal secondary data that was used to calculate energy efficiency. The results indicate that the importance of formal as well as informal management controls increases in those firms with a high energy-related strategic flexibility. Furthermore, there is in general a positive relation between the use of formal management controls and energy efficiency, whereas the emphasis companies place on informal management controls does not result in a significant effect on energy efficiency. This study contributes to a general understanding of how organizations balance formal and informal controls in the simultaneous pursuit of efficiency and flexibility.



**KEYWORDS:** energy efficiency; formal and informal management controls; management control system; strategic flexibility; structural equation modeling


**WORD COUNT**: 8,071 words

# 1 INTRODUCTION

One of the most promising means of achieving cleaner production in the manufacturing industry is to reduce energy consumption and thus to enhance industrial energy efficiency (Schulze e*t al.*, 2016). Consequently. major energy-consuming countries have announced new additional measures for enhancing energy efficiency: While China is targeting a 16% reduction in energy intensity by 2015 (China State Council, 2011), the European Union has committed itself to the '20-20-20' targets for 2020. These targets aim on reducing the EU greenhouse gas emissions by 20%, establishing a share of 20% renewable energy sources in total energy supply and increasing energy efficiency by 20% (Council of the European Union, 2007). Likewise, Japan aims on significantly enhancing its energy efficiency in the industrial sector as well as on cutting 10% from electricity consumption by 2030 (Japanese Ministry of Economy, Trade and Industry, 2010). In all these different initiatives, the industry sector plays a significant role in achieving the energy related targets (Trianni *et al.,* 2013). Enhanced energy efficiency has also received economic relevance for the manufacturing companies themselves as it decreases both the energy consumption on the one hand (which also reduces total energy costs) as well as additional energy cost savings due to efficiency improvements related to the optimization within the energy procurement (Thollander, Danestig and Rohdin, 2007). Yet, among several barriers to achieve energy efficiency (Rohdin, Thollander, and Solding, 2007), a major challenge for a lot of organizations is to balance the promotion of strategic flexibility on the one hand, and enhancing efficiency on the other (Kortman *et al.*, 2014). Efficiency requires the exploitation of existing capabilities and is often best served by well-defined processes that specify how different activities should be carried out. Flexibility, in contrast, requires the exploration of new opportunities which can best be achieved if employees are allowed to deviate from routine activities (Eisenhardt *et al.,* 2010). Therefore, prior literature suggests that managers should aim at balancing strategic flexibility and operational efficiency to enable a sustainable competitive advantage (Perez-Valls *et al.*, 2015).

However, the linkage between operational efficiency and strategic flexibility is subject to various tensions that arise from contrary competitive priorities and conflicting targets within middle management (Kortmann *et al.,* 2014). Yet, strategic flexibility supports the reconfiguration of processes and the adaptive use of resources (Zhou and Wu, 2010), and thus provides organizations with the ability to swiftly react to dynamically altering environments (Shimizu and Hitt, 2004). However, companies that place high emphasis on strategic flexibility may overlook opportunities that are derived from operational excellence or economies of scale (Kortmann *et al.,* 2014). Hence, previous studies suggest that high levels of strategic flexibility may come at the costs of lower operational efficiency (Baker and Nelson, 2005) and decreased performance (Grewal and Tansuhaj, 2001).

Within the last years, a rising tension between efficiency and flexibility is visible within energy management of industrial companies. This corporate activity is commonly defined as the "proactive, organized and systematic coordination of procurement, conversion, distribution and use of energy within a company, aiming at continuously reducing energy consumption and related energy costs" (Association of German Engineers cited in Schulze. *et al.,* 2016, p.3694). On the one hand manufacturing companies are faced with governmental pressure to improve energy efficiency and increased market pressure as result of rising energy sourcing prices within the last years (Backlund *et al.*, 2012). On the other hand, they are also exposed to factors like resource dependency, e.g. the EU's external dependency on Russian natural gas which was recently visible during the Ukrainian crisis in 2014, or security of energy supplies which is a highly current issue due to rapid expansion of renewable energy and the closely related radical restructuring of the energy supply, especially in Germany. Those factors represent significant risks and limit the companies' strategic flexibility. Production companies in the context of energy management therefore are forced to cope with both factors, energy efficiency and strategic flexibility, simultaneously.

Various studies have confirmed that management control can mitigate the trade-off between efficiency and flexibility to a considerable extent (Jørgensen and Messner, 2009). A case study by Ahrens and Chapman (2004) in a British restaurant chain showed that the implementation of control systems can be used to ensure efficiency as well as flexibility and transparency of operations (Jørgensen and Messner, 2009). A filed study in the area of innovative information technology of Brown and Eisenhardt (1997) confirmed that successful innovation processes in flexible or organic organizations require a combination of intensive communication with more mechanistic or rather formal elements of the organizational structure, i.e. comprehensive project budgets. Brown and Eisenhardt (1997) came to the conclusion that mechanistic and organic companies as well as their control practices do not exist in their pure form. Jørgensen and Messner (2009) present an in-depth field study carried out in a manufacturing organization and analyse in detail control functions in the particular setting of new product development. They concluded that the combination of different control mechanisms helps the organization to balance efficiency and flexibility (Jørgensen and Messner, 2009). All these different studies describe conditions in which controls were employed to enhance efficiency and flexibility within an organization at the same time. The specific application of management controls might therefore be able to mitigate the beforehand described tension between efficiency and flexibility in the context of energy management of production companies. However, current findings on a mediating use of management control elements were derived from case studies in highly specific settings and in other contexts than energy management. Hence, empirical research on the effectiveness of management controls as mediator for the tension of energy-related strategic flexibility and energy efficiency is lacking at all. This makes the derivation of conclusions and implications for this context rather difficult

