TECHNISCHE UNIVERSITÄT MÜNCHEN

TUM School of Management

Lehrstuhl für Finanzmanagement und Kapitalmärkte

Determinants for Corporate Hedging Decisions

Empirical Evidence from the Global Energy Market

Martin Lievenbrück

Vollständiger Abdruck der von der Fakultät TUM School of Management der Technischen Universität München zur Erlangung des akademischen Grades eines

Doktors der Wirtschaftswissenschaften
(Dr. rer. pol.)

genehmigten Dissertation.

Vorsitzender: Univ.-Prof. Dr. Rainer Kolisch

Prüfer der Dissertation:

1. Univ.-Prof. Dr. Christoph Kaserer
2. Univ.-Prof. Dr. Thomas Hamacher

Die Dissertation wurde am 12.06.2013 bei der Technischen Universität München eingereicht und durch die Fakultät TUM School of Management am 15.11.2013 angenommen.

Abstract

The research of corporate, derivative-based hedging has so far focused on few financial theories to explain hedging patterns. In the present thesis, two new impact factors are analyzed using a global panel data set for energy utilities. Evidence is presented that cultural differences are among the most influential drivers for hedging strategies. In addition, the production technology of a company is put forward as a boundary condition for hedging decisions.

Kurzfassung

Die aktuelle Forschung zum Thema Hedging konzentriert sich auf wenige Finanztheorien zur Erklärung des Hedgingverhaltens von Unternehmen. In der vorliegenden Arbeit wird ein globales Energiesample zur Erforschung zweier neuer Determinanten für Hedgingstrategien vorgestellt. Dabei wird gezeigt, dass kulturelle Unterschiede einen starken Einfluss auf relevante Entscheidungen haben. Zudem erweist sich, dass die Produktionstechnologie eine Randbedingung für die Hedgingentscheidungen von Unternehmen darstellt.

Contents

List of Figures

List of Tables

1 Introduction

The recent crisis has led to market disruptions and a series of price volatilities peaked in 2008[1]. This has brought back to common memory the market risks companies are exposed to. Most market volatilities have calmed down to pre-crisis levels by now[2]. Still I believe, the awareness of being exposed to ever present market risks is relatively high compared to the time before the crisis began.

With this aspect in mind, it is not difficult to motivate why hedging against risks, especially market risks, is of such considerable relevance for our daily business and why a deep understanding of both the risks companies face and the measures they take to manage or mitigate these risks is crucial for decision-makers. Here the research community is called upon to develop a sound theory on corporate hedging. The foundations for this have been laid in early publications that try to explain hedging as a means to increase shareholder value in the presence of certain market imperfections. Unfortunately, these theories cannot explain all hedging patterns we see in reality. Thus, many open questions with regard to the motivation for hedging have to be answered. In my thesis I build on prior research on the determinants for hedging and put forward both on the firm- and the country-level new factors that influence hedging. As the understanding of the relation between hedging and shareholder value can be considered quite well understood, I put forward the production technology as a boundary

[1] As examples I would like to mention the CBOE Crude Oil Volatility Index or the Volatility S&P 500 which both presented a new record since beginning of the data period available to me in 1990.

[2] Examples are again the two above mentioned indices, CBOE Crude Oil Volatility Index and Volatility S&P 500.

condition and the cultural environment as a “soft” factor both influencing hedging decisions.

Smith and Stulz (1985) were among the first to study the determinants for hedging and its impact on shareholder value. Without any doubt, this paper has to be considered one of the most important contributions that set off the modern discussion on hedging. Smith and Stulz (1985) begin with a comment stating the irrelevance of hedging in a perfect market. But as we all know, our markets are far from being perfect, and thus on the following pages the authors investigate in how far hedging can be beneficial given the presence of several well-known market imperfections. Of all the theories that evolved[3], two are of special interest in the context of my thesis. One theory considers hedging as a means to reduce the costs of a potential distress: By hedging, future minimum cash flows can be locked in that serve to meet the fixed obligations a company faces. Through this, the company’s probability of default is reduced and thus the present value of the fixed costs of a potential bankruptcy is kept on a low level. The second theory considers the underinvestment problem. Here the cash flow harmonization and the securing of minimum cash flows helps to ensure certain investment plans which in case the company had to rely on more costly, external financing would potentially not be implemented. By this means, hedging serves to ensure financing for investments that create value for shareholders. Certain other theories have either been presented by Smith and Stulz (1985) or developed later, but most of them consider corporate hedging as motivated by its positive impact on the shareholder value. In the last two decades, many empirical studies have tried to prove that companies hedge to create value according to the financial theories that have been established earlier. Some studies succeeded in this research objective, others failed[4]. Overall,

[3]Only the theory of costs of distress is explicitely discussed in the paper by Smith and Stulz (1985). The underinvestment problem has been introduced later and is discussed in more detail for instance in Froot, Scharfstein, and Stein (1993). The rationales behind these two theories though are largely similar.

[4]Some examples for publications that failed to prove these financial theories or found mixed or partly inconsistent results are Mian (1996); Stulz (1996); Graham and Rogers (1999, 2002); Dionne and Garand (2003); Marsden and Prevost (2005); Aretz and Bartram (2010).

we still do not understand all the hedging patterns we see. This is the starting point of my thesis, in which I want to introduce new determinants that help understand hedging patterns.

The first observation that strikes me when regarding the past research on hedging is that most studies purely focus on the theories put forward in the late 80s (like e.g. in the above cited paper Smith and Stulz (1985)). As I mentioned before, these theories try to explain hedging from the perspective of shareholder value. Thus, they present good rationales why firms should hedge in order to optimize the firm value. On the other hand we have seen in the past that not in all cases firms follow these “advices” — I have mentioned earlier that in several studies the expected hypotheses could not be confirmed. In contrast, hedging strategies seem to depend on a variety of other factors that cannot be explained by the aforementioned theories. In this situation, a new approach might be to study boundary conditions that imply a motivation for companies to follow a certain hedging strategy that is not purely driven by the goal to maximize the shareholder value. Bartram, Brown, and Fehle (2009) are among the first to take this new path by considering a large pool of country-level determinants that shape the institutional environment a company acts in. The determinants they observe are not or only to a certain extent motivated by the aforementioned theories. Unfortunately, in spite of the large sample they build on, the results offer little new insights. Still this 2009 paper has opened the way to new research ideas by considering a new field of explanatory variables.

I will follow this example in the way that I will not purely rely on the commonly used variables meant to test the aforementioned financial theories. In contrast, I will separately consider firm- and country-level variables and thereby both test impact factors presented in earlier studies and introduce new impact factors that have so far not been considered. On the firm-level I will consider the earlier discussed and well-known theories on costs of distress, underinvestment problems and economies of scale and introduce the production technology as a new boundary condition for hedging strategies. On the country-level I will again consider determinants that have proven to be significant in prior research (namely in the paper published by Bartram et al. (2009)) and put forward the culture as a new explanatory factor for hedging. Both new factors, production technology and culture, prove to have an impact on certain hedging decisions.

Another important point to mention here is the scope of the samples that are studied. Most prior and even present studies purely build on national data – to the best of my knowledge only two international data sets are currently used for studying hedging determinants. One is used by Bartram et al. (2009), the other by Lel (2012). By considering international data sets we could ensure that country specific characteristics are less likely to impact our findings. But even the two aforementioned samples show some deficits. Bartram et al. (2009) build on a sample from 2001 and thus only consider one crisis year. Apart from the fact that panel data would be more helpful to control for developments over time, their results are not necessarily representative for years of stable economic growth due to the special situation in which the world economy was in the year 2001. Data spanning an economic business cycle would surely improve the explanatory power of the results. Lel (2012) uses an even more out-dated sample (1990 to 1999). In this time the accounting standards across countries were still differing much with respect to reporting rules of derivatives and hedging instruments. Therefore he purely relies on cross-listed companies that are traded on a US stock exchange. This improves the reliability of the data but also induces some selection bias into the results: The considered companies are potentially not representative for other foreign companies that are not cross-listed in the US. In my thesis, I try to contribute to the current status of research in the way that I consider a recent (2001 to 2009) panel data set of a global choice (57 countries) of companies. Still it will be an important challenge for the future research on hedging to further improve the reliability and the scope of the data used to reduce the risk of sample-induced biases.

For the analysis presented, I will build on a unique, hand-collected sample of approximately 3,800 company years across 57 countries. The hedging information has been manually extracted from published annual reports. In contrast to prior research on hedging, I do not only rely on one dimension that characterizes the hedging strategy of a company[5]. I consider three hedging characteristics: The hedging dummy, which measures if a company hedges a certain risk type, the hedging volume, which equals the notional amount of the derivatives used for hedging, and finally the hedging instruments, which is again a dummy variable indicating if a company uses non-linear derivatives. Similar to most prior studies, I purely rely on derivative based hedging and do not consider any other risk management means like long-term contracts or natural hedges.

