Influence of regulatory uncertainty on capacity investments – Are investments in new technologies a risk mitigation measure?

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Abstract

Understanding the investment decisions of power companies is vital for a regulator as particularly deficient investments in generation capacity could jeopardize the market in the long run. Considering potential risks that could hamper investments, the paper focuses on regulatory uncertainty and firms' behavior to mitigate risk.

The question of how uncertainty influences investment decisions has been explained by a number of researchers. In the specific case of regulatory uncertainty it is agreed that organizational strategies and decision processes are influenced. However, it is not agreed whether this form of environmental uncertainty triggers or hampers investment decisions. One stream in literature supports the argumentation that regulatory uncertainty results in reducing, postponing or cancelling of decisions. An opposing stream questions the direct consequence of regulatory uncertainty and the link to postponements of investment decisions. The argumentation can be based on either a real-option perspective that states that an organization exposed to regulatory uncertainty can have a benefit from small initial investments. Or the resource-based view can be predominant that argues that environmental uncertainty increases the probability that a company invests proactively.

The paper provides a literature review to give a better understanding of the impact of regulatory uncertainty on firms and their corporate responses to mitigate the risk associated to generation investments. We further discuss potential investments in new technologies in the current environment (especially CCS) as risk mitigation measure in the light of regulatory uncertainty.

Finally, we propose a new framework to give an answer to the question of generation investment under uncertainty. By matching the factor of irreversibility with the degree of perceived regulatory uncertainty, firms will follow different investment strategies, depending of the combination of the factors and value of the option to postpone based on the real option approach. Therefore, at highly regulatory uncertainty firms may prefer to invest in new technologies because of their high flexibility and high option value and rather postpone large irreversible projects.

Keywords: regulatory uncertainty, risk mitigation, CSS

1. Introduction

In the pre-liberalized power markets, the vertically integrated power companies were fully able to recover their investments through the cost-plus regime[1]. Investment decisions could be done under relative high certainty as investment risks were entirely transferred to the ratepayers. With the emergence of the competitive market, firms nowadays have to consider the business risk when deciding on an investment, which can alter the outcome.

The liberalization of the EU electricity market introduced new challenges for firms, which made them behave differently. Power firms have to face uncertainties not only due to the unpredictability of market developments (like fuel prices), but also due to regulatory uncertainty that can, e.g., influence the market design, set new environmental constraints, approve or disapprove new technologies or set standards for energy efficiency. All uncertainties faced by a firm significantly influence investment decisions. However, on the contrary to market uncertainty, uncertainty in regulation can change abruptly, from one day to the other with huge business impact on the firm. A single new policy can thus turn the profitability of an investment from positive to negative or even prevents any value generation of the investment (due, for example, to the blockage of a technology). In sum, regulatory uncertainty do affect investment projects and may delay or deter the investment choices. As the underlying uncertainties cannot be changed or will only disappear over time, firms have to think about practices to manage their risks and to shift the cost of risk to other stakeholders.

The article investigates the influence of regulatory uncertainty on generation investments by means of a literature review in two sections. The first section, Chapter 2, analyzes the general connection of regulatory uncertainty and investment decisions for all organizations, and the second section, Chapter 3, focuses on firms in the power sector and the particular role of technology in generation investments. The paper tries to give a framed answer to the question whether regulatory uncertainty hampers or triggers investments. This is done by a framework of firms' strategic responses dependent on the degree of regulatory uncertainty and the flexibility of the investment to decide on. Technologies play a vital role in this decision process as they come with different investment flexibilities. In cases where regulatory uncertainty is high firms may tend to invest in flexible new technologies to mitigate their business risk associated to regulatory uncertainty. Several propositions are made for discussion and eventually hypothesis are suggested for empirical testing.

[1] Under a cost-plus regime firms are allowed to pass their cost of generation as well as their regulated profits to the customers. The central fact is that all cost of the firm can be recovered and incentives for cost reduction or efficiency increase are not given without further constraints by the regulator.

2. The role of regulatory uncertainty on investment decisions

The following chapter analysis the influence of regulatory uncertainty on firms' investment decisions, i.e., bringing light into the question whether perceived regulatory uncertainty rather hampers or triggers investments.

The chapter is structured along four parts. First, uncertainty as part of the external environment of the firm is classified and perceived regulatory uncertainty settled as concept of institutional theory. Second, investment questions are discussed in respect to uncertainty in general, and, third, in respect to regulatory uncertainty. Fourth, strategic responses are analyzed how firms best respond to regulatory uncertainty in order to mitigate their business risk. Eventually, a framework of strategic responses is proposed that shows that the question is not answerable with one dimension, but a second dimension, the flexibility of the investment must be considered as well. The stated propositions are drawn from strategic management under uncertainty, the Resource-Based View of the firm (RBV), and the real option approach.

2.1 Firm's perception of uncertainty

Thompson (1967:13) stated that "the central problem for complex organizations is one of coping with uncertainty". The impact of uncertainty on business decisions and corporate performance has been a key concept in organizational research since many years. Scholars analyzed firms' reactions and adaptations to uncertainty (e.g., Miles & Snow, 1978, Lawrence & Lorsch, 1967) and developed scales to measure the impact of uncertainty on organizations (Duncan 1967, Lawrence & Lorsch, 1967). Furthermore, a differentiation has been introduced between objective and perceptual types of uncertainty (Milliken, 1987, Lang, 1990, Aragón-Correa & Sharma, 2003).

2.1.1 Classifications of uncertainty

Basically, uncertainty in strategic management organization theories refers to the unpredictability of environmental or organizational variables (Miles & Snow, 1978, Pfeffer & Salancik, 1972) or the inadequate information about these variables (Duncan, 1972, Galbraith, 1977). If uncertainty increases the predictability of corporate performance decreases. As a consequence, the firm's business risk will be increased. Uncertainty can result from different causes, which can be originating from exogenous shocks, unforeseeable behavioral choices or the two causes combined (Lessard, 1988).