Consequently, this study strives to contribute to the sparse knowledge on how to design management control systems of production companies such that the tension between energy-related strategic flexibility and energy efficiency gets reduced. More specifically, using survey data of 236 German manufacturing companies this study empirically investigates the impact of energy-related strategic flexibility characteristics of firms on the design of their management control system as well as on their energy efficiency. Therefore, we use a structural equation modeling approach and combine primary data that captures the energy-related strategic flexibility characteristics as well as the design of formal and informal controls with secondary data that was used to calculate energy efficiency. The corresponding findings contribute to the current understanding of how formal and informal controls can be employed in organizations that aim at a simultaneous pursuit of energy-related strategic flexibility and energy efficiency. From a more general perspective, this study also adds to the line of research that investigates the role of contextual and strategic factors on a firm's MCS (Pondeville *et al.*, 2013).

The remainder of this paper is structured as follows. The next section introduces the basic concepts of strategic flexibility and formal as well as informal management controls, develops our research hypotheses and describes the research model. Subsequently, the data collection procedure and sample characteristics are described, before our analytical procedures and study results are discussed. Finally, theoretical and managerial implications as well as suggestions for policy makers are laid out and limitations as well as future research avenues are discussed.

# 2 THEORETICAL FRAMEWORK

## 2.1 ENERGY-RELATED STRATEGIC FLEXIBILITY

The term strategic flexibility has been widely used by researchers in various research fields to denote organizations' abilities to respond to demands from dynamic competitive environments. Hitt et al. (1998) emphasize that the most important attribute that firms need to survive in a competitive context is strategic flexibility. In their understanding strategic flexibility is the firm's ability to anticipate and adapt rapidly to its environment and thus to gain competitive advantage. Shimizu and Hitt (2004) define strategic flexibility as "the organization's capability to identify major changes in the external environment, quickly commit resources to new courses of action in response to those changes, and recognize and act promptly when it is time to halt or reverse existing resource commitments." Aaker and Mascarenhas (1984) consider strategic flexibility in the context of strategic options. This view focuses on dynamic capabilities that allow an organization to identify, create and maintain options, claiming that the organization has the capability for strategic flexibility only when it is able to build and implement an optimal set of strategic options (Sanchez, 1993).

Other researchers have analysed strategic flexibility from a different perspective. From the various conceptualizations of strategic flexibility, we focus on the resource-based perspective proposed by Sanchez (1995), in which strategic flexibility depends jointly (1) on the resource flexibility of the product creation resources available to a firm and (2) the coordination flexibility of the firm in using its available resources. In this regard also the ability of managers to recognize and conceptualize limitations and opportunities inherent in the organization's complex resources situation, and their capability to develop action alternatives for the company is important (Widati, 2012).

In the context of energy as a strategic resource, the strategic flexibility of a company is determined by various factors. These comprise the energy cost intensity of the production processes, the influenceability of production-related energy costs, the dependency on particular energy sources (e.g. electricity, oil or natural gas) as well as the economic and technical risk exposure due to price volatility and supply shortages (Posch, 2011). The more those factors are prevalent the lower is the ability of a company to adapt on energy-related environmental changes.

## 2.2 FORMAL AND INFORMAL MANAGEMENT CONTROLS

Management controls are specific mechanisms managers can apply within the process of strategy implementation to influence individual and/or collective action towards organizational objectives (Anthony and Govindarajan, 2007). Existing literature in this regard differentiates between formal and informal types of controls (Strauß and Zecher, 2013) and suggests that organizations achieve higher levels of effectiveness when the top management follows a combined use use of formal and informal management controls (Kleine and Weißenberger, 2014). Formal controls are deliberately articulated organizational mechanisms (Chenhall *et al.,* 2011) and can be subdivided into results and action controls. Results controls aim at measuring and comparing the performance of organizational members against pre-set desired targets in an objective manner (Merchant and Van der Stede, 2012). They aim at creating meritocracies in which the highest reward is given to the person (or business unit) with the highest performance (Strauß and Zecher, 2013). On the other hand, action controls involve taking steps to ensure that employees act in the organization's interest and make their actions themselves focus of control (Merchant and Van der Stede, 2012). They set structures and expectations by defining the necessary work steps with respect to routine tasks and include for example the use of formal policies and procedures manuals (Cardinal, 2001).

Informal controls on the other hand relate to organizational cultures influencing its members and are essentially based on mechanisms inducing self-regulation (Ouchi, 1979). They comprise personnel and cultural controls. Personnel controls build on employees' natural tendencies to control or motivate themselves and increase the likelihood that employees will engage in self-monitoring. They can be implemented through employee selection as well as placement, training and job design (Merchant and Van der Stede, 2012). Cultural controls in addition encompass the firm-specific set of beliefs, normative patterns and values that all organizational members should share (Flamholtz *et al.*, 1985). In conjunction theses sets provide an organizational definition which guides members with respect to a universal, value-based direction (Simons, 1995) and encourage mutual monitoring, a powerful form of group pressure on individuals (Merchant and Van der Stede, 2012).

Based on the understanding of the relevant basic concepts of this study, the hypotheses derivation and the overview of the research model is laid out in the following.