I concentrate on listed companies and electricity providers. The latter decision is motivated by the fact that the energy sector is exposed to a variety of market risks. Most energy providers face commodity price risks (CO) when buying primary energy sources and selling power. Furthermore, the non-US companies are exposed to an exchange rate risk (FX) as most primary energy markets are denominated in US Dollar while the electricity is sold in the local grid in local currency. Finally, many projects require heavy funding which usually involves high portions of debt. This exposes the companies to an interest rate risk (IR). Summarizing, electricity utilities are generally exposed to all three market risk types: exchange rate risks (FX), interest rate risks (IR) and commodity price risks (CO). Thus, this industry is uniquely suitable to study the effects of certain determinants for market risk hedging. In addition, the market structure and the core business model of utilities allow to introduce relatively easy measures for the risk exposures these companies face. This enables me to control for the exposure of each company in a more thorough way than is done in most former studies.

Overall, I contribute to the present research in several dimensions:

- I consider a recent data set that covers both crisis and non-crisis years.
- I build on a global set of firms from 57 countries.

[5]In most prior studies either a hedging dummy or sometimes the hedging volume have been studied, but only seldomly both factors are analyzed in the same publication.

- I consider not only one dimension of hedging but three factors, namely a hedging dummy, the hedging volume and the instruments used.
- I consider the three market risk types exchange rate (FX), interest rate (IR) and commodity price risks (CO) – most prior studies take into account only one or two of these risks.
- I focus on one industry that is exposed to all three considered risk types and I build financial measures to control for the respective company's exposures.
- Apart from the well-known drivers for hedging on the company- and the country-level that have been studied in prior research, I present two additional impact factors, namely the production technology and cultural aspects, which have so far not been considered.

My main findings are as follows:

- The US Dollar denomination leads to a much lower FX hedging probability in the US compared to other countries.
- I do not find proof for the well established financial theories on costs of distress and underinvestment problems being of significant relevance for hedging decisions firms take. I do however find evidence for economies of scale facilitating the introduction of hedging for larger compared to smaller companies. Once hedging has been established, however, the hedged volumes are only little affected by company size.
- The production technology affects hedging, as many power plants are hedged using a delta hedging approach. Deep-in-the-money base load technologies lead to higher hedging volumes. At-the-money peak load technologies increase the chance that companies use options and derivatives with non-linear risk profiles.
- On the country-level, I can confirm the plausible relation between the hedging activity and the derivative market development in a country that has been presented by Bartram et al. (2009). Furthermore, I

show that the net energy dependency of a country has some impact on hedging probabilities.

- Finally, I show that culture has a strong impact on all three hedging dimensions – this impact is the second most important impact factor in economical terms after the company size: Companies in short-term oriented cultures tend to hedge more and companies in cultures that are characterized by masculine values are less likely to use non-linear derivatives.

The remaining part of my thesis will be structured as follows: I will begin with a short introduction to the characteristics of the energy market in order to provide the non-familiar reader with the knowledge relevant for an understanding of the remaining part of this thesis. This will be done in chapter 2. As my hedging data purely builds on annual reports I will introduce some important facts about the accounting rules concerning derivatives and hedging in chapter 3. I will then turn my attention towards the discussion of prior literature and research on hedging and by this also introduce the main theories on hedging determinants in chapter 4. This will be followed by the introduction of my data set and the explanation of the process of data gathering from the annual reports (chapter 5). The remaining chapters will present my analyses. In chapter 6, I will discuss some descriptive results that are meant to give an overview of the hedging patterns in the energy market. In chapters 7 and 8 I turn my attention towards the field of firm-level determinants. These chapters are to be considered as a thematic unity: The first one will deal with well established theories, namely the influence of economies of scale and the aforementioned costs of distress and the underinvestment theory, and the second one will introduce a new driver by presenting some implications from the production technology for hedging strategies. The final chapters 9 and 10 deal with the country-level variables. Again, I use the first one of them to analyze established hypotheses on different country-level impact factors (namely the findings made by Bartram et al. (2009)) and in the second part (chapter 10) I will present culture as a new factor influencing hedging strategies.

2 The energy sector

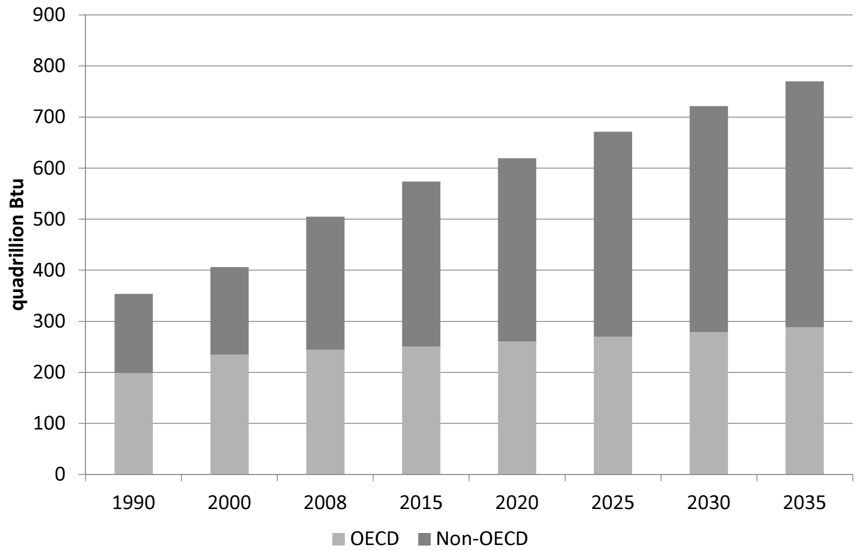
Energy and especially electricity consumption is vital to our modern society. The International Energy Agency has reported an increase of primary energy supply since 1971 by factor 1.4 – the electricity generation even grew by factor 3.1 since then[6] (International Energy Agency, 2012). Also the public interest in the energy markets has gown following the liberalization of markets, sharply increasing oil prices and environmental concerns (Burger, Graber, and Schindlmayr, 2007, p.xiii). Looking upon the future perspective on energy consumption we are likely to see a continuation of the past growth. The US American Energy Information Administration forecasts an increase in energy consumption till 2035 of more than 50 % based on 2008 figures[7]. The whole forecast is shown in figure 2.1.

This all makes clear that the importance energy has for our modern economy is still increasing. But what are the fundamentals underlying this sector? What does its structure look like? Clearly energy markets have some very different fundamentals compared to e.g. stock markets. Geman (2005) lists some of these on page xvi, stating that the demand for energy is very inelastic, that physical transactions are still necessary for the consumption, and that primary (fossil) energy sources are limited. In addition not all of them are easily storable. As the present work will focus on the energy market, it seems appropriate to recap some basic principles.

[6]The corresponding constant annual growth rates are 2.2 % and 3.7 % respectively.

[7]The corresponding constant annual growth rate is 1.7 %.

Figure 2.1: Global energy consumption



Historical and forecasted world energy consumption 1990 to 2035. Source: Energy Information Administration (2011).

2.1 Structure of the global energy market

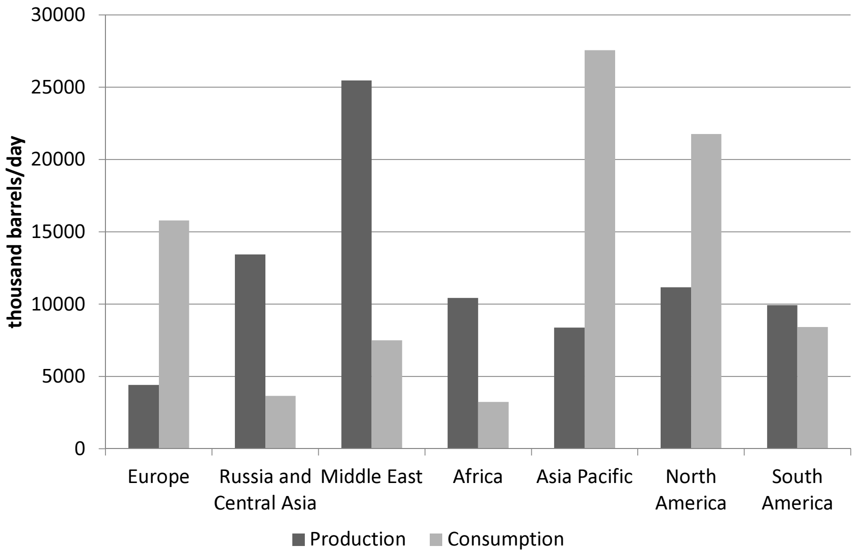
When talking about energy markets, several energy sources are included. The easiest distinction can be made by the position in the energy value chain. Primary energy sources are defined as raw materials that have not been transformed or processed and that have a positive calorific value. Classical primary energy sources are oil, gas, coal, lignite and uranium. All these commodities have a calorific value that indicates their energy content and all of them can further be converted into fuels or electricity, which makes them primary energy sources. For most of these commodities (e.g. coal, oil, gas and uranium) different parallel value chains exist: Coal can for instance be fired in steel mills or power plants, oil can be cracked into different fuels and then used in the transportation system, in power plants or even as tar in the building and construction sector. Electricity on the other hand is a secondary energy source – it is produced using primary (coal, uranium, gas) or other secondary energy sources (diesel). Other secondary energy sources are oil derivatives or heat.