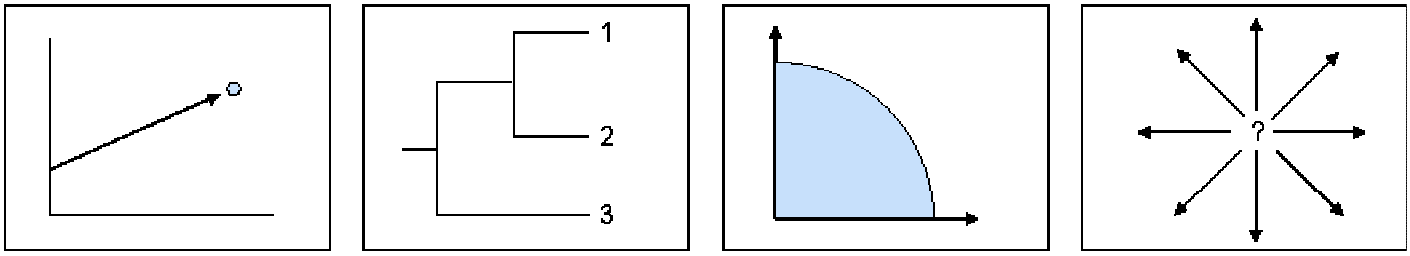
Miller (1992) classifies the uncertain variables as perceived by managers into three groups: general environment, industry and firm-specific variables. Each group has a number of uncertain components. **Table 1** shows the components of the general environmental uncertainty, which includes uncertainty from government regulation as subcomponent of government policy uncertainties. Miller's distinction helps to identify possible uncertain variables in order to get a holistic picture of the firm's environment. However, variables may vary with the individual perceptions by managers according to their cultural backgrounds and specific firm characteristics (Yasai-Ardekani, 1986).

Table 1: General environmental uncertainties (Miller, 1992)

Political uncertainties	Government policy uncertainties	Macroeconomic uncertainties	Social uncertainties	Natural uncertainties
• War • Revolution • Coup d'état • Democratic changes in government • Other political turmoil	• Fiscal and monetary reforms • Price controls • Trade restrictions • Nationalization • Government regulation • Barriers to earnings repartition • Inadequate provision of public services	• Inflation • Changes in relative prices • Foreign exchange rates • Interest rates • Terms of trade	• Changing social concerns • Social unrest • Riots • Demonstrations • Small-scale terrorist movements	• Variations in rainfall • Hurricanes • Earthquakes • Other natural disasters

In order to measure the intensity or degree of uncertainty, Courtney et al. (1997) developed a differentiation of four levels of uncertainty and show up appropriate analytical tools for decision-makers to deal with the respective uncertainty (cf. **Graphic 1**). The first level of uncertainty is described as "**clear-enough future**" where a single forecast is sufficient to determine a firm's strategy. At the second level, the "**alternate futures**", a strategy must be developed according to the different discrete outcomes that define the future. The third level of uncertainty, described as "**range of futures**", does not allow any more the creation of scenarios, and a large range of possible outcomes must be taken into account to determine the future. Finally, the fourth level is characterized by "**true ambiguity**" which is the case when no basis for forecasts exist.

Graphic 1: Four distinct levels of uncertainty (Courtney et al, 1997)



Finally, a critical component while thinking of an investment is its timing as uncertainty evolves over time. In this sense, Doh & Pearce (2004) distinguish between continuous and discontinuous uncertainty. Continuous uncertainty refers to a relative stable environment with slow and steady changes whereas discontinuous uncertainty is characterized by uneven changes.

2.1.2 The concept of perceived regulatory uncertainty

We refer to the term "regulatory uncertainty" to appropriately address the inability of a company's decision-maker to have a clear understanding of future regulations that will evolve in its organizational environment (Birnbaum, 1984). Regulation in our context describes a specific form of government action including supervision and market control over actors and their behavior (Eberlein & Grande, 2005). We see regulatory uncertainty as discontinuous uncertainty to reflect the non-continuous, uneven changes in regulation over time. Typically, a single regulatory decision can change the business environment of a firm abruptly. As firms are obliged to respect the regulatory decisions, we refer to the regulatory environment as a way of exercising coercive power of regulatory agencies on organization (Scott, 2001).

According to Courtney's uncertainty classification, regulatory uncertainty is primarily based on the second and third level of uncertainty. For example, a regulatory authority announces that a threshold for pollution of a pollutant will be introduced, but the precise level of the threshold will be announced at a later date (level 2 uncertainty). Therefore, the firm is only uncertain about the threshold and faces alternate futures, e.g., scenarios with low, middle or high thresholds. In the second example, the regulatory authority is not yet sure about the choice between an introduction of a simple threshold or of a more sophisticated system like the emission trading scheme in the EU (level 3 uncertainty). In this case, the firm faces a range of futures and has a higher difficulty to prepare his business.

We anchor perceived regulatory uncertainty in institutional theory as a sub-concept of perceived environmental uncertainty. The focus on the perception of uncertainty is especially important in this concept because the perceived influence of regulation on a firm may be different from objective uncertainty (Finkelstein & Hambrick, 1996).

A key element to work with the term regulatory uncertainty is the distinction of different types of perceived environmental uncertainties according to Milliken (1987) that helps to better reflect the "point of impact" of uncertainty on the organization. Milliken differentiates between three types of environmental uncertainty: **state uncertainty**, **effect uncertainty**, and **response uncertainty**:

- **State uncertainty** is related to the inability of the organization to predict its future organizational environment or a particular component of the environment.
- **Effect uncertainty** is defined as an "inability to predict what the nature of the impact of a future state of the environment or environmental change will be on the organization" (Milliken, 1987:137).
- **Response uncertainty** is characterized by the understanding of the environment and its causes, but a lack of knowledge of response options available for the organization.

For this article, we focus primarily on state uncertainty where the power generation firm does not yet know the future state of regulations or policies that affect the power generation sector.

2.2 Influence of uncertainty on investment decisions

As discussed above, scholars agree that strategies of organizations are influenced by regulatory uncertainty, (e.g., Thompson, 1967, Carter, 1990, Parnell et al., 2000, Hitt et al., 1982, Ireland & Palia, 1982). Further, strategic management can be used to cope with uncertainty by shaping their competitive environment (Allaire & Firsirotu, 1989, Guth, 1976, Jauch & Kraft, 1986). However, it is not agreed whether environmental uncertainty triggers or hampers investment decisions. There is a wide range of attempts by scholars to describe and measure the influence of uncertainty on investment decisions. One of the first authors to recognize the impact of uncertainty on the timing of investments was Roose (1954) who analyzed the great depression in the 1930s and stated that investment timing may be affected by noneconomic uncertainties, arising from political or social uncertainties.

Based on an economic viewpoint, Cukierman (1980) came to the conclusion that risk-neutral firms decrease their investment activities when uncertainty increases. Firms find it profitable to further delay an investment decision to collect more information. Bernanke (1983) shares this argumentation with a similar model that shows how future uncertainty decreases if information is gathered. However, this argumentation might not hold true if future uncertainty will not be decreased by information gathering. The result is an "opportunity cost" that arises through the decision to not invest now but at a later stage. Pyndick (1991) considers such opportunity cost for irreversible investments (like in power plants), but points out the difficulty to measure the opportunity cost. Most importantly, if such opportunity cost includes resources and the environment, stochastic processes are needed to solve the modeled investment problem, which makes it unrealistic to use in reality.