## 2.3 Hypothesis Development

Existing literature suggests that the role of management controls is determined by the strategic environment and commitments of a company (Henri, 2006). Formal control mechanisms seem most suitable for manufacturing companies that focus on cost minimization and are characterized by relatively stable production processes as well as high product standardization (Brownell and Merchant, 1990). Companies that focus on product differentiation will in contrast move away from formal control mechanisms to measures which support the achievement of strategic priorities associated with differentiation, innovativeness and organizational learning (Das and Elango, 1995). Successful implementation of flexibility within an organization "requires cross-functional responsiveness to specific customer-initiated demands" (Abernethy and Lillis, 1995). This suggests that effective management control requires a shift from formal control measures that focus on efficiency within manufacturing to measures that foster interfunctional adaptation as well as co-operation and capture customer-initiated demands (Macintosh, 1985). From a theoretical perspective it thus seems reasonable to assume, that the degree of a firm's strategic flexibility determines the use of formal and informal management controls. Firms with low strategic flexibility seem to focus on formal controls while firms with higher strategic flexibility seem to rather implement informal controls.

Empirical evidence on the links between strategic flexibility and the implementation of management controls in manufacturing organizations is scarce. Abernethy and Lillis (1995) interviewed managers of forty-two manufacturing companies to study the impact of manufacturing flexibility strategy on the design of MCS. They defined MCS as integrative liaison devices – such as teams, task forces, meetings and spontaneous contacts – and efficiency performance measures. They found a positive relation between manufacturing flexibility strategy and the use of integrative liaison devices that help managing functional interdependencies needed in the pursuit of flexibility. Additionally, they found a negative relation between the use of efficiency performance measures for the evaluation of manufacturing performance and the commitment to flexibility. Ahrens and Chapman (2004) in their single-case study illustrate how management especially put emphasize on using management controls to position employees in a way that they are able to deal directly with work-related contingencies to ensure organizational flexibility. Based on these arguments and empirical findings, we hypothesize the following:

*Hypothesis 1: The degree of a firm's strategic flexibility is associated with their use of formal and informal management controls.*

*Hypothesis 1a: The degree of a firm's strategic flexibility is negatively associated with the emphasis companies place on formal management controls.*

*Hypothesis 1b: The degree of a firm's strategic flexibility is positively associated with the emphasis companies place on informal management controls.*

Previous studies strived to shed light on the effectiveness of MCS in general or a set of management controls in specific by examining their various outcomes. These can be separated into topics surrounding the practicality of the MCS or a specific set of controls, behavioral and organizational outcomes (Chenhall, 2003). Furthermore, the three categories of outcomes are intertwined. If the MCS or a specific set of controls are found to be useful then they are likely to be used by managers within the organization, leading to a better information base for corresponding tasks. As a result, managers using MCS or a specific control set take improved decisions and are better in achieving organizational goals (Chenhall, 2003). Regarding the usefulness of MCS, the aspects of supporting decision-making, enabling organizational learning and focusing organizational attention seem to be of high relevance. First, one main purpose of management controls is to provide information useful for decision-making, planning and evaluation (Merchant and Otley, 2007). Broad accounting information including financial as well as non-financial data provided by MCS supports managerial decision making (Mia and Chenhall, 1994). Second, MCS provide managers with information on outcomes which are not meeting the previously set targets and by doing so, enable organizational learning (Widener, 2007). Empirical studies illustrate that organizational learning is positively associated with firm performance (Tippins and Sohi, 2003). Third, MCS focus organizational attention towards specific concerns and provide a clear message from top-management that those aspects are important to the company (Henri and Journeault, 2010). It is expected, that those outcomes of MCS, namely supporting decision-making, enabling organizational learning and focusing organizational attention, are also relevant for the relationship between formal and informal management controls (as a specific set of controls) and organizational performance.

Previous research in management accounting empirically confirmed a positive effect of environmental or eco-control, comprising formal as well as informal management controls, on environmental performance of companies (Epstein and Wisner, 2005). Similar effects seem reasonable in case of energy efficiency which is a specific subdimension of the environmental performance. Hence, the use of formal and informal management controls should increase energy efficiency by reducing both energy consumption and energy costs of a company. Thus, we propose the following hypotheses:

*Hypothesis 2: The emphasis companies place on formal and informal management controls is positively associated with their energy efficiency.*

*Hypothesis 2a: The emphasis companies place on formal management controls is positively associated with their energy efficiency.*

*Hypothesis 2b: The emphasis companies place on informal management controls is positively associated with their energy efficiency.*

## 2.4 Overview of the Research Model

Summarizing our hypotheses development, Figure 1 illustrates our research model that reflects the relationships between energy-related strategic flexibility, formal as well as informal controls and energy efficiency. Strategic flexibility as independent variable is first expected to have a negative effect on formal management controls (hypothesis 1a) and a positive effect on informal management controls (hypothesis 1b). Formal and informal management controls in turn are expected to contribute positively to the energy efficiency of firms (hypothesis 2a and 2b). The direct link between strategic flexibility and energy efficiency is not formally hypothesized, but implemented as control path.