Another classification between the different energy sources can be made according to their transportability. Some energy commodities like oil, coal or uranium can be transported without major constraints, others cannot. Examples here are lignite, gas or power. As an example of easily transportable energy sources I consider oil which can be shipped over large distances from the production sites to the destinations where it is finally consumed. Figure 2.2 shows the 2005 numbers for oil production and consumption in different regions in the world following Eni (2011). The net exporting regions are immediately evident. One example is the Middle East, where less than 30 % of the production is consumed and more than 70 % is exported to other regions. Europe or Asia Pacific on the other hand consume 3.6 times (3.3 times respectively) the produced volume. Overall, the oil market is very international and oil is not purely consumed in the regions where it has been produced – it is an easily transportable commodity.

Another example for an easily transportable energy source is coal. The World Coal Institute (2009) outlines the major coal transportation routes in the world. The longest routes include shipping of coal from Australia or Indonesia to Europe. In 2002 a total of 47 million tons have been transported this way. Forecasts mentioned in the same source predict a total of 75 million tons of coal shipped in the year 2035.

Some other energy sources cannot be as easily transported over long distances. There are at least two reasons that impede a boundless transportation: First, the transportation might depend on local (fixed installed) grids. Examples for this first group are gas or power. Though it is possible to transport gas in liquid condition as so called liquefied natural gas (LNG),

Figure 2.2: Global oil production and consumption 2010



Oil production and consumption in 2010 across the world in thousand barrels per day assorted by regions. Source: Eni (2011).

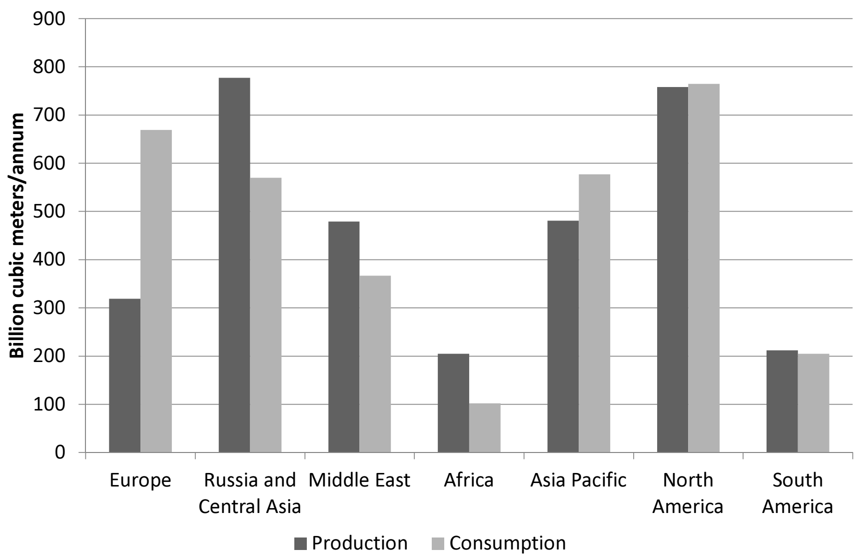
it still makes up only a fraction of global gas trades[8]. Electricity transportation on the other hand is always bound to local grids. These power grids can expand over large areas but often they do not even span a whole country but only a certain part of it. For instance the US American market consists of 10 grid areas (Federal Energy Regulation Commission (FERC), 2013). Obviously, the electricity trading can only take place within these grid areas and the adjacent grids that are connected.

Second, the transportation might be too expensive compared to the inner calorific density of the energy source and thus its value. An example for this is lignite which is often burned in production-near power plants and generally not shipped over long distances.

[8]The International Gas Union (2010) reported a total of 223.8 mmtpa of LNG transported in 2010, which equals roughly 304.4 bcm and thus 9.6 % of global gas transported in that year (BP, 2012).

To visualize the impact of transportability on the global trading structure I include figure 2.3, showing the production and consumption figures for the global gas market. Though we again see some net importers and exporters, the net gas imports/exports are much lower than the earlier presented figures for the oil market. Africa is the largest relative net exporter in the sample, consuming less than 50 % of its production rates. Again Europe is front-runner for the imports, consuming more than double of its own gas production. The existing differences must be mainly attributed to intercontinental pipeline systems rather than real global LNG trading. Eni (2011) reported that in 2009 72 % of the gas import to Europe came via large pipelines from Russia or North Africa, only the remaining 28 % (12 % of total consumption) reached Europe as LNG. This explains both the high European imports and the high Russian and African exports. Overall gas is still mainly traded regionally bound to pipeline systems. As one can imagine, this results in huge differences in prices between trading regions.

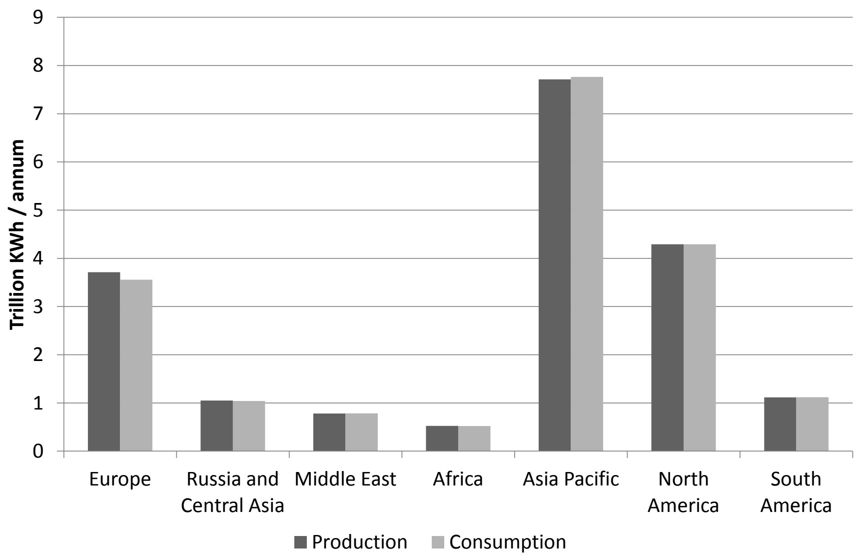
Figure 2.3: Global gas production and consumption 2010



Gas production and consumption in 2010 across the world in billion cubic meters per annum assorted by regions. Source: Eni (2011).

With respect to power the corresponding trading regions are even smaller. Figure 2.4 shows the consumption and production for different regions in the world. One can see that local production almost matches local consumption. This asserts the hypothesis that power is a by far more locally traded good than e.g. oil. Overall the net imports/exports of electricity are smaller than the production or consumption approximately by factor 1,000. Overall one must consider power neither as a globally (like e.g. oil) nor as a regionally (like e.g. gas) but rather as a locally traded commodity.

Figure 2.4: Global power production and consumption 2010

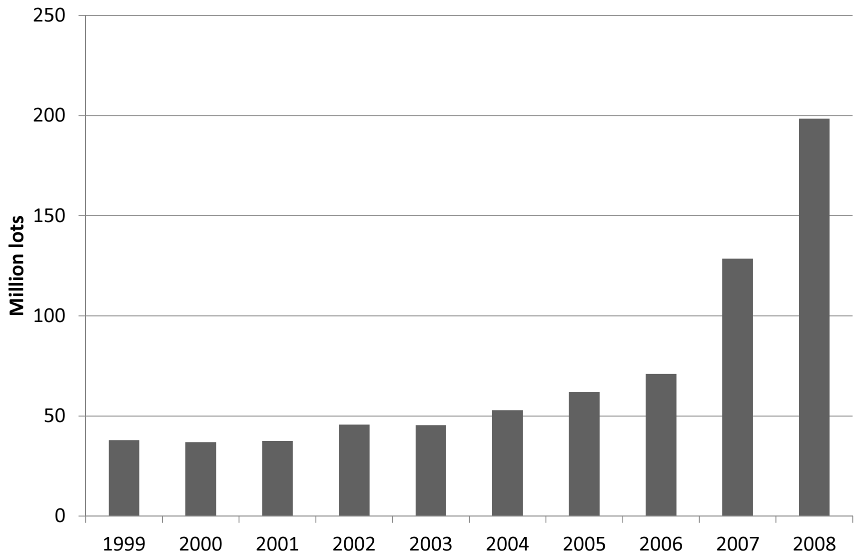


Power production and consumption in 2010 across the world in trillion Watt hours per annum assorted by regions. Source: Energy Information Administration (2013).

The size of trading regions for different commodities also impacts two major factors that will be of considerable importance in the following discussions.

First, globally traded commodities often see a higher liquidity in relevant derivative markets. E.g. oil forwards and futures are among the most liquidly traded commodity derivatives. In contrast, gas and power derivative markets are less liquid and liquidity differs across regions in the world. Geman (2005) reports more than 300,000 daily WTI and Brent crude oil trades on NYMEX and IPE on average in 2004 (216,728 on NYMEX only). Natural gas trades occur on average less than 65,000 times a day on the two mentioned exchanges (61,165 NYMEX) and only 322 power trades per day are recorded. The number of WTI oil trades at Nymex has increased by more than factor 4 between 1999 and 2008. Figure 2.5 shows the corresponding numbers.

Figure 2.5: NYMEX oil trades



Number of WTI oil trades at NYMEX between 1999 and 2008. Source: CME group (2012).