A fundamental change in thinking about investments under uncertainty came with the real option theory, a term principally coined by Myers (1977) (see also, e.g., Dixit & Pindyck, 1994, Dixit, 1992, Dixit, 1989). If one considers the above mentioned "opportunity cost" as "cost of waiting", uncertainty can, under certain circumstances, act as a trigger for investments. The real option approach compares investments in real assets to financial options, but with the involvement of managerial decisions in a firm. It basically builds on the concepts of irreversibility and delay (Hubbard 1994). Like in a financial option, the real option offers the right to invest at a later stage without any obligation. The cost for this choice is the initial investment, which also limits a potential loss if the right to invest is not carried out. This choice to sequence an investment is particularly relevant for irreversible investments, which are sunk and cannot be recovered at a later date.

If a company is exposed to uncertainty, real options offer an approach to analyze the right timing of investment and the associated value or cost to postpone an investment. According to real option theory, the value of waiting (i.e., the option) becomes more valuable the more volatile the underlying asset is. Combined with uncertainty triggered by regulation this means that the option to wait is more valuable the greater the regulatory uncertainty is. As a consequence, a firm that realized an initial investment, for example in a multi-stage investment, has thus the possibility to benefit from the upside potential of the option, but the loss is limited to the initial investment made.

It can be therefore concluded that uncertainty per se does not automatically hamper investments. It rather depends on the specific firm internal and external circumstances The influence of uncertainty on investment decisions strongly depends on the uncertain variable as perceived by the manager, so no general deduction can be made.

For the following, we limit our focus to the implications of perceived regulatory uncertainty on investment decision in order to find a suitable corporate response framework. To do so, we first review the literature according to streams of argumentation in the next section. Second, the shortcoming will be discussed that authors have focused too little on the question of the appropriate strategic investment response under uncertainty and given investment options. Third, a framework will be presented that closes this gap by linking theory of strategy under uncertainty with the resourced-based view and real option theory.

2.3 Influence of perceived regulatory uncertainty on investment decisions

Like the influence of uncertainty on investment decisions in general, the argumentation in literature for the impact of regulatory uncertainty is basically twofold. The group of scholars seeing regulatory uncertainty as negative impact on investment decisions states that regulatory uncertainty gives an additional cost from a transaction cost perspective, which thrive organizations to wait or postpone projects until further information or clarity is gathered (e.g., Luo, 2004).

The opposing group of scholars argue that regulatory uncertainty even triggers investments as firms can gain a competitive advantage. The rational is based on either the resourced-based view of the firm or the real-option approach. According to the resource-based view, investment under regulatory uncertainty can secure the firm specific valuable resources that can be leveraged for the firm's performance (e.g., Rugman & Verbeke, 1998). Alternatively, according to the real option approach, firms can benefit from investments under regulatory uncertainty by gaining a right for a future, larger investment, which then will generate large payoffs. The option has thus no enforced obligation to actually do the investment in the future (e.g., Doh & Pearce, 2004). The value of the option is thus driven by the development of the underlying uncertainty, in our case, regulatory decisions or developments.

2.3.1 Regulatory uncertainty as impediment for investments

Some scholars support the argumentation that regulatory uncertainty results in reducing, postponing or cancelation of investments. Based on the analysis of adopted regulations in the past, Marcus and Kaufmann (1986) studied the US synfuels program from the 1970s and 1980s, which was for a short period the cornerstone of the US national energy policy. The goal of this industrial policy was to incentivize businesses to invest in the development of synthetic fuels, but companies hesitated and reacted uncertain and inconsistent. Because of several flaws in the policy implementation, uncertainty could not be removed and the level of investment was not successful. Beside this individual case, Bittlingmayer (2001) empirically analyzed the impact of policy or regulatory uncertainty on investment decisions through the level of antitrust enforcements. In his large data set of over 21 major industry groups in the US, he observed investment decisions over a four decades period

from 1947-91. He came to the conclusion that lower investments were made in periods with higher regulatory uncertainty and businesses preferred a "wait and see"-strategy. Interestingly, he focused on "endogenous" uncertainty, i.e. the individual perception of the uncertainty, less than on exogenous shocks. An energy price shock, for example, may lead to a political reaction and creates therefore even higher uncertainty among businesses. This means that only the probability of major changes is already responsible for postponing, not the actual facts. This broader perspective is shared with Duncan (1972) who focuses on the "individual's ability to assign probabilities" (Duncan 1972: 318).

In today's business, Luo (2004) analyzes multinational enterprises with their resource commitment[2] in foreign emerging markets. He concludes that resource commitment reduces when market uncertainty (incl. regulatory uncertainty) is increased, i.e., the probability of investments decreases. This relation was particularly strong for companies that are less strategically proactive. He draws his conclusions based on the transaction cost theory (e.g., Williamson, 1985), which states that uncertainty in such contextual environment is difficult to control. For the specific case of market uncertainty he considered the transaction cost theory to be outweighing the monopolistic advantage theory (e.g., Dunning, 1995, Hymer, 1976). The latter states that multinational enterprises have unique, monopolistic capabilities, which allow them to also operate in uncertain markets. Therefore, those enterprises can even enlarge their businesses in times with high market uncertainty when other firms voluntarily or involuntarily left the market. Multinational enterprises fill the vacuum and capitalize on their monopolistic capabilities.

Finally, Porter & van der Linde (1995) argue that, in principle, "greater certainty encourages in any area" (Porter & van der Linde, 1995:100). According to their argumentation, the relationship between the environmental and industrial competitiveness has been analyzed in literature so far in a primarily static way, meaning that only one goal could be optimized at the expense of the other. Drawing on Porter's competitive advantage of nations (Porter, 1990), they attribute "properly crafted environmental regulation" the ability to trigger innovation and thus offset the cost for complying with regulation for private companies. By means of innovation firms strengthen their competitive advantage in relation to other firms. Innovative firms can even be more internationally competitive than those who have the cheaper input factors or higher production numbers. Porter & van der Linde (1995) state that regulation can even serve to reduce uncertainty, which eventually helps to trigger environmental investments. On the contrary, if regulation is not properly adopted, uncertainty does not decrease and investments can be discouraged (as seen in the US synfuel case by Marcus & Kaufmann (1986)).