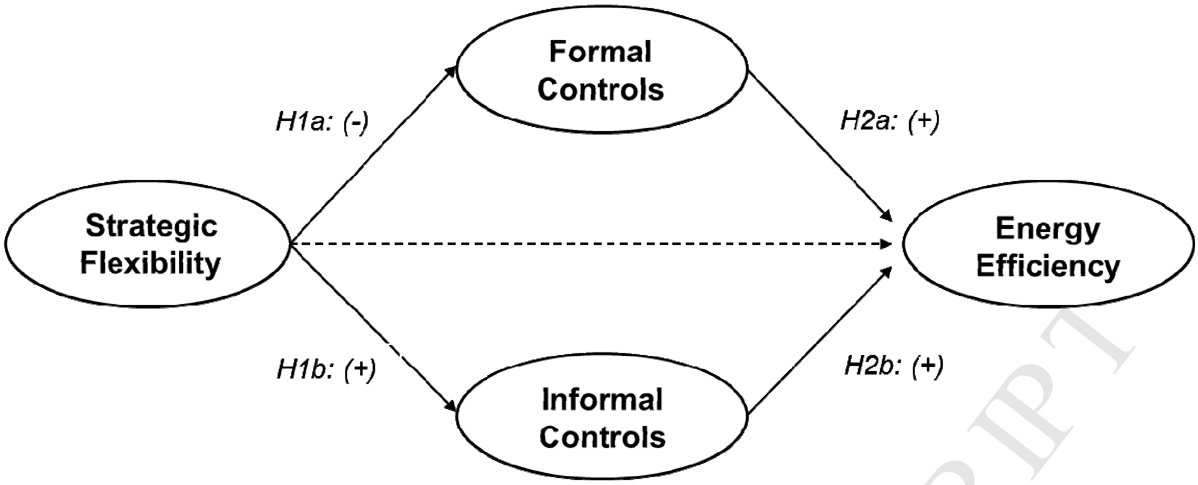


Figure 1: Research model

# 3 RESEARCH DESIGN

## 3.1 DATA COLLECTION AND SAMPLE

The data was gathered by a market research institute via computer-assisted telephone interviews (CATI) in the German manufacturing industry. The relevant firms were selected in case that (1) they belong to the German manufacturing industry, (2) they achieve a sales volume of at least 10 million € per year (3) they employ at least 100 employees. The last two criteria were employed to ensure that the implementation of an energy management as well as a management control system was both affordable and relevant for the company.

A pretest with practitioners and academics in the respective fields was used to assess the questionnaire's content and comprehensibility. According to the feedback, small revisions had been made. The questionnaire was structured as follows: First general information about the company was asked before longitudinal income statement data and longitudinal energy consumption data (differentiated into specific types of energy sources: electricity, long distance heating and coal, oil and gas) for the years 2010 to 2011 was assessed. Finally, several questions were implemented to operationalize the company's MCS and to gather general information on the respondent.

From 1276 companies that were addressed in the first place, 236 responses could be confirmed as completed and valid for the subsequent analysis, leading to a response rate of 18.5%. A subsequent non-response bias test on the dependent variable energy efficiency

(Armstrong and Overton, 1977) confirmed that the 25% early respondents did not significantly differ from the 25% late respondents and thus non-response bias should be no overwhelming concern. The descriptive analysis shows that a large share (70%) of the firms represents SMEs and about one third represents large enterprises with at least € 100 million sales volume and more than 500 employees. The included companies were primarily manufacturers of machinery and equipment (42%), while the rest was rather equally distributed among manufacturers of fabricated metal products (9%), manufacturers of rubber and plastic products (6%), manufacturers of food products (6%), and manufacturers of computer, electronic and optical products (6%). For details on the sample, please see appendix.

## 3.2 Measures

### 3.2.1 Energy-related strategic flexibility

Our conceptualization of energy-related strategic flexibility of firms comprises two main dimensions: (1) resource dependency and (2) risk exposure. Consequently, we operationalized energy-related strategic flexibility as second-order construct of type IV employing formative measures for both first- and second order constructs (Jarvis et al., 2003). Items used to measure resource dependency were energy cost intensity of the production processes, scope of decision-making with regard to the energy mix, and dependency on particular energy sources (e.g. electricity, oil or natural gas). Risk exposure included items covering energy price volatility and supply shortfalls of specific energy sources. We developed the items of the first-order factors based on previous conceptual research by Posch (2011). In our model each first-order variable is operationalized by three items employing five-point Likert-scales, anchored by “not at all applicable” and “fully applicable”.

### 3.2.2 Formal and informal management controls

We adapted existing measures from previous empirical research conducted by Auzair and Langfield-Smith (2005), Chenhall and Langfield-Smith (1998) and Widener (2007) to operationalize formal and informal management controls. Items used to measure formal management controls cover the use of energy-related performance measures, existence of action accountability and individual incentives as well as defined policies and procedures. Informal management controls were measured by using items covering active communication, organizational commitment, the energy-related set of values and normative patterns as well as effective personnel selection and training. Each latent construct is measured by six formative items using five-point Likert-scales, anchored by “strongly disagree” and “strongly agree”.