Second, the currency in which a commodity is traded also depends on the fact whether trading is global or regional or even local: Oil, coal and uranium trading are often denominated in US Dollar. Gas trading between countries is often linked to the US Dollar though figures can be published in other currencies. But locally traded commodities like power or lignite are denominated in local currency. As one can easily imagine, this has a direct implication on the market risks a utility takes. Though the energy sector exists for a longer time, management of market risks has only developed in the last two to three decades. Formerly, risk management was mainly concerned with operational risks. I will now describe one of several reasons that can be given for this development.

2.2 Deregulation and market development

Historically energy production was mainly a monopolistic business. Huge corporations, many of them state owned, were ensuring the security of supply. As energy is a vital product in our technological society and power outages or shortcomes in power provision can have severe consequences this was often considered to be the only possible market structure. In this market environment business and risk management differed largely from other industries. There was little or no competition and many risks could simply be passed through to end customers. In addition no company had to strategically decide where to play in a long value chain. All steps from purchasing primary energy sources to delivering power to the end customers were often concentrated in few or even a single company. Following the early deregulation in the oil sector after 1986 (Bhattacharyya, 2011), in the 1990s many countries have started to open their power markets to new companies. This resulted in several new direct or indirect developments.

First, new companies have evolved and existing market players have grown across national borders into new markets. This led to a new competition in the market and the need for enhanced efficiency in the company structures that were still configured for the former monopolistic markets.

Second, the different steps in the value chain, which were previously bundled, have now been separated opening way to completely new business concepts focusing on the value creation through only few of these steps.

This led to the evolving of smaller companies active in less capex intensive steps of the value chain (e.g. selling in the retail market). It is worth mentioning here that in the present work I will consider companies that are active in the production or at least in the energy wholesale market, though of course some of them, mainly former monopolists, are still active in all steps of the energy value chain.

Third, risks had to be priced more accurately. This can be attributed to both the unbundling of steps in the value chain and the increased competition which all led to more transparency of the price setting. In this view, risk management and especially hedging of market risks gained new importance, as competitors could decide not to pass through price risks to customers but secure them and potentially attain a favorable market position by doing so.

2.3 Risks in the energy market

The mentioned deregulation led to a new discussion of the risks a utility is exposed to. Geman and Roncoroni (2006) state that energy utilities are first of all exposed to volume and price risks. The relevant risks, especially the power price risks, are large compared to price risks in other underlyings. Deng and Oren (2006) comment on page 940: “Electricity spot prices in the emerging power markets are volatile [...] Uncontrolled exposure to market price risks can lead to devastating consequences for market participants”. As this plays an important role in the coming sections, I will briefly outline the underlying power business structures and derive a high level picture of a typical utility’s risk position.

The core business of a traditional utility can be easily described as buying primary energy sources (like oil, gas, coal, lignite and uranium), transforming these sources into electricity, selling electricity and delivering it to the end customers. As mentioned earlier, all these steps have been unbundled following deregulation. I will put my focus on the first steps of this value chain, namely the purchasing of primary energy sources, the conversion into power and the selling of power on the wholesale market. This business concept results in the following risks.

First, utilities face an exchange rate risk. This has been indicated earlier when talking about US Dollar denomination of most primary energy sources. When a utility buys its primary energy in US Dollar and sells the mainly locally traded secondary energies (power and heat) in local currency, the business is clearly exposed to the US Dollar. The amount of this exposure can be estimated by the COGS – the cost of goods sold. For utilities COGS are mainly incurred through buying fuels (primary energies). If the company is located in the US, the US Dollar denomination of primary energy sources is of course irrelevant as the electricity sales also generate cash flows in US Dollar[9]. My FX exposure proxy will be as follows: If a company is not located in the USA, its FX exposure is estimated using the COGS. In case the company is locaed in the US, its FX exposure proxy is zero:

$$\text{Exposure}_{FX} = \frac{\text{COGS} \cdot \text{I}_{non-US}}{\text{Total assets}} \tag{2.1}$$

with I_{non-US} being the indicator function with value "0" if a company is located in the US and "1" otherwise.

Second, I assume that each utility has an exposure to energy commodities. This exposure, though, can differ largely based on the utility's production portfolio. As one can imagine easily, renewable power plants only constitute a commodity exposure on the demand site (the power selling side). Fossil

[9]Though I will make this assumption, in reality even those firms that have all balance sheet assets and cash flow prices in US Dollar may have an FX exposure. A detailed discussion of this fact is given in Adler and Dumas (1984). The main idea is that e.g. sales can vary if the customer's cash flows depend on exchange rate risks. This implies an indirect FX risk to the utility. On the other hand Jorion (1990) shows that the comovement between stock returns and the value of the US dollar for US multinational companies is highly correlated to the degree of foreign operations. Thus, the first order effect seems to be much stronger than any second order influence. In addition, Joseph and Hewins (1997) show that hedging is primarily implemented to meet the first order effects and only seldomly to manage second order impacts like the ones mentioned here. I will therefore and for simplicity reasons neglect this second order effect.

production plants on the other hand incur an exposure both on the supply and the demand side: Primary energy sources need to be bought and power needs to be sold. A good proxy here seems to be the sum of COGS and Sales.

$$\text{Exposure}_{CO} = \frac{\text{COGS} + \text{Total sales}}{\text{Total assets}} \tag{2.2}$$

Third, it is trivial that a utility's core business involves building power plants. But these projects are generally more capex intensive than typical projects in many other industries[10]. These amounts can usually not be taken without a substantial share of debt. E.g., Bradley, Jarrel, and Kim (1984) find that energy companies are highly leveraged – more precisely they report the second highest debt to value ratio for electricity and gas utilities in a sample of 25 industries. Only Airlines have a higher ratio. As this debt is normally indexed to an interest rate index, it follows that utilities are also substantially exposed to an interest rate risk. Unexpected changes in the interest rates can have a major impact on a firm's value and investments (Bartram, 2002). Unfortunately the amount of debt with a fixed interest rate and with floating interest rates are not always given in annual reports outside the US and Europe. I will thus use total debt as a proxy for a utility's interest rate exposure:

$$\text{Exposure}_{IR} = \frac{\text{Total debt}}{\text{Total assets}} \tag{2.3}$$

Major other risks which the business concept of a utility involves are a credit risk through long-term contracts with suppliers, cooperation partners or customers and operational risks. As mentioned earlier, these risks shall not

[10] As an example, one can briefly calculate the approximate costs for building a new medium sized coal fired power plant: The International Energy Agency (2010) reports between 2,310 and 4,263 US Dollar for construction of one kW installed capacity in a coal fired power plant. An average plant of 600 MW installed capacity (size example for the two unit Cliffside project by Duke Energy Carolinas which was planned in 2006) would consequently cost around 2 billion US Dollar.

be considered in detail here as hedging them usually is done via appropriate contract design.

As stated before, utilities have started to increasingly manage their risk exposures in the last decades. Here a unique characteristic of the energy sector plays an important role: Market risks make up the majority of risks a utility faces (as discussed above) and most of these risks can be traded. Interest rate risks, which are important in the energy sector due to the high investments leading to higher leverages than observed in other industries, exchange rate risks, occurring frequently for non-US-based companies that earn their money in the spread between US Dollar denominated primary energy sources and locally sold power, and commodity price risks, cover the main price risks both on the supply and the demand side of a utility. Compared to other industries, utilities are thus in the advantageous position to handle most risks they are exposed to by using derivatives. This is, as explained earlier, the reason why this analysis puts the focus on this special industry.

An interesting fact in this context is the growing global structure of energy trading. Even former regional trading becomes more and more global. One example here is the LNG (liquefied natural gas) market. Traditionally gas was transported via pipelines only. In the 80s first LNG shipping was introduced into the market. Since then LNG trading volumes have grown from less than 25 mmtpa in 1980 to more than 220 mmtpa in 2010 (International Gas Union, 2010). Potential drivers for future increases in LNG volumes could be the growing demand especially in China, while figures in traditional delivery areas like Japan, Korea or Europe are currently stagnating. On the other hand new liquefaction regions like US or Australia could gain more importance, especially with the US becoming a swing supplier for both Europe and Asia.
Another example is the growth of global coal trades over time. The World Coal Institute (2009) has reported an average annual increase of 8 % in seaborn steam coal trade over the last twenty years. Steam coal is used in the electricity production. But still global trades in the coal business only make up approximately 18 % of the global consumption – showing that coal

is still mainly used in the country where is has been mined.

For the reader interested in a more thorough consideration of risks and risk management in the energy market, there are a variety of books and papers to be recommended. One comprehensive overview of tools, instruments and methods used in the energy risk management is given in Dahlgren, Liu, and Lawarree (2003) or Denton, Palmer, Masiello, and Skantze (2003). In addition a theoretical model for the optimal hedging position in FX risk though not specifically for the Energy market is given in Campbell, Medeiros, and Viceira (2010).