The common point of these authors who see regulatory uncertainty as an impediment for investments is their single-edged viewpoint of uncertainty. First, there are different degrees of uncertainty, as for example described by Courtney et al. (1997), from a relatively clear future to true ambiguity, which significantly influence a firm's decision to invest. Second,

[2] Resource commitment is principally a regular investment of a firm. However, the firm would only invest in strategic resources to strengthen its competitive advantage. The latter is determined by a bundle of valuable resources that are at the disposal of the firm. The argumentation is based on the Resource-Based View of the firm.

there is no static environment in which a firm acts. As time goes by, also competitors do act and may gain a competitive advantage or create an entry barrier through their investment. Of course, in an idealistic static world, a firm would wait to acquire further information to weaken the uncertainty and invest later, but this does not hold true in the real world. Third, historic examples of investment hesitance as analyzed by Marcus & Kaufmann (1986) and Bittlingmayer (2001) refer to situations were the regulation can be viewed as "inappropriate" for the industry. In cases where the regulatory environment is contradicting or different policies are not well aligned, investments are discouraged by the simple principle of their bad design. Porter & van der Linde (1995) argued in favor of the properly crafted regulation and their ability to trigger investments and help firms to be more competitive. It is thus necessary to include further components to the analysis to answer the investment question. This is done in the next sections.

2.3.2 Regulatory uncertainty as trigger for investments

There are several lines of argumentation that are in favor of regulatory uncertainty as positively influencing investment decisions. One argument for triggering investments by regulatory uncertainty can be explained by the resource-based view of the firm (RBV). According to the RBV, the sustained competitive advantage of firms derives from their controlled resources and capabilities, which are valuable, rare, imperfectly imitable and not substitutable (Barney, 1991, Barney et al., 2001, Conner, 1991). These capabilities evolve from continuous innovation, organizational learning, stakeholder integration and a proactive environmental strategy (Aragón-Correa & Sharma, 2003). A proactive environmental strategy can help a firm to keep its resources valuable and inimitable by means of innovation and can be seen as a risk mitigation measure.

Aragón-Correa & Sharma (2003) argue that flexible regulation[3] is likely to lead to a competitive advantage for firms because of the firms' discretion to choose between different efficient and productive technologies. They propose a general theory that links the influence of external business characteristics (in their case **uncertainty**, **complexity** and **munificence**) to the ability of a firm to develop a proactive environmental strategy and its competitive advantage. Though RBV covers only the resources and capabilities of the firm, Aragón-Correa and Sharma also draw on contingency theory, which states that organizational performance is a result of alignment between the exogenous context variables (such as uncertainty) and the endogenous organizational design variables. They argue that perceived state uncertainty, according to Milliken's uncertainty classification, positively influences the link between a proactive environmental strategy and competitive advantage. Therefore, regulatory uncertainty would let initiate firms to develop, for example, a proactive environmental strategy, which helps reaching a good performance. Environmental uncertainty thus increases the probability that a company invests proactively.

[3] Flexible regulation determines the goal that must be reached by firms and not the path to this goal (e.g., defining a threshold for pollution rather than the specific technology that must be adopted to reach the threshold).

A limitation must be set to this link as Aragón-Correa & Sharma focus on "environmental strategy". For the electricity industry, this might hold true, for example, for the use of different CO_2 mitigation technologies. However, if a firm faces uncertainty about the regulatory acceptance of a technology, the link is questionable.

In their article, Correa & Sharma (2003) further propose a negative link between **perceived organizational effect uncertainty** and the probability that a firm creates a proactive environmental strategy. The same negative proposition is made for **decision response uncertainty** and a proactive environmental strategy. The main argument behind this rationale is that organizational as well as decision response uncertainty evolve from a lack of organizational resources or capabilities and therefore investments are eventually withheld.

A second important article based on the RBV, published by Rugmann & Verbeke (1998), supports that "green investments" in an uncertain environment can be successful. However, this is only the case if the leveraging potential of the resource commitment for a firm is strong. Mostly, this can only be evaluated ex-post. The second factor in their consideration is the reversibility of the investment in a specific resource. As organizations generally try to avoid irreversible investments if they do not have a clear understanding of the future's environment they conclude that firms prefer flexible investments with high potential on the performance.

According to the two factors, Rugmann & Verbeke differentiate between four cases shown in **Table 2**. In the worst case, the combination of low leveraging potential and low flexibility leads to an "**irreversible green mistake**" (quadrant 1). The investment leads to a trap for the firm because of the exit barrier of the sunk cost. On the opposite, the best case, the investment leads to a "**green success**" (quadrant 4). Firms are thus willing to do resource commitments if the investment offers a combination of high flexibility and a strong leverage of the environmental performance of the firm.

In the intermediate case that high flexibility is combined with a weak leveraging potential as in the "**reversible green mistake**" scenario, the resource commitment is not successful, but an exit options exists (quadrant 2). The last scenario, the "**green gamble**" (quadrant 3), is characterized by low flexibility and a high leveraging potential, which is a success for the firm, but at high risk. The irreversibility acts as an entry barrier for other firms (Rivoli & Salorio, 1996).

Table 2: Development of firm-level green capabilities (deduced from Rugmann & Verbeke, 1998)

Leveraging potential of resource commitments for environmental performance **Flexibility of resource commitments**	**Weak**	**Strong**
Weak	1. Irreversible green mistake	3. Green gamble
Strong	2. Reversible green mistake	4. Green success

2.4 Strategic responses to regulatory uncertainty as risk mitigation techniques

Risk management helps firms to limit their exposure to environmental uncertainty. Firms can either apply financial risk management techniques or directly change their strategic management responses to reduce their risk exposure (Miller, 1992). Financial risk management techniques include insurances or standard buying and selling instruments, like forward contracts, futures, and options. Whereas finance and economics literature focuses on analyzing financial risk instruments (e.g. Dixit, 1989 or Dixit & Pindyck, 1994), the focus of the article is on strategic responses. In case that financial risk management techniques cannot be applied, for example, in absence of the necessary market, strategic moves become the necessary answer to limit firms' risk (Miller, 1992).

2.4.1 Classification of strategic responses

Miller (1992) provides a framework with five generic strategic management responses: avoidance, control, cooperation, imitation, and flexibility. For the case of regulatory uncertainty, the organizational response framework should be limited to four generic strategies on the basis of Engau & Hoffmann (2009): **reduction**, **adaptation**, **avoidance**, and **disregard**.

First, in the case of **reduction**, uncertainty can be limited by influencing, simplification, and investigation. One possibility of influencing is lobbying of political institutions, which can be done by influencing specific conditions or directly addressing political actors (Courtney et al., 1997, Little and Li 1995, Henisz & Delios, 2004). A further way may be simplification of the uncertain factors (Bourgois & Eisenhard, 1988) or investigation by collecting additional information and building on professional expertise in the decision-making processes (Miller & Friesen, 1983, Hickson et al., 1971).