### 3.2.3 Energy Efficiency Performance

Several approaches to conceptualize and measure energy efficiency have been discussed in literature (Fleiter, Hirzel and Worrell, 2012) We define energy efficiency in line with Virtanen et al. (2013) as the ratio between the energy input and the useful output of a process. More specifically, we operationalize the corresponding construct as second-order factor of type III using formative measures in case of first-order constructs and reflective measures in case of second-order constructs (Jarvis *et al.*, 2003). With respect to the first-order constructs we implemented two dimensions: (1) a hybrid economic-thermodynamic indicator that refers to energy consumption efficiency and (2) a pure economic indicator which expresses the energy cost efficiency. More specifically, two ratios were calculated based on data of the years 2010 and 2011. For the denominator in both cases, we employed the added value per year from the companies’ income statement derived from the database DAFNE as well as from the German Electronic Federal Gazette (“Bundesanzeiger”). For the numerator of the first-order construct “energy consumption efficiency”, the sum of the total energy consumption per year (2010, 2011) was calculated based on all different types of energy sources in kWh. In case of the numerator of the first-order construct “energy cost efficiency”, the sum of total energy costs per year (2010, 2011) was calculated based on all different types of energy sources in €. In case of both numerators we relied on survey data. Given that energy efficiency as ratio is operationalized recursively, such that high values represent low energy efficiency and vice versa, we converted all negative effects on energy efficiency to positive ones and vice versa.

### 3.2.4 Controls

Besides our central variables, we also employed the following controls. Based on the WZ 2008 code, each company’s industry sector was clustered into low, medium and high energy-intensive using secondary data on the energy-intensity of several industry sectors gathered from the German Federal Statistical Office. Company size was implemented by the number of a company’s employees. Finally, the position of the respondent was employed as additional control variable.

# 4 ANALYSIS AND RESULTS

In order to evaluate our research model and to assess the corresponding hypotheses we used structural equation modeling (SEM). More specifically, we decided to use Partial Least Squares (PLS)-SEM instead of covariance-based techniques like LISREL or AMOS as PLS-SEM is able to model hierarchical constructs with formative measures, which are present within our research model (Chin, 2010). Hierarchical constructs can be easily established within PLS-SEM using the approach of repeated indicators. We applied this approach and thus repeated the indicators used at first-order level at the subsequent levels to run the PLS algorithm (Wetzels *et al.*, 2009). For the estimation of the model parameters we used a path weighting scheme including mean replacement for missing values and nonparametric bootstrapping with individual-level changes preprocessing to calculate the standard errors (Hair *et al.*, 2014). Since no statistical criteria for the goodness of the holistic PLS model exists, we applied the common evaluation process, starting with hierarchical measurement model evaluation and concluding with structural model assessment (Henseler *et al.*, 2009). For our calculations we used the programme SmartPLS 2.0 (Ringle *et al.*, 2005).

With respect to the formative first- and second-order constructs, indicator relevance and multicollinearity were assessed (Götz *et al.*, 2010). In case of energy efficiency and strategic flexibility all first-order indicators, except one, have a significant effect on the corresponding second-order variable, while in case of formal and informal controls not all formative indicators were significantly related to the corresponding construct. However, as a formative construct is formed by the sum of all underlying indicators, even not significantly related indicators should be kept instead of being eliminated as it would be the case for reflective indicators (Chin, 2010). Finally, in case of the second-order construct strategic flexibility both second-order weights turned out to be significant (see Figure 2). Since the highest variance inflation factor of all formative first- and second-order constructs was 2.99, multicollinearity should not be present (Hair *et al.*, 2014). Finally, with regard to the reflective second-order dimensions of energy efficiency, all indicator loadings turned out to exceed the common threshold of 0.7 (Chin, 2010). Furthermore, the composite reliability also surpasses 0.7 (Hair *et al.*, 2014). With regard to discriminant validity, the average variance extracted (AVE) of each construct surpasses 0.5 and also exceeds the highest squared correlation with all other constructs (Fornell and Larcker, 1981). Overall, the measurement model seems suitable for further evaluation at the structural model level (see Table 1 in the appendix for detailed results).

At structural model level, the explained variance in our dependent variables varied between 0.14 for energy efficiency, 0.12 for formal controls and 0.10 for informal controls (see Figure 2). With respect to the predictive power of our model, we calculated Stone-Geisser's Q2 using a blindfolding approach (Fornell and Bookstein, 1982). As all Stone-Geisser's Q2 values turned out to be different from 0, we can assume that our structural model has predictive power (Tenenhaus *et al.*, 2005). In order to assess multicollinearity, we calculated the variance inflation factor (VIF) for our structural model. Our results indicate that the VIF at structural model level is 1.93 and thus multicollinearity should not affect our results. Subsequently, we proceed with hypotheses testing based on an assessment of the path coefficient and the corresponding significances.

Overall hypothesis 1 can be confirmed, as a firm's strategic flexibility affects the use of formal and informal controls. More specifically, contrary to our expectations, a firm's degree of strategic flexibility fosters the use of formal controls ($\beta = 0.35$, $p < 0.01$), rejecting hypothesis 1a. Yet, in line with our predictions, a firm's degree of strategic flexibility also enhances the use of informal controls ($\beta = 0.32$, $p < 0.01$), leading to a confirmation of hypotheses 1b. Besides, hypotheses 2 can only be partly confirmed. More specifically, our results indicate that formal controls significantly enhance energy efficiency ($\beta = 0.32$, $p < 0.05$), confirming hypothesis 2a. However, contrary to hypothesis 2b, the emphasis companies place on informal management controls has no significant effect on energy efficiency ($\beta = -0.05$, n.s.). While not explicitly hypothesized, we also controlled for a direct effect of strategic flexibility on energy efficiency. However, the direct effect turned out to be insignificant ($\beta = 0.13$, n.s.).