2.4 Future challenges and developments

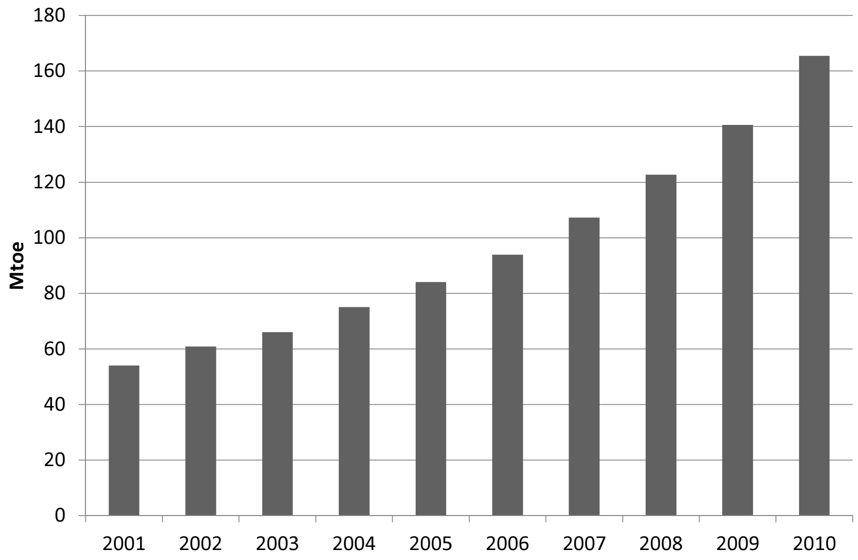
Some of the core principles discussed earlier are necessary to understand the dynamics in the energy sector. However, predicting the future structure of the energy market is difficult in the present time as some fundamental changes are taking place.

First, there is an increasing demand for energy in the developing countries. E.g. the energy supply in China has more than six-folded since 1971 (International Energy Agency, 2012). Electricity demand has even grown from little more than 260 TWh in 1980 to more than 3,600 TWh in 2010 (Energy Information Administration, 2013) – which is an increase by approximately factor 14. On which level this appetite for energy is going to settle down is not yet clear. Unclear is also the generation mix that can meet this exploding demand in the future.

Second, there is a growing consciousness for ecological concerns and an increased willingness to allocate a price to environmental charges. In the Kyoto protocol in 1997 a strict target for the greenhouse gas emission reductions till 2012 has been set for industrialized countries on average by 5.2

% compared to the 1990-levels. Though recent discussions on the continuation of this program are stagnating – or at least no quantitative targets are currently set – the direction our actions take is clear: All greenhouse gas emission will have a price in the future. The electricity production sector will likely have to bear a major share of the reductions that are necessary. This means that we will see much more renewable production technologies in the future than today and that fossil power plants will have to be reduced by capacity to meet whatever target will be set.

Figure 2.6: Global renewable production



Global renewable production 2001 to 2010. Numbers exclude hydro power plants. Source: BP (2012).

This on the other hand will have a great impact on the energy sector. It is still not clear where the needed investment volumes will come from, what impact we will see on the retail prices and what will be a proper pricing mechanism. The current approach to use the supply and demand curve to calculate an equilibrium might not be the appropriate method in a world where marginal costs of production are near zero and the power prices mainly have to cover former capex.

These ongoing developments and the resulting challenges will surely have their impact on the energy markets. What this impact will look like in detail, can currently only be guessed.

2.5 Implications for further analyses

I will briefly summarize the major implications for the following analyses and this work as a whole here:

- *Market liquidity* – Liquidity in commodity markets differs. Some commodities like oil are traded globally and related derivatives can be used without major constraints. Other commodities like power depend on local grids. Here market liquidity differs largely between regions. E.g. Europe has some of the most liquid power markets, while the accessibility of certain power derivatives in the US can be considered difficult. As no detailed information on market liquidity for commodities is available to me, I will critically question results and use country dummies where possible.
- *Market risks* – The most important market risks an energy provider faces are exchange rate, interest rate and commodity risks. All of these risks can be hedged using derivatives with one limitation. Some commodities are mainly locally traded like power, for which market liquidity is still low in various regions in the world. This fact will be considered in some detail in the following.
- *Risk exposures* – I use proxies for the companies' exposures to the three considered risk types, as real exposures are only seldomly reported. The following estimates are used:

$$\text{Exposure}_{FX} = \frac{\text{COGS} \cdot \text{I}_{non-US}}{\text{Total assets}} \tag{2.4}$$

$$\text{Exposure}_{CO} = \frac{\text{COGS} + \text{Total sales}}{\text{Total assets}} \tag{2.5}$$

$$\text{Exposure}_{IR} = \frac{\text{Total debt}}{\text{Total assets}} \tag{2.6}$$

A major assumption here is that utilities buy primary energy sources in US Dollar and sell power in local currency, as has been discussed in detail in section 2.3.

3 Accounting standards and hedge accounting

All research in the following chapters builds on information on corporate derivative usage in the energy market extracted from annual reports. In the following I will dedicate some considerations to the informativeness of annual reports when it comes to hedging and derivative information. I will therefore try to give a brief overview on accounting rules concerning derivative positions and especially hedge accounting. IAS 32 and IAS 39, both regulating the handling of derivative positions from an accounting perspective, are considered some of the most detailed and complex rules under IFRS. As the goal of this work as a whole shall not be to turn the reader into an accounting specialist, I will focus on a broad perspective and the general knowledge that is necessary for the understanding of the upcoming discussions on derivative hedging.

3.1 Derivatives and hedging under IFRS

IAS 32.11 defines a financial derivative as a contract that gives rise to a financial asset of one entity and a financial liability or equity instrument of another entity. See Hayn and Waldersee (2008) on page 147: “IAS 32.11 definiert ein Finanzinstrument als einen Vertrag, der gleichzeitig bei dem einen Unternehmen zu einem finanziellen Vermögenswert und bei dem anderen zu einer finanziellen Verbindlichkeit oder einem Eigenkapitalinstrument führt"). These instruments must be handled in a certain way according to present accounting standards. The rule IAS 39 regulates this topic under IFRS. Following IAS 39.9, all financial instruments must be classified when first approached in the balance sheet. Categories are held-to-maturity, available-for-sale, held-for-trading and at fair value through profit and loss. Depending on the classification, the instrument is then stated at acquisition costs (held-to-maturity) or marked-to-market (rest). This means that for instruments not held to maturity, the value must be updated accordingly. Changes in the fair value are covered either in the profit and loss statement (held-for-trading and fair value through profit and loss) or directly in the equity (available-for-sale). As most derivatives are booked as held-for-trading (classification as held-to-maturity and available-for-sale must be argued for and is not always possible), changes in the market value of a derivative often directly impact the company's income. Therefore derivatives are in general known to increase the earnings volatility. Therefore special hedge accounting rules are needed to incentivize companies to use derivatives for hedging purposes – in the other case, taking derivatives into the own books would increase the volatility and thus the risk more than it would help manage existing risks.

In reality, derivatives are often used to reduce risks. Both IFRS and US GAAP distinguish between three possible types of hedges: Fair value hedges (IAS 39.86(a)), cash flow hedges (IAS 39.86(b)) and hedges in a net investment in a foreign entity (IAS 39.86(c)). Fair value hedges serve to mitigate the volatility in a value of a certain asset position by building a counter position that is negatively correlated to the asset that shall be hedged. This means that in case the hedged item increases its value, the value of the hedging instrument decreases by the same amount and overall the balance sheet value of both positions together keeps unchanged. In a cash flow hedge, the company aims to reduce the volatility of future cash flows by introducing hedging instruments whose negative cash flow equals the cash flow of the hedged item. A net investment hedge finally serves to hedge an investment in a foreign currency due to a subsidiary in a foreign country.

According to IFRS, only certain positions can be appointed as hedged items. The resepctive position can be an asset or liability but cannot be a derivative itself. It can be an unrecognized firm commitment – a risk that is not recognized in the balance sheet but existent for the firm. Furthermore, it can be a transaction that is highly probable and finally it can be a net foreign investment. In case the hedged item is an asset or liability position, it must be classified as hedged item as a whole – it is not allowed to simply hedge a certain part of this position. One exception is given, when the item is a financial instrument itself. In this case IFRS allows hedging only a certain portion, in case the efficiency of the hedge can be calculated. This rule has been introduced to ensure that the efficiency of a hedge can be measured appropriately. It is doubtful if for non-financial hedged items sensitivities towards certain risks can be separated from each other and thus the rules only allow considering the position as a whole. This is different for traded financial positions, where sensitivity analyses can be implemented more easily.

Besides the requirements for the hedged item, IFRS also presents some requirements for the hedging instrument. Only financial instruments and especially derivatives qualify as hedging instruments. One exception is given for hedging FX risks where also non-financial assets or liabilities are allowed for hedging purposes. One example are FX receivables that can be netted. In addition it is not allowed to simply designate a certain part of a derivative for hedging purposes – only in the case of derivatives, a certain percentage can be classified as hedging instrument. In reality derivatives are among the most important instruments used for hedging purposes. One reason is the relatively low investment and the high liquidity and thus availability. In addition it is easier to match the maturities between the hedged item and the hedging instrument when using derivatives which are often available for different time horizons.

Finally, in the rule IAS 39.88, IFRS also names some requirements for the hedging relation which all have to be fulfilled. The most prominent are the following two: First, the hedging relation must be documented and designated formally. Second, the hedge must be highly effective and the underlying calculation must be assertive. The effectiveness is hereby defined as the delta of the hedging instrument with respect to the hedged item. This effectiveness must be monitored continuously.