A second way of dealing with regulatory uncertainty can be **adaptation**. Organizations can adjust their organizational design via mergers, acquisitions and divestures (Thompson, 1967, Cyert & March, 1963, Bergh & Lawless, 1998). Firms can also adapt by increasing the flexibility in their investment portfolio (Wernerfelt & Karnani, 1987, Bourgeois & Eisenhardt, 1987, Collis, 1992) or by cooperating with other companies that are similarly or less exposed to regulatory uncertainty (Thompson, 1967, Carter, 1990). Furthermore, firms may copy or imitate the strategies of peers in order to minimize the effect of relative competitive disadvantages (Anderson & Paine, 1975, Bourgeois & Eisenhard, 1987).

A third way of responding to regulatory uncertainty can be the **avoidance** of negative effects, e.g. by postponing investment decisions (Hoffmann et al., 2009, Yang et al., 2004, Bittlingmayer, 2001, Bourgouis & Eisenhardt, 1987, Luo, 2004) and waiting for clarity of the specific regulation (Wernefelt and Karnani, 1987). Firms may also try to standardize their internal procedures or stabilize the organization by, for example, agreeing on long-term contracts (Lev 1975, Thompson 1967). Lastly, an extreme way of response to uncertainty may be the withdrawal from certain market (Miller, 1992).

Finally, a fourth strategic response is if organizations **disregard** environmental uncertainty. An extreme case would be the business-as-usual strategy to simply postulate that the uncertainty does not affect the organization and their decisions (Emery, 1967). Another case of disregard is the substitution of uncertain decision criteria with assumptions drawn

from comprehensive analyses (Collis, 1992). Additionally, Courtney et al. (1997) describe organizations that opt for no-regret moves to focus on decisions that are advantageous for all possible evolutions of the uncertainty variable.

2.4.2 The option-based approach to strategic responses

Doh & Pearce (2004) analyzed firms in an uncertain regulatory environment and how they can best respond via entrepreneurial strategies. By means of the real option theory they recommend firms to adjust their investments along the degree and slope of regulatory uncertainty (degree of uncertainty adapted from Courtney et al., 1997). According to the degree of uncertainty, four different generic strategies are proposed: **preemptive**, **optioned**, **synchronous**, and **adaptive strategies**. **Preemptive strategies** are best at low regulatory uncertainty and are characterized by firms doing a "first strike" with a high resource commitment. **Option strategies** are best at low to moderate regulatory uncertainty where firms do initial investment, which keeps the right to do a further investment step at a later stage. **Synchronous strategies** are best at moderate to high regulatory uncertainty to synchronize investments to the progress of policy change. Finally, **adaptive strategies** are best at highly uncertain environments where investments are made as a response to policy change. The latter is thus a purely reactive strategy without risking even initial investments under uncertainty.

Two articles that are discussed above, from Rugmann & Verbeke (1998) and Doh & Pearce (2004), are essential to deduce adequate strategic investment responses for firms in case of regulatory uncertainty. However, both articles miss important components to describe investments as strategic response (as dependent variable) based on regulatory uncertainty, the independent variable. Anchoring their analysis in the RBV, Rugmann and Verbeke (1998) describe well the link between flexibility of investments and their ability to leverage the environmental performance. Yet, they only give a framework to evaluate a firm's decision ex-post as a firm would only invest if it is convinced that the resource commitment will increase the performance. If the investment eventually turned out to be a leverage can only be evaluated in retrospect. Doh & Pearce (2004) use the real option approach to classify winning strategies according to the regulatory uncertainty and speed of change, but did not reflect the irreversibility in their framework. Further, with their classification of "slope" of regulatory change, they rather refer to objective uncertainty, which should be changed to perceived uncertainty as the perception is the most relevant criteria in the decision making process.

It seems compulsory to consider both the RBV and the real option approach to determine to what degree firms invest under regulatory uncertainty. However, scholars did not provide a framework so far that shows firms how to respond to regulatory uncertainty depended on the type of investment. The strategic responses under regulatory uncertainty will be closer analyzed in the next section.

2.4.3 Proposed framework to classify strategic responses to regulatory uncertainty

Principally, firms evaluate investment decisions based on the financial profitability of the investment opportunity. This evaluation is based on the firm's financial calculations

influenced by subjective perceptions and valuations of the organizational environment including uncertainty about regulation. One common approach of evaluating different available investment opportunities is a risk-return matrix, that analysis the investment in the context of the entire portfolio. The scatter plot consists of two axis, the expected return and the standard deviation of the downside risk of each investment. The firm is now able to rank the investment projects at the efficient frontier in the graph and can select the favorite project according to its risk appetite. The disadvantage of this approach is the negligence of the option to wait and to invest later, which is particularly important for regulatory decisions.

The firm has thus to include the nature of the reversibility of an investment. If the latter is compared with the degree of the regulatory uncertainty, different winning strategies will emerge based on the option value to invest now or later. **Table 3** links the reversibility[4] of an investment with the degree of perceived regulatory uncertainty. To specify the level of perceived regulatory uncertainty we refer to Courtney et al. (1997) and pool "clear enough future" and "alternate futures" to low uncertainty and "range of futures" and "true ambiguity" to high uncertainty. Flexibility of resource commitment refers to the ability of the investment to be used in alternative purposes; a true irreversible resource commitment is therefore sunk. We refer to the term "resource commitment" to anchor the investment decision in the RBV, i.e., the aspiration of the firm to create valuable, rare, inimitable and non-substitutable resources. Only those resource commitments are considered that are assessed to offer a medium to high leverage on the firm's performance.

Table 3: Strategic responses under uncertainty according to flexibility of resource commitment

Flexibility of resource commitment **Level of perceived regulatory uncertainty**	**High**	**Low**
Low	1. Proactive investment strategies (very low option value)	3. Strategies of adaptation to uncertainty (higher option value)
High	2. Strategies of incremental investments (lower option value)	4. Strategies of uncertainty avoidance (very high option value)

The framework depicts four different combinations of perceived regulatory uncertainty and flexibility of resource commitment. It allows managers to choose the appropriate strategic response, which is most promising to lead to high returns.

The ideal case for a company would be the combination of low uncertainty and high flexibility, quadrant 1. The option value to wait is very low and therefore, **proactive**

4 "Reversibility" and "flexibility" are used synonymously in this context.

investment strategies are most suitable to increase a firm's performance. The investment is done immediately without waiting until the uncertainty resolves. In the opposite case, if uncertainty and flexibility are high (quadrant 4), the option value of waiting is highest and **strategies of uncertainty avoidance** promise highest return. Strategies that avoid uncertainty include postponements of investment decisions or withdrawal form the respective market.

Proposition 1: In case of low perceived regulatory uncertainty and high flexibility of the resource commitment firms tend to follow proactive investment strategies.
Proposition 2: In case of high perceived regulatory uncertainty and low flexibility of the resource commitment firms tend to follow strategies of uncertainty avoidance.