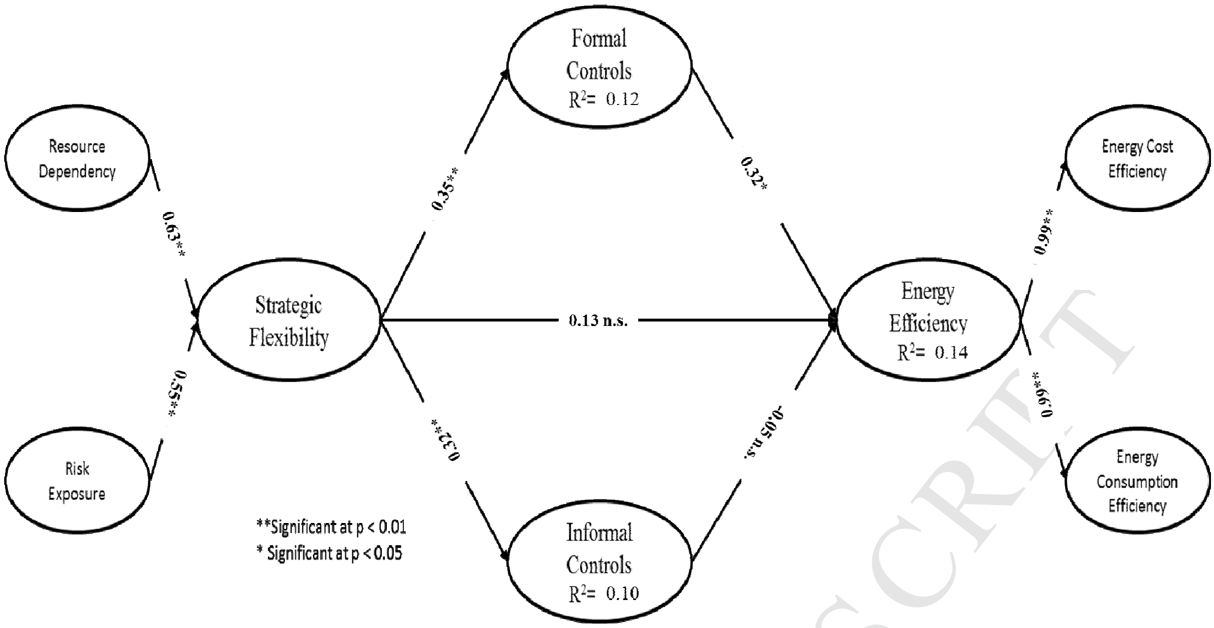


Figure 2: Structural model results

# 5 CONCLUSION

## 5.1 THEORETICAL AND MANAGERIAL IMPLICATIONS

The main research goals of this study were to evaluate whether and how (1) energy-related strategic flexibility influences the use of different types of management controls and (2) whether and how different types of management controls relate to energy efficiency. Our findings contribute to both management accounting and environmental management research by providing first insights into the interplay of strategic flexibility, management control and energy efficiency.

With respect to the first research goal, our results confirmed that energy-related strategic flexibility indeed influences both formal and informal types of controls. As suggested within our hypothesis development, a high degree of energy-related strategic flexibility fosters the implementation of informal controls. Hence, with rising degrees of a firm’s energy-related strategic flexibility, the use of personnel controls like placement, training and job design to increase the likelihood that employees will engage in self-monitoring (Merchant and Van der Stede, 2012) as well as cultural controls that foster the company-specific set of values, beliefs and normative patterns (Flamholtz *et al.*, 1985) increases. This finding is in line with previous research, suggesting that informal control mechanisms are particularly well suited for organizations that pursuit interfunctional co-operation and adaptation (Abernethy and Lillis, 1995). However, in contrast to our expectations, energy-related strategic flexibility also enhances the implementation of formal controls. Based on findings of previous research, showing that manufacturing firms with a rather high degree of standardization move away from the use of formal controls (Govindarajan, 1988), we suggested that the movement will proceed in favor of the implementation of informal controls. Yet, instead of only implementing mechanisms that induce self-regulation in form of personnel and cultural controls (Ouchi, 1979), our findings suggest that companies striving for energy-related strategic flexibility foster all types of controls. This finding might suggest that a high degree of energy-related strategic flexibility requires both the presence of formal and informal regulatory mechanisms to support strategic priorities associated with differentiation, innovativeness and organizational learning (Simons, 1987).

With respect to the second research goal, our results partly confirmed our expectations concerning the effects of management controls on energy efficiency. With respect to formal controls, our findings confirmed that energy efficiency is indeed strengthened by formal controls, which is in line with previous research that confirmed a positive effect of environmental or eco-control on companies' environmental performance (Henri and Journeault, 2010). Hence, with respect to formal controls the findings from neighbouring research areas in the context of environmental control seem to be transferable to the specific context of energy management control. However, contrary to our expectations, informal controls did not significantly enhance energy efficiency. Our hypothesis was based on previous findings, suggesting that informal controls might support organizational learning (Widener, 2007), which in turn was shown to enhance firm performance (Tippins and Sohi, 2003). We expected a similar pattern for energy efficiency, as operational efficiency is also part of firm performance. However, based on the insignificant finding, one might conclude that informal controls might indeed support organizational learning but the latter might not necessarily be tied to energy efficiency. While organizational learning contributes to several capabilities within a company, which in turn enhance firm performance as overarching concept, energy efficiency is much more specific and narrow and thus might not directly be affected by organizational learning.