In case all the above mentioned requirements are met, hedge accounting rules allow a company to book the hedging instrument and the hedged item in a special way. In case of a fair value hedge, the difference between the mark-to-market and the book value of the hedged item is taken into the profit and loss (IAS 39.89). By this means it can be achieved that the fair value adjustments made on the hedging instrument offset the changes applied to the hedged item. By doing this, no further earnings volatility arises for the company.
In case of a cash flow hedge, the hedging instrument is taken to realize future cash flows that offset another highly probable future cash flow series. In case the hedging instrument's value would be changed according to the fair value principle, the company would incur an additional profit and loss volatility till the hedged cash flows are realized. In this case, hedge accounting rules allow a company to book the changes of the hedging instrument's value in a special equity item called the cash flow hedge reserve. By this the general rule of realizing value changes in the profit and loss statement is abandoned.

Though hedge accounting rules by US GAAP are not perfectly equal to the rules described above, they have been elaborated prior to the IFRS standards and must be viewed as the structure from which most international hedge accounting rules have originated.

Overall, one can see that the requirements for hedge accounting are quite high. Therefore some companies decide not to apply hedge accounting at all. Even if companies use hedge accounting, not all positions taken to hedge risks can be captured under hedge accounting rules and some therefore remain as held-for-trading positions in the company's books. Thus, one has to be cautious when extracting derivative information regarding hedging from the annual reports: The classification into hedges and positions held-for-trading does not necessarily coincide with a company's intention for holding the corresponding derivative position. As this plays a major role for the process of data gathering, I will refer to this topic again in chapter 5.

3.2 Implications for further analyses

Overall, two major implications from the above stated facts are important for the understanding of the following research on hedging and especially the data collection process:

- *Reliability of information* – The international accounting standards IFRS and US GAAP determine that all derivatives a company holds must be recognized in their balance sheet. This is the rationale underlying the decision to classify a company reporting under IFRS, US GAAP or any other international accounting standard as a non-hedger in case there are no derivatives mentioned in their annual reports. I will make use of this convention in chapter 5.
- *Reliability of classification* – Most derivatives are recognized as held-for-trading when taken into the books of a company. Hedge accounting imposes strict rules on the hedged item, the hedging instrument and the hedging relation (e.g. the effectiveness and the documentation of the latter). Therefore, the classification of a derivative as held-for-trading does not necessarily mean that this position does not qualify for hedging purposes. I therefore do not purely rely on the classification of derivatives as hedging instruments under hedge accounting to assign a position to the categories "hedging" or "speculation". This will also be used in the chapter 5.

4 Prior research on hedging determinants

An increased research on determinants for corporate hedging and the effect on shareholder value begins in the late 1980s. Early literature considers the determinants for and consequences from hedging on a theoretical level. This must be attributed to two facts. First, the theoretical understanding of hedging was still low and thus the need to build a sound foundation for further research was considered the main task. Second, the data availability for empirical research presented problems, as consistent hedge and derivative accounting policies were still missing in most countries. In addition it took a long time for derivatives to become accepted measures for risk management. For a long time they were just viewed as objects used for speculation purposes. One can grasp the perception of derivatives some decades ago when reading the introduction to the paper Working (1953) on page 314: “Much of the popular suspicion of futures trading stems from a sense of mystery associated with it”. In the late 80s a rigorous and theoretical research on the use of derivatives for hedging and speculative purposes began. Among others the paper of Smith and Stulz (1985) on value creation through hedging in the presence of market imperfections like taxes, underinvestment problems or costs of distress should be mentioned here. The theories presented in this paper have been studied further in many following theoretical and empirical works. Amit (1990) studies on a general level the reasons for firms to reduce their business risks and finds evidence consistent with value maximization theories. In the 1990s first empirical studies were published, still building on national samples and rather few observations. In this time research aims at validating the forecasted results from theoretical approaches. But many papers from empirical research in that time come to contradictory conclusions – the results differ largely based on the chosen sample and the method of data generation and are not always in line with the hypothesized expectations (compare e.g. Mian (1996); Stulz (1996); Graham and Rogers (1999, 2002); Dionne and Garand (2003); Marsden and Prevost (2005); Aretz and Bartram (2010) and the discussions below). Today, hedging is still not perfectly understood and research yields sometimes inconsistent findings. Two reasons for this may be the limitation of samples (many papers still build on national samples) and the need to better control for yet unstudied impacts. To the best of my knowledge only two empirical papers build on truly international samples, Bartram et al. (2009) and Lel (2012). However, even these samples are still characterized by certain limitations in perspective: Bartram et al. (2009) build on dummy variables only. In addition they consider only one year – 2001 – which must also be considered as a crisis year and is thus only difficult to compare to other times. Lel (2012) uses an ADR sample – companies that are cross-listed in the US. The advantage is a more reliable information on hedging strategies, the disadvantage the atypical characteristics of companies that are cross-listed. They are by no means comparable to foreign companies that are not listed in the US.

The first and general topic to discuss when regarding derivative hedging is the differentiation between derivatives used for hedging and for speculation purposes. Allayannis and Ofek (2001) analyze this question building on a sample of Standard & Poors 500 non-financial firms. SFAS 105 required firms to report their face, contract or notional amounts of financial instruments since 1990. They find evidence that the exchange rate exposure is strongly and negatively correlated with the exchange rate derivative usage. Thus firms in their sample most likely use derivatives for hedging rather than for speculation purposes. Still the purpose of derivative usage is a topic every study of hedging has to address. I will discuss this point in more detail in the section on the data gathering process (see chapter 5).

This is just a short discussion on the developments in the hedging research. In the following I will give a more in-depth perspective into the theories that have been considered in the past studies.

From the results of Modigliani and Miller (1958) we know that firm value is invariant under changes in the financing structure given a perfect capital market and the absence of taxes. Here a "perfect market" is characterized by the following assumptions:

- Equal access to production technology for all market participants
- Absence of market friction in the form of transaction costs or costs of distress
- No asymmetries of information between market participants
- No market participant with the power to set prices
- No barriers to entry or exit the market

This implies among others that all risks of equity and derivatives are already priced fairly and hence no company can create value or achieve an advantage through the usage of derivatives: Risk management can be easily done by shareholders themselves by investing into other assets and thus building a portfolio that matches their risk appetite. Correspondingly there is no need to pay companies for their risk management. Thus an application of the Miller-Modigliani-Theory is the irrelevance of hedging decisions for firm value.

This however only holds in an environment strictly marked by the afore mentioned assumptions whereas in reality it is known that markets are rather imperfect. For this reason it is possible to observe that firm value is dependent on hedging strategies (see e.g. Campello, Lin, Ma, and Zou (2011) or Graham and Rogers (1999)). Furthermore one can attribute this dependency of firm value on hedging to certain violations of the assumptions in the Miller-Modigliani-Theory. This leads to the different hypotheses about value creation through hedging in the cases of taxes, costs of distress and underinvestment problems plus motives for hedging through management risk aversion that will be presented in the following. As most of these theories have been discussed broadly on a theoretical level in the article of Smith and Stulz (1985), I will refrain from discussing the theoretical background in detail but rather give a short explanation of the underlying rationales and give some examples of papers that deal with the respective theory. I recommend Smith and Stulz (1985) to those interested in further details on theoretical value creation through hedging.

The remaining part of this chapter shall be structured along the separate theories and explain them in some detail.

4.1 Tax curve convexity

One of the most obviously violated assumptions of the Miller-Modigliani-Theory is the existence of taxes in real economy. Here the shape of the tax curve can lead to advantages through hedging in certain situations. The theoretical rationale behind this goes back to early considerations of a potential convexity in the income-tax diagram and is for instance explained in more detail in Slitor (1948) or the above mentioned Smith and Stulz (1985).

Let us imagine an increasing tax rate as a function of the pre-tax earnings, i.e. the expected taxes are convex with respect to the taxable income. Jensen's inequality suggests that the after-tax earnings decrease less through hedging than the pre-tax earnings. Thus incurred costs for the risk premium in hedging instruments lead to a lower tax rate and are consequently only partly mirrored in the reduction of after-tax earnings. In this case hedging increases firm value.

There are different constellations that constitute convexity in the tax curve and hence make it advantageous for firms to hedge. The most simple is a statutory progressivity in the tax curve. In reality this can be found in only few countries and if so, the effect is rather small. For this reason research rather focuses on another reason for convexity in the effective tax curve of a firm – so called tax preference items. These are tax loss carry forwards or tax credits (e.g. for foreign tax payments or investments). They also give the tax curve a convex shape which yields the same results.

Smith and Stulz (1985) and Smith (1995) suggest that if the pre-tax income of a firm is below a certain threshold, the tax preference items lose their value. For this reason one should expect that the probability of a company to hedge is higher, when the firm faces more tax preference items and when the pre-tax income is above the sum of these items. The amount of savings through hedging in the presence of a convex tax curve differs with the carry forwards a company has. Graham and Smith (1999) develop a theoretical model and find a large range of possible savings from little more than 5 % to more than 40 % of expected tax liabilities.