For the two other quadrants, when either low uncertainty is combined with low flexibility or both are high, the strategic response is less clear. In case that uncertainty and flexibility are high as in quadrant 2, the option value to wait is low and **strategies of incremental investments** are best to achieve a high return. Incremental investments include staged or multi-phase investments where investments are balanced according to the regulatory decision steps until uncertainty has been resolved. Staged investments offer the advantage to position early in the market, for example, to secure market share or to benefit from early technology development.

Proposition 3: In case of low perceived regulatory uncertainty and low flexibility of the resource commitment firms tend to follow strategies of incremental investments.

Finally, if low uncertainty and low flexibility met in the investment decision as in quadrant 3, the option value to wait is high and **strategies of uncertainty adaptation** to the business environment create highest returns. Adaptation can be done through limiting investments to no-regret moves or by increasing the flexibility in the complete portfolio through cooperation with other companies that are less exposed to regulatory uncertainty or to imitate the investment behavior of the peers to minimize the own disadvantage if the irreversible investment does not lead to the desired return. Furthermore, adapting to uncertainty also includes no-regret moves or substitution of uncertain decision criteria with assumptions drawn from comprehensive analyses.

Proposition 4: In case of high perceived regulatory uncertainty and high flexibility of the resource investment firms tend to follow strategies of adaptation to uncertainty.

Chapter 3, focuses on firms in the power sector and the particular role of technology in generation investments. In cases where regulatory uncertainty is high firms may tend to invest in flexible new technologies to mitigate their business risk associated to regulatory uncertainty. Several propositions are made for discussion and eventually prepare hypothesis for empirical testing.

3. The role of technology power generation investments

The previous chapter analyzed the influence of regulatory uncertainty on investment decisions for firms independently of their sector. Chapter 3 focuses henceforward on the power sector and the link between technology investments and the flexibility of the resource commitment. The hypothesis behind is that power firms change their investing behavior because of regulatory uncertainty, i.e., favoring one technology over the other as the technology offers higher flexibility in the uncertain regulatory environment.

Three sections are offered to frame the analysis. First, investment options in generation capacity will be presented. Second, risks in the power sector will be discussed associated in the context of different technologies. Third, the question of investment flexibility with technologies will be discussed in light of regulatory uncertainty.

3.1 Investment options in generation

To frame the investment choices for power companies in the analysis, we consider both investments in newly built power plants with different technologies as well as investments in modifications of existing fossil-fuel fired power plants. The investment choices are summarized in **Table 4**.

Table 4: Investment options for power companies (deduced from Sullivan & Blyth, 2006)

Investment choices for newly built power plants	**Investment choices for existing fossil-fuel fired plants (coal, gas, oil)**
• Combined cycle gas turbines • Advanced-super-critical coal plant, with or without carbon capture and sequestration (CCS) • Nuclear • IGCC (integrated gasification combined cycle) • Renewables (wind, solar, etc.)	• Converting coal plant to gas-firing • Converting oil plant to coal or gas-firing • Upgrading plants with CCS facilities • Heat rate improvements • Biomass co-firing • Early abandonment • Plant life extension

3.2 Risks in different generation technologies

Different generating technologies come with different risks. The primary goal of a power generation firm is to maximize profit by an optimized use of its asset portfolio. The decision to use or activate each asset is determined by the electricity price that can be received at a particular moment. In the long run, power firms have to decide whether investments should be made in new generation assets and which technology should be taken. In this context, decisions must be also made about the time of retirement of existing power plants.

Each generation technology has different risk characteristics, such as plant size or capital and operational cost (cf. **Table 5**). When comparing generation technologies, a coal-fired power plant has significantly higher capital cost per installed kW than gas, but is much less

exposed to fuel cost. Coal-fired power plants have thus a higher financial risk (Sullivan and Blyth, 2006)

Table 5: Comparison of different generation technologies with risk characteristics (Deduced from Finon, 2008, IEA, 2007)

Technology	**Capital size per unit**	**Lead time**	**Capital cost share**	**Fuel cost share**	**CO_2 cost share**	**Fuel price risk**	**Regulatory risk (during construction)**
Risk		**Plant risk**		**Market risk**			**Regulatory/ policy risk**
Gas turbine (100 MW)	Very low (€ 20 m)	Very short	Low	Very high	Me-dium	High	Low
CCGT (400-600 MW)	Low (€ 100-200 m)	Short	Low	High	Me-dium	High	Low
Coal (2 x 700 MW)	Large (€ 700-1'000 m)	Long	High	Me-dium	High	Me-dium	High
Nuclear (1500 MW)	Very large (€ 2-3 bn)	Long	Very high	Low	Nil	Low	High
Hydro	Very large	Long	Very high	Very low	Nil	Nil	High
Renewables (wind farm/ 200 MW)	Medium (€ 300 m)	Medium	High	Very low	Nil	Nil	Medium

3.3 Flexibility in generation investments

Generally, firms favor flexible over inflexible investments to avoid being trapped by a resource commitment that later turns out to be suboptimal. Different technologies are characterized by specific capital expenditures as well as specific sequencing of the expenditures. On the contrary to large-scale irreversible investments, some technologies allow firms a higher flexibility in their investments than others, in particular new technologies that are not yet ready to commercialize. The option to invest in stages to further develop new technologies and only proceed if, at each step, the technology seems promising, opens an option value for the firm. Although exposed to high uncertainty, the investment can be interesting for a firm if the resource commitment is flexible and the leverage of the resource commitment for the performance is high.

It must therefore be analyzed how uncertainty influences the value of technology options as well as the optimal investment timing. McGrath (1997) analyzed technology positioning investments under uncertainty with the help of a real option approach. The value of the option is thus equal to the value of the underlying claim to cumulative returns from operations minus the cost of the technology development and the cost of commercialization. The more volatile the value of the cumulative returns from the operations are, e.g., through regulatory uncertainty, the more valuable is the option. Particularly, if technology position investments are done in a first sequence and there is a time gap between the investment for commercialization, the option becomes even more attractive. In our context, new technologies in the power sector share these advantages and may explain the investment activity in new technologies of power firms without doing large investments in large-scale projects.