While not all of our expectations could be confirmed, our findings yet provide managers with important insights on the interplay of strategic flexibility, management controls and energy efficiency. As stated before, a major challenge for numerous firms is to balance promotion of energy-related strategic flexibility and efficiency considerations (Kaplan and Norton, 2008). Previous research confirmed, that often operational efficiency is maximized on cost of strategic flexibility. Yet, our findings suggest that industrial companies, pursuing a high degree of energy-related strategic flexibility, might still be able to maximize energy efficiency. More specifically, companies that strive to maximize both strategic flexibility and their energy efficiency should implement formal controls to equalize negative effects of strategic flexibility on energy efficiency. Within this regard, industrial companies could make use of both results and action controls to enhance their energy efficiency. More specifically, companies might implement regulatory mechanisms to monitor individual or group performance (Abernethy *et al.*, 2010). Such results controls ensure that a good performance gets the necessary reward and thus employees' motivation to fulfill energy related tasks is enhanced, which improves energy efficiency. Additionally, companies might implement regulatory mechanisms to align the actions of employees with the goals of the company (Merchant and Van der Stede, 2012). Such action controls transmit expectations and structure by determining the necessary procedures for routine tasks (Cardinal, 2001). This should ensure that employees' actions are in line with the energy-related goals of the company, which would also contribute to energy efficiency.

Since our findings did not confirm a significant effect of informal controls on energy efficiency, companies might refrain from using such controls when trying to enhance energy efficiency. However, companies should carefully weigh decisions to reduce the use of informal controls as such regulatory mechanisms might be important in several other areas such as interfunctional co-operation and adaptation (Macintosh, 1985).

Achieving cleaner production by enhanced levels of industrial energy efficiency has become a critical concern for global policy makers and society (Trianni *et al.*, 2013). Our findings provide useful insights for policy makers within this regard. As outlined above, levels of high energy-related strategic flexibility induce the implementation of formal controls which in turn enhance energy efficiency. Hence policy maker should strive at providing optimal circumstances for companies to reach higher levels of energy-related strategic flexibility.

While resource dependency as one dimension of energy-related strategic flexibility is difficult to influence externally, risk exposure as second dimensions seems suitable for external measures. Within the latter respect, policy maker should strive to keep short-term price changes and supply shortfalls of energy sources to a minimum such that a company's risk exposure is minimized. As a consequence, companies should be able to achieve higher levels of energy-related strategic flexibility and thus formal controls, which contributes to companies' energy efficiency and thus to a cleaner production in industry.

## 5.2 Limitations and further research potential

While we strived at maximizing the validity and reliability of our research design, our study has some limitations which provide fruitful avenues for future research. First, we developed a new measurement inventory to assess energy-related strategic flexibility based on research based on previous conceptual research by Posch (2011) as no specific measure was present. While this approach ensured that our measurement inventory was tailor-made to assess strategic flexibility in the context of energy management, it remains a newly conceptualized measure that needs further testing and probably refinement in other contexts. Hence future research might use this measurement inventory with other samples to enhance its external validity. Second, our data was derived solely from the German manufacturing industry sector. While this should not principally be of serious concern, especially the importance of informal controls for energy efficiency might vary with different cultural settings in companies. The same could also be true for SMEs compared to large companies. Hence, future research might strive to replicate our findings in different cultural settings and for different firm sizes. Within this respect, specific group comparisons might deliver fruitful insights on how the detected interplay between strategic flexibility, management controls and energy efficiency might vary. Third, our research model included several company characteristics as controls. However, previous research indicates that contextual factors like nature of the environment, technology, size, company structure, strategy or national culture (Chenhall, 2003) might be important moderators in the context of energy management. Hence, future studies might follow a contingency approach and examine how such contextual factors moderate the relationship between strategic flexibility, management controls and energy efficiency.

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# Appendix

| Second-order Construct | First-order Construct | Item | Weight | Sig. (t-value) |
|---|---|---|---|---|
| **Strategic Flexibility** VIF= 1.121 | Resource dependency VIF= 1.377 | Energy costs represent a significant share of total costs in our company. (r) | 0.591 | 7.192 |
| | | Due to technical reasons, the choice of a specific energy source is for our company of very high importance. (r) | 0.544 | 6.958 |
| | | The scope of decision-making regarding the determination of a specific energy mix in our company is very high. (r) | 0.09 | 1.030 |
| | Risk exposure VIF= 2.397 | Short-term price changes of energy sources are difficult to compensate in the portfolio management of our energy procurement. (r) | 0.621 | 4.546 |
| | | The temporary supply shortfall of a particular energy source has considerable impacts on our company. (r) | 0.240 | 1.959 |
| | | The temporary supply shortfall of a particular energy source cannot or only hardly be compensated by our company. (r) | 0.475 | 3.857 |
| Energy Efficiency CR=0.961 AVE=.859 | Energy consumption efficiency VIF= 2.988 | Calculated value for 2010 | 0.371 | 3.592 |
| | | Calculated value for 2011 | 0.674 | 9.225 |
| | Energy cost efficiency VIF= 1.663 | Calculated value for 2010 | 0.674 | 11.609 |
| | | Calculated value for 2011 | 0.427 | 5.114 |
| Formal Controls VIF= 1.904 | | In our company we can manage our energy consumption in real-time thanks to our energy cockpit. | 0.563 | 2.786 |
| | | In our company we have an indicator for each goal and a concrete indicator for the measure of the objective | -0.043 | 0.333 |
| | | A specialized energy team is installed to take care of cross-departmental processes. | 0.393 | 2.310 |
| | | A comprehensive documentation of energy management processes is in place. | 0.264 | 1.211 |
| | | The internal energy goals are split based on different value chain levels (Production, procurement, logistics, sales). | 0.110 | 0.961 |
| | | All relevant main energy sources have specific goals. | 0.079 | 0.568 |
| **Informal Controls** VIF= 1.881 | | All our employees who have tasks in energy management are participating in regular training workshops. | -0.028 | 0.181 |
| | | In our company there are individual incentives for employees to improve energy efficiency. | 0.192 | 1.225 |
| | | Our employees in energy management are qualified. | 0.122 | 0.638 |
| | | The internal communication for energy relevant issues is very good (e.g. principles, guidelines, newsletter, and circular emails). | 0.194 | 1.062 |
| | | Our company has an active network and relations to contacts in science and research of energy management. | 0.176 | 1.094 |
| | | Energy management has an interdepartmental role and all functional areas (Marketing, Sales, Finance/Controlling, Procurement, Production, etc.) are included. | 0.715 | 4.578 |