Nance, Smith, and Smithson (1993) are among the first to look at the influence of tax structure on hedging decisions using empirical data. The sample covers survey data from 169 firms in 1986 for which hedging information have been gathered. In addition to the hedging information they use Compustat data for firm financials. In their sample 104 (61,5 %) firms were classified as hedgers. The authors find that investment tax credits and statutory progressivity lead to a higher probability of hedging. The predicted theory unfortunately could not be proved for tax loss carry forwards where non-hedgers show a higher mean value in the chosen sample. The analytical results in this paper also provide evidence for other theories mentioned in the following sections as the costs of distress or the underinvestment theory.

However other works like e.g. Graham and Rogers (2002) do not find evidence for higher probability of hedging in the case of convexity in the effective tax curve. A potential explanation for the missing link might be the existence of stronger strategic reasons for hedging decisions. Following this assumption hedging is mostly introduced to steer the company and its overall risk position on a higher, strategic level than to realize extra earnings by creating tax reduction items. Mian (1996) for instance also finds only little empirical evidence for tax reasons causing firms to hedge.

One other interesting finding made by Mian (1996) is the relatively low probability for hedging among utilities. This shows that hedging has changed a lot during the last decades and thus empirical findings from the 1990s may have to be considered with some caution when trying to understand today's companies' hedging behaviors.

Overall the evidence for the tax curve convexity leading to more hedging is mixed. Especially when it comes to the impact of tax carry forwards, one might consider the possibility that hedging as a means to manage risks is too strategic to be influenced by the goal to realize additional tax savings.

In the present hedging literature it is not common to control for the tax curve convexity. Either a paper studies this special effect or the effect is neglected in multivariate regressions. This is probably due to the high effort needed to survey the necessary information for each company and the low significance of results in prior research. I will therefore restrain from controlling for this effect in my analyses.

4.2 Costs of financial distress

Mello and Pearson (2000) write on page 127 "An optimal hedge maximizes the firm's financial flexibility – slack in the form of excess cash or unused debt capacity – when liquidity is most valuable. This lowers the danger of costly financial distress, reduces the effective cost of external financial constraints, and makes value maximizing investments affordable". This citation shows one thing clearly: It is difficult to discuss costs of distress and leave out a consideration of other liquidity means of hedging, namely the underinvestment theory. I think it is worthy while to try and disentangle both effects and give a definition and discussion on each in a separate subsection. However, I recommend the reader to keep in mind that both effects are linked to each other and must be viewed as two sides of the same coin. I will begin with a discussion on costs of distress at this point and add another passage on the underinvestment theory.

Companies must keep in mind that creditors have legal claims on the payment of interest and principal amounts to certain times. However, due to volatility in cash flows firms might not be able to meet all these claims and hence become insolvent. This potential situation of insolvency evokes further costs in two ways: First, each bankruptcy involves direct payments as for instance fees for lawyers and transaction costs. These costs reduce the post bankruptcy firm value for shareholders and thus also leads to a lower present value for the company. Second, an increased probability of insolvency leads to indirect costs, as banks and suppliers fearing not to be paid for by the struggling company increase their risk premium in the contracts, leading to higher supply and financing costs and consequently to an imperfect financial and cost structure. In contrast, a reduction of the probability of distress would make the debt capacity increase. By this, a company could increase the use of the tax shield (Myers, 1984) and by doing so, create shareholder value. The probability of distress for a company is directly linked to the company's leverage and the volatility of its cash flows. Therefore managing internal and external cash flows e.g. by hedging with the result of reducing their volatility and therefore the overall probability of distress lowers the costs of distress, increases the debt capacity and by doing so creates value.

Estimating bankruptcy costs in reality is rather difficult. Warner (1977) analyses the amount of bankruptcy costs studying a number of railroad companies which were in bankruptcy proceedings between 1933 and 1955. He finds costs amounting to approximately 1 % of market value (Warner, 1977, p.343). But by studying the bankruptcy records only the direct costs of distress can be measured. For estimating the indirect costs, it is necessary to develop another approach. Altman (1984) compares estimated pre bankruptcy profits with realized profits three years before a company files the bankruptcy to estimate the indirect costs.

Regardless of the problems in quantifying the costs of distress, their impact on hedging has been studied a lot in prior literature. Smith and Stulz (1985) are among the first to analyze this theory in depth (the interested reader can find another good source of information in Aretz, Bartram, and

Dufey (2007)). Smith and Stulz (1985) suggest that relative transaction costs for bankruptcy are a decreasing function of firm size. Thus, smaller firms facing relatively high costs of bankruptcy are more likely to hedge. On the other hand the risk of distress increases with higher shares of fixed claims in the financial structure of the firm, leading to the assumption that higher levered firms should have a higher probability to hedge. Graham and Rogers (1999) and Graham and Rogers (2002) find evidence that both higher leverage and profitability are positively correlated with the size of notional amounts of derivatives. Mian (1996) on the other hand finds that hedging is inconsistent with the costs of distress theory. For his study he builds on the annual reports of 3,022 firms from 1992. This must be considered as a large sample even in our current perspective. The aforementioned paper by Nance et al. (1993) prove on their sample that firms hedge in order to lower their costs of distress. In an early study Berkman and Bradbury (1996) analyze 116 1994-firm-years and find largely consistent results for the costs of distress theory. Among other aspects, they show that a higher leverage leads to a higher hedging probability in their sample. The results are also mainly consistent with the underinvestment and economies of scale theories that will be explained in the following sections. Of cause this directly shows one problem when regarding the cost of distress theory: It assumes higher hedging probabilities for smaller companies which is an opposite prediction as made by the yet to be explained economies of scale theory. Therefore the potentially existing effect of a higher hedging probability for smaller firms can almost never be seen as other contrary effects superpose it.

Leland (1998) studies several aspects of capital structure, hedging and investment risks. He finds among others extended leverage capacities for hedging companies. Howton and Perfect (1998) analyze a sample of 451 Fortune 500 / S&P 500 firms and further 461 randomly selected firms and find huge differences in the probability of derivative usage (61 % for FSP firms and 36 % of randomly selected firms) but mainly consistent results with theoretical foundations, e.g. cost of distress theory: Firms with higher leverage and lower liquidity ratios tend to hedge more, as do firms with a lower interest coverage ratio. Unfortunately not all results are significant.

Visvanathan (1998) highlights another related topic that is of interest in this discussion. By considering the hedging behavior of S&P 500 firms, he shows that swaps are not used to reduce interest rate sensitivity in general but mainly to adapt the maturity structure. Thus derivative usage is most common, when it helps a firm to transform short-term into long-term debt that is bound to a fixed interest rate. Following, it might be easier to prove the costs of distress theory when properly controlling for the debt maturity structure.

In the present hedging literature it is common to use either the Z-score or simply the leverage as an estimate for the costs of distress. This is of cause a less precise control variable for the effect than e.g. the method used by Warner (1977). But the advantage is obvious: Leverage is known for almost all companies in the samples whereas the above mentioned method to calculate the costs of distress requires the restriction of the sample on insolvent companies. I will in my analyses control for the costs of distress by including leverage and profitability in my models.

4.3 The underinvestment theory

According to pecking order theory it is preferable for firms to use internal funds over external for their financing needs. In the process of deciding about new projects this originates a problem in case internal funds are not available and external funding is very expensive. Raising external funds increases the costs of debt. This may ultimatively result in a situation where only creditors benefit from new projects. Hence existing investment opportunities may be disregarded in spite of a positive NPV. A theoretical model to describe this issue has been presented in several papers, e.g. Myers (1977); Myers and Majluf (1984); Bessembinder (1991). Early theories on the pecking order problem still build the basis for the underinvestment theory on hedging though newer findings indicate that the decisions related to the pecking order are more complex than assumed in the early literature (see e.g. Frank and Goyal (2003) for a discussion on smaller firms).

The use of hedging instruments can lower volatility of cash flows and thus reduce the scarcity of internal funds. Funds saved through this action can then be invested in new opportunities and by this the underinvestment problem can be reduced. This theory has been presented in the paper of Froot et al. (1993) outlining a theoretical framework for corporate risk management.

However the empirical evidence concerning this rationale is vague. On the one hand Nance et al. (1993) come to the conclusion that companies with higher R&D expenses are more likely to use derivatives. On the other hand Mian (1996) does not find significant proof for or against this theory based on his analysis of the market-to-book-value and derivative usage in the 1992 annual reports for more than 3000 firms. The differences in the results might of course also come from the fact that different proxies for the investment opportunities of a firm are used.

Which proxy is most suitable for analyzing the investment opportunities of a firm is still discussed controversially and not yet solved. In this work I will follow the approach using the market-to-book-value as in the energy sector most R&D is performed and hence the corresponding costs incurred in plant building companies and not in the utilities themselves.

Howton and Perfect (1998) find evidence for the underinvestment theory, as firms with a higher R&D ratio in their sample tend to hedge more. Gay and Nam (1998) also analyze the underinvestment problem. Using several alternative measures they find a positive relation between a firm's investment opportunities and its derivative use, especially when the relevant firm has low liquidity reserves. They also find proof for natural hedges as firms with a positive correlation between expenditures and internal cash flows use less derivatives.