In the current debate of environmental regulations, in particular CO_2 regulation, it is possible that firms hesitate to decide for large investments, but want to keep the track in technology development so that firms may to scale a technology when the uncertainty is resolved. An example for such a technology is Carbon Capture and Sequestration (CCS) that is not approved anywhere in the world yet. It is still a theoretical approach to capture the CO_2 from fossil fuel power plants, compressing it to reach the liquid state and storing it underground, as for example in depleted gas fields or saline formations. The first integrated pilot-scale CCS power plant, "Schwarze Pumpe", in the Eastern part of Germany started operation in September 2008 and is owned by Vattenfall.[5] Other power companies also announced developing CCS further, but so far, regulatory uncertainty about the technology remains. A reasoning could be that power generation companies in Germany hesitated to invest in large-scale plants because of the irreversibility of the investment at the given high uncertainty about the CO_2 regulation. Though, the power generation firms try to avoid loosing market share through a technology based advantage of competitors and also invest in developing CCS further (e.g. the German utility RWE operates a pilot-scale CO_2 scrubber in Niederaussem lignite-fired power plant).

Proposition 5: Firms exposed to high regulatory uncertainty view new technologies as risk mitigation measures to leverage on the flexibility of their resource commitments.

4. Discussion and conclusion

Combining the analysis from the influence of regulatory uncertainty on investment decisions and the characteristics of different technologies it can be argued that regulatory uncertainty influences technological decisions indirectly. In case that the future is clear enough, firms make their investment choices dependent on plant and market factors. If, additionally, regulatory uncertainty arises, generation firms have to reevaluate their investment cases and switch to technologies that are the least harmed by potential regulatory decision. A firm tries thus to invest in technologies that even offer a large

[5] More information about the Vattenfall CCS project can be found at http://www.vattenfall.com/www/co2_en/co2_en/index.jsp.

upside potential in return, but at fixed cost. Investments in new technologies bring along the two advantages, large upside for the generation portfolio and pre-determined cost.

In the article, the question of how uncertainty influences investment decisions has been analyzed systematically by reviewing the impact of uncertainty on organizations, the different argumentations for supporting or contradicting the argument that perceived regulatory uncertainty triggers investments as well as the firm's strategic responses.

To help structuring the discussion how investments are influenced by perceived regulatory uncertainty a new framework is proposed by matching the factor of irreversibility of the resource commitment with the degree of uncertainty. We argue that firms will follow different investment strategies, depending of the combination of the factors and the inherent value of the option to postpone by means of the real option approach.

In summary, investments are favored without delay if the resource commitments offer sufficient flexibility. If such a case is combined with low uncertainty, the full investment amount is devoted in order to reach the optimal return. If uncertainty is higher, only incremental investments will be favored to balance the investments with the progress of regulatory decisions. These incremental investments can be option based or multi-phase investments to gain the optimal option value of the initial investments.

On the contrary, if resource commitments are inflexible and high regulatory uncertainty is perceived by the firm, strategies of uncertainty avoidance, i.e., postponing or deferring the entire investments, promise highest returns. Finally, if low flexibility of the resource commitments meets low uncertainty, firms try to adapt to the specific uncertainty with, for example, no-regret moves or bypassing uncertainty through collaboration with other firms.

Furthermore, we support the argument that firms under high regulatory uncertainty tend to invest in new technologies because of their high flexibility and high option value and rather postpone large irreversible projects. The investment in new technologies can be thus seen as a risk mitigation measure of the firm. However, the argument requires further theoretical examination to be valid and must be supported by empirical analysis.

Bibliography

Allaire, Y., & Firsirotu, M. E. 1989. Coping with strategic uncertainty. *Sloan Management Journal*, 30(3), 7–16.

Anderson, C.R., & Paine, F.T. 1975. Managerial perceptions and strategic behavior. *Academy of Management Journal*, 18(4), 811-823.

Aragón-Correa, J. A., & Sharma, S. 2003. A Contingent Resource-Based View of Proactive, Corporate Environmental Strategy. *Academy of Management Review*, 28(1), 71-88.

Barney, J. B. 1991. Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99-120.

Barney, J. B. 2001. Is the Resource-Based "View" a useful Perspective for Strategic Management Research? Yes. *Academy of Management Review*, 26(1), 41-56.

Bergh, D. D., & Lawless, M. W. 1998. Portfolio restructuring and limits to hierarchical governance: The effects of environmental uncertainty and diversification strategy. *Organization Science*, 9(1), 87-102.

Bernanke, B. S. 1983. Irreversibility, Uncertainty, and Cyclical Investment. *The Quarterly Journal of Economics*, 98(1), 85-106.

Birnbaum, P. H. 1984. The choice of strategic alternatives under increasing regulation in high technology companies. *Academy of Management Journal*, 27(3), 489-510.

Bittlingmayer, G. 2001. Regulatory Uncertainty and Investment: Evidence from Antitrust Enforcement. *Cato Journal*, 20(3), 295-325.

Bourgeois, L. J., & Eisenhardt, K. M. 1987. Strategic Decision Processes in Silicon Valley: The Anatomy of a "Living Dead". *California Management Review*, 20(1), 143-159.

Carter, N. M. 1990. Small Firm Adaptation: Responses of Physicians' Organizations to Regulatory and Competitive Uncertainty. *Academy of Management Journal*, 33(2), 307-333.

Collis, D. 1992. The Strategic Management of Uncertainty. *European Management Journal*, 10(2), 125-135.

Conner, K. R. 1991. A historical comparison of resource-based view theory and five schools of thought within industrial economics. *Journal of Management*, 17(1), 121-154.

Courtney, H., Kirkland, J., & Viguerie, P. 1997. Strategy under uncertainty. *Harvard Business Review*, 3(4), 117-187

Cukierman, A. 1980. The Effects of Uncertainty on Investment under Risk Neutrality with Endogenous Information. *The Journal of Political Economy*, 88(3), 462-475.

Cyert, R. M., & March, J. G. 1963. *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice-Hall.

Dixit, A. 1989. Entry and exit decisions under uncertainty. *The Journal of Political Economy*, 97(3), 620-638.

Dixit, A. 1992. Investment and Hysteresis. *Journal of Economics Perspectives*, 6(1), 107-132.

Dixit, A. K., & Pindyck, R. S. 1994. The Options Approach to Capital-Investment. *Harvard Business Review*, 73(3), 105-115.

Doh, J. P. & Pearce, J. A. 2004. Corporate Entrepreneurship and Real Options in Transitional Policy Environments: Theory Development. *Journal of Management Studies*, 41(4), 645-664.

Duncan, R. B. 1972. Characteristics of organizational environments and perceived environmental uncertainty. *Administrative Science Quarterly*, 17(3), 313-327.

Dunning, J. 1995. *Multinational Enterprises and the Global Economy*. Wokingham: Addison-Wesley.

Eberlein, B., & Grande, E. 2005. Beyond delegation: Transnational regulatory regimes and the EU regulatory state. *Journal of European Public Policy*, 12(1), 89-112.