Table 1: Hierarchical measurement model results

Description of the sample

| Number of Employees | # | % |
|---|---|---|
| Between 100 and 499 | 167 | 70,8 |
| Between 500 and 999 | 25 | 10,6 |
| Between 1.000 and 4.999 | 25 | 10,6 |
| ≥ 5.000 | 19 | 8,1 |
| **Total** | **236** | **100,0** |

| Sales Volume per Year (in € million) | # | % |
|---|---|---|
| ≥ 10 and < 25 | 66 | 28,0 |
| ≥ 25 and < 100 | 91 | 38,6 |
| ≥ 100 and < 500 | 43 | 18,2 |
| ≥ 500 | 36 | 15,3 |
| **Total** | **236** | **100,0** |

| Organizational Function of Respondent | # | % |
|---|---|---|
| Corporate Management | 17 | 7,2 |
| Finance/Accounting | 30 | 12,7 |
| Purchasing | 57 | 24,2 |
| Production | 24 | 10,2 |
| Energy or Environmental Management | 40 | 16,9 |
| Staff Division | 16 | 6,8 |
| Others[a] | 52 | 22,0 |
| **Total** | **236** | **100,0** |

[a] This group includes corporate functions like technical/operational services, industrial engineering, maintenance, building/facility management, quality management and business process reengineering.

| Position of Respondent | # | % |
|---|---|---|
| Director/Board Member | 10 | 4,2 |
| Divisional Head | 42 | 17,8 |
| Department Head | 97 | 41,1 |
| Management Representative for Energy or Environmental Management | 24 | 10,2 |
| Senior Expert | 37 | 15,7 |
| Management Assistant | 7 | 3,0 |
| Others | 19 | 8,1 |
| **Total** | **236** | **100,0** |

| WZ 2008 Code[b] | | # | % |
|---|---|---|---|
| **C. Manufacturing Industry** | | | |
| 10 | Manufacture of food products | 14 | 5,9 |
| 11 | Manufacture of beverages | 0 | 0,0 |
| 12 | Manufacture of tobacco products | 0 | 0,0 |
| 13 | Manufacture of textiles | 3 | 1,3 |
| 14 | Manufacture of wearing apparel | 2 | 0,8 |
| 15 | Manufacture of leather and related products | 0 | 0,0 |
| 16 | Manufacture of wood and of products of wood and cork, except furniture | 1 | 0,4 |
| 17 | Manufacture of paper and paper products | 4 | 1,7 |
| 18 | Printing and reproduction of recorded media | 7 | 3,0 |
| 19 | Manufacture of coke and refined petroleum | 1 | 0,4 |
| 20 | Manufacture of chemicals and chemical products | 7 | 3,0 |
| 21 | Manufacture of basic pharmaceutical products and pharmaceutical preparations | 2 | 0,8 |
| 22 | Manufacture of rubber and plastic products | 14 | 5,9 |
| 23 | Manufacture of other non-metallic mineral | 6 | 2,5 |
| 24 | Manufacture of basic metals | 10 | 4,2 |
| 25 | Manufacture of fabricated metal products, except machinery and equipment | 22 | 9,3 |
| 26 | Manufacture of computer, electronic and optical products | 14 | 5,9 |
| 27 | Manufacture of electrical equipment | 8 | 3,4 |
| 28 | Manufacture of machinery and equipment | 100 | 42,4 |
| 29 | Manufacture of motor vehicles, trailers and semi-trailers | 5 | 2,1 |
| 30 | Manufacture of other transport equipment | 6 | 2,5 |
| 31 | Manufacture of furniture | 2 | 0,8 |
| 32 | Other manufacturing | 7 | 3,0 |
| 33 | Repair and installation of machinery and equipment | 1 | 0,4 |
| **Total** | | **236** | **100,0** |

[b] The WZ 2008 is a national statistical standard for the classification of economic activities which was introduced by the German Federal Statistical Office in 2008 as part of the harmonization of classifications at European level (NACE Rev. 2). As a result, a hierarchically structured classification of economic activities has been developed, consisting of 21 sections (A-U). The table displays the complete structure of section C ‘Manufacturing Industry’.

**Highlights:**

- A rising tension between efficiency and flexibility considerations is visible within energy management of production companies.
- The use of management controls can mitigate the trade-off between flexibility and efficiency.
- The importance of formal and informal controls declines in firms with a high energy-related strategic flexibility.
- There is in general a positive relation between the use of formal management controls and energy efficiency.