Emery, F. E. 1967. *The next thirty Years: Concepts, Methods, and Aspirations*. Human Relations, 20, 199-237.

Engau C., & Hoffmann V. H. (2009). Effects of Regulatory Uncertainty on Corporate Strategy - An Analysis of Firm Responses to Uncertainty about Post-Kyoto Policy, unpublished working paper.

Hoffmann V. H., Trautmann T., & Hamprecht J. 2009. "Regulatory uncertainty – a reason to postpone investments? Not necessarily", Journal of Management Studies, 46(7), 1227-1253.

Finkelstein, S., & Hambrick, D. C. 1996. *Strategic leadership: Top executives and their effects on organizations*. Minneapolis/St. Paul: West Educational Publishing.

Finon, D. 2008. Investment risk allocation in decentralized electricity markets. The need of long-term contracts and vertical integration. *OPEC Energy Review*, June 2008.

Guth, W. D. 1976. Toward a Social System Theory of Corporate Strategy. *The Journal of Business*, 49(3), 374-388.

Henisz, W. J., & Delios, A. 2004. Following the herd and sleeping with the enemy: Strategies for managing policy uncertainty. *Academy of Management Proceedings*, M1-M6.

Hickson, D. J., Hinings, C. R., Lee, C. A., Schneck, R. E., & Pennings, J. M. 1971. A strategic contingencies' theory of intraorganizational power. *Administrative Science Quarterly*, 16, 216-229.

Hitt, M. A., Ireland, R. D., & Palia, K. A. 1982. Industrial Firms' Grand Strategy and Functional Importance: Moderating Effects of Technology and Uncertainty. *Academy of Management Journal*, 25(2), 265-298.

Hubbard, R. Glenn 1994. Investment Under Uncertainty: Keeping One's Options Open. *Journal of Economic Literature*, 32(4), 1816-1831.

Hymer, S. H. 1976. *The International Operations of National Firms: A Study of Direct Foreign Investment*. Cambridge, Massachusetts: MIT Press.

Galbraith, J. R. 1977. *Organization design*. Reading, Mass.: Addison-Wesley

IEA 2007. *Tackling investment challenges in power generation*. OECD, Paris, 2007.

Jauch, L. R., & Kraft, K. L. 1986. Strategic Management of Uncertainty. *The Academy of Management Review*, 11(4), 777-790.

Lang, J. R. 1990. Increased environmental uncertainty and changes in board linkage patterns. *Academy of Management Journal*, 33(1), 106-128.

Lawrence, P. R., & Lorsch, J. W. 1967. Differentiation and Integration in Complex Organizations'. *Administrative Science Quarterly*, 12(1), 1-47.

Lessard, D. R. 1988. Country risk and the structure of international financial intermediation. In Courtenay C. Stone, editor, *Financial risk: Theory, evidence and implications*, 197-233. Boston, Mass.: Kluwer Academic Publisher.

Lev, B. 1975. Environmental uncertainty reduction by smoothing and buffering: An empirical verification. *Academy of Management Journal*, 18(4), 864-871.

Lindsay, W. M, & Rue, L. W. 1980. Impact of the Organization on the Long-Range Planning Process: A Contingency View. *Academy of Management Journal*, 38(2), 201-233.

Little, J. L., Li, M. & Simerly, R. 1995. Linking environmental change to strategic response: Some empirical evidence from the U.S. oil industry. *Psychological Reports*, 77(2), 1123-1135.

Luo, Y. 2004. Building a strong foothold in an emerging market: a link between resource commitment and environmental conditions. *Journal of Management Studies*, 41(5), 749-773.

Marcus, A. A., & Kaufman, A. M. 1986. Why it is so difficult to implement industrial policies: Lessons from the synfuels experience. *California Management Review*, 28(4), 98-114.

McGrath, R. G. 1997. A real options logic for initiating technology positioning investments. *Academy of Management Review*, 22(4), 974-996.

Miles, R. E., & Snow, C. C. 1978. *Organizational strategy, structure, and process*. *Academy of Management Journal*, 3(3), 546-562.

Miller, D., & Friesen, P. H. 1983. Strategy-making and environment: The third link. *Strategic Management Journal*, 4(3), 221-235.

Miller, K. D. 1992. A Framework for integrated risk management in international business. *Journal of International Business Studies*, 23(2), 311-331.

Milliken, F. J. 1987. Three types of perceived uncertainty about environment: State, effect, andresponse uncertainty. *Academy of Management Review*, 12(1), 133-143.

Myers, S. C. 1977. Determinants of Corporate Borrowing. *Journal of Financial Economics*, 5(2), 147-175.

Parnell, J. A., Lester, D. L., & Menefee, M. L. 2000. Strategy as a Response to Organizational Uncertainty: an Alternative Perspective on the Strategy-Performance Relationship. *Management Decision*, 38(8), 520-530.

Pfeffer, J., & Salancik, G. R. 1972. *The external control of organizations: A resource dependence perspective*. New York: Harper & Row.

Pindyck, R. S. 1991. Irreversibility, Uncertainty, and Investment. *Journal of Economic Literature*, 29(3), 1110-1148.

Porter, M. E. 1990. *The Competitive Advantage of Nations*. New York. Free Press, 1990.

Porter, M. E., & van der Linde, C. 1995. Toward a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives*, 9(4), 97-118.

Rivoli, P. and Salorio, E. 1996. Foreign direct investment and investment under uncertainty. *Journal of International Business Studies*, 27(1), 335-357.

Roose, K.D. 1954. *The Economics of Recession and Revival: An Interpretation of 1937-38*. New Haven, Connecticut: Yale University Press.

Rugman, A. M. & Verbeke, A. 1998. Corporate Strategies and Environmental Regulations: An Organizing Framework. *Strategic Management Journal*, 19(4), 363-375.

Scott, W. R. 2001. *Institutions and Organizations* (Second Edition ed.). London: Sage Publications.

Sullivan, R., & Blyth, W. 2006. *Climate Change Policy Uncertainty and the Electricity Industry: Implications and Unintended Consequences*. Chatam House, August 2006.

Thompson, J. D. 1967. *Organizations in action: Social Sciences Bases of Administrative Theory*. New York: McGraw-Hill.

Wernerfelt, B. & Karnani, A. 1987. Competitive Strategy under Uncertainty. *Strategic Management Journal*. 8, 187-194.

Williamson, O. E. 1985. The Economic Institutions of Capitalism. New York: Free Press

Yang, B., Burns, N. D., & Backhouse, C. J. 2004. Management of Uncertainty through Postponement. *International Journal of Production Research*, 42, 1049-1064.

Yasai-Ardekani, Masoud 1986. Structural adaptations to environments. *Academy of Management Review*, 11(1), 9-21.