Again Adam (2002) considers companies from the North American gold mining industry using the survey based information provided by the "Gold & Silver Hedge Outlook" between the years 1989 to 1999 to study the underinvestment theory. He finds a positive correlation between a lower limit for the revenue that is guaranteed by the hedging strategy and the capex invested by the company. One can read this finding in the following way: First, hedging serves to ensure that all fixed claims the company is exposed to can be satisfied and only then it guarantees that the investments the company wants to undertake can be financed. Consequently he finds evidence that companies hedging their investments can afford to finance 12 % of their capex internally while companies not hedging at all have to rely totally (to 100 %) on external financing for their investments. This result shows the afore-mentioned relation between costs of distress and the underinvestment problem.

Another paper considering the US gold mining industry is Dionne and Garand (2003). Though they do find evidence for taxes and costs of distress being related to hedging decisions, the significance to prove the underinvestment theory is rather low. One argument they offer is the possibility of natural hedges that might occur in this industry (Froot et al., 1993). This argument however should hold in the same way for Adam (2002) analyzing the same industry. Here natural hedges do not reduce the significance of the evidence found for the underinvestment theory. The explanation given by Dionne and Garand (2003) is thus questionable.

Geczy, Minton, and Schrand (1997) also study the underinvestment theory and find significant proof for it. In addition they show that the choice of instruments used is impacted by the source of exposure. Cornaggia (2013) considers the US agricultural industry and also finds evidence for a positive relation between hedging and productivity that has to be attributed to investments financed through internal sources that have been made free through hedging.

Marsden and Prevost (2005) on the other hand study a 1994 and 1997 sample of New Zealand companies and find evidence that firms with more investment opportunities use less derivatives to hedge. This is in sharp contrast to the underinvestment theory.

Again, the results found are not always consistent with the theory. In several cases, empirical findings suggest that firms hedge in order to manage internal funds – however, some empirical publications do find evidence against the theory.

In my analysis I include the market-to-book ratio and the free cash flow from operations to control for the underinvestment problems. A consideration of natural hedges (positive correlation between internal cash flows and investment opportunities) is not necessary in my study, as natural hedges are often industry specific and I focus on one single industry. Thus all companies in my sample should have similar natural hedges.

4.4 CEO alignment

Principal agent theory suggests that information between shareholders and managers is spread asymmetrically – managers have a deeper insight into the firm's decisions than shareholders have. In addition managers as well as employees are considered risk averse in contrast to shareholders, because they cannot as easily diversify their concentration risk to their company's equity development as the shareholders can. Hence managers a priori have a concave utility function of wealth. Therefore shareholders and managers do not necessarily have the same interests with regard to risk management and have to be aligned by suitable devices. Here the compensation packages of managers play an important role in reshaping the manager's wealth curve.

Stulz (1984) and Smith and Stulz (1985) develop hypotheses for the different compensation structures and the resulting incentives managers have with regard to hedging. First, they conclude that in case the manager's end-of-period wealth curve is a concave function of the firm value, i.e. compensation is not or only little used to reduce manager's risk aversion, the manager will maximize his income by hedging all risks and thus remove all the volatility from the firm's value. This follows from Jensen's Inequality (Jensen and Meckling, 1976) suggesting that a concave function evaluated at the expected value of a random variable is smaller than the expected value of the concave function. In a second step they consider a manager whose end-of-period wealth function is convex with respect to the firm value but who still has a concave utility function. In this case the manager will introduce hedging for certain risks leaving others open. The manager then has an incentive not to hedge as his wealth will be maximized jointly with the firm's expected value, but he will still avoid some risks due to his risk aversion illustrated in the concavity of the utility function. Only in the third case of a convex wealth function and no concavity in the utility function, the manager will leave all risk positions open and not hedge at all. Smith and Stulz (1985) explain that this convexity can be achieved through bonuses and stock options. DeMarzo and Duffie (1995) analyze this theory and add a perspective on the impact of accounting standards: The more informative accounting standards are, the more CEOs tend to act in the interest of shareholders.

Tufano (1996) finds evidence for the CEO alignment theory, analyzing the compensation packages of managers in the gold mining industry. His results show that managers compensated with large proportion of stock options tend to introduce less hedging. Rogers (2002) finds a similar result considering 850 randomly chosen companies from all 1994 10-K filings: If CEOs are more risk affine (if they hold larger positions in options than in shares), they tend to introduce less hedging in their company. Haushalter (2000) analyzes the correlation between the number of stock options as part of the managerial compensation and the extent to which hedging is introduced for oil and gas producers in the years 1992 through 1994. His results, though, should be considered with caution as the sample is rather small. Therefore, for one year his results give evidence whereas for another period they are conflictive with the above mentioned theory. Dionne and Triki (2004) again study the US gold mining industry and find evidence that managerial risk aversion is correlated with hedging on a low significance level. The relation is in line with the expectations: The more common shares a CEO holds, the higher the probability to hedge, the more options he has, the lower the probability. In the latter case apparently the value through higher volatility increases superposes the higher concentration risk by CEOs.

Other studies on this topic are Nance et al. (1993) showing that firms hedge to control for agency problems. Kumar and Rabinovitch (2011) consider a sample taken from the oil and gas exploration and production industry and present evidence that CEO entrenchment correlates with hedging efforts. Adam, Fernando, and Salas (2008) study the gold mining industry and find a relation between selective hedging and managerial stock option holding. They also study the impact of costs of distress and firm size and come to the counterintuitive result that smaller firms and firms with higher costs of distress tend to speculate more.

At this point it might be worth discussing the link between the managerial risk aversion and the costs of distress or underinvestment theory. I have argued that higher volatility in general is value creating for the shareholders and thus managers acting in the pure interest of shareholders should actually not hedge. Unfortunately costs of distress and underinvestment theory suggest that in some situations it is better for the shareholders to introduce hedging, e.g. when otherwise costs of financing are increasing over-proportionally or interesting investment opportunities lose their attractiveness for shareholders. This shows that the real intentions of shareholders with respect to hedging are quite difficult to predict as the consideration of many variables is necessary to understand the in-depth situation of a company.

Further complexity is introduced by managerial overconfidence: Managers can use derivatives not to reduce the company's risk, but also to take additional risk positions. Adam, Fernando, and Golubeva (2011) analyze this phenomenon and pose the question if overconfidence makes managers take more risks. They find evidence for increases of derivative positions following cash flow gains but not reduction after losses. Thus it is probable that gains are attributed to one's own abilities while losses are considered to be the effect of negative market performance.

In my analyses I will not control for CEO alignment. This is mainly due to the fact that CEO compensation information is hardly available for my sample and even a detailed analysis of the information given in annual reports must be considered with caution as accounting standards differ largely with respect to this question. This is also the reason for the fact that all major prior studies on the relation of CEO alignment and hedging are based on US samples only.

4.5 Economies of scale

As mentioned earlier the cost of distress theory suggests that smaller firms have a higher incentive to hedge in order to reduce their probability of default and the associated costs which for these are due to the fixed part relatively high compared to larger firms. Empirical results run counter to this theory showing that in general firm size has a positive influence on the hedging probability – very often this effect is even the strongest among the factors regarded. Mian (1996) provides the following explanation for this finding: Larger firms face lower transaction and administrative costs and furthermore benefit from their knowledge of implementing a proper risk management.

Nearly all studies support this theory by their findings. One of the last is Bartram et al. (2009) analyzing a sample of over 6,000 companies, that has been automatically composed based on a key-word searching algorithm. Also El-Masry (2003) finds an increasing probability of hedging for larger firms studying a sample of 401 UK non-financial firms. Block and Gallagher (1986) study the relation between size and hedging and find a positive correlation in a sample of Fortune 500 companies. Among the major companies 24 % used futures for hedging purposes while only approximately 5 % of the smaller ones did. The list of papers supporting this theory is long – most of the previously mentioned studies come to the conclusion that larger firms are more likely to hedge.

Alkeback and Hagelin (1999) offer a different explanation for the same finding: In smaller firms CEOs often lack the knowledge about derivatives and thus do not dare or intend to use them. They analyze a Swedish survey sample and find out that this reason is the most important obstacle for derivative usage. They also compare their findings to prior research from the US market (Bodnar, Hayt, Marston, and Smithson, 1995; Bodnar, Hayt, and Marston, 1996; Berkman, Bradley, and Magan, 1997) and admit that the lacking knowledge is only a major concern in Sweden and has not been identified as a determinant by the aforementioned authors.

Unfortunately several of the cited papers do not properly distinguish between the decision to hedge and the hedging volume. The first decision clearly involves economies of scale and also it touches the argument given by Alkeback and Hagelin (1999): Smaller firms are seldomly able to build a large risk management department including a trading floor and a portfolio management to start hedging and their CEOs are more likely used to steering other small companies that neither do have these departments. But once a small company has introduced all the infrastructure to hedge, the only difference between their costs to hedge and the costs larger companies face are economies of scale in transaction costs. This difference might be less severe than the costs to implement the infrastructure needed for hedging. Thus the effect of economies of scale on the hedging volume could be less pronounced than on the hedging probability. I will take a detailed look at the impact factor “size” in my multivariate analyses and thereby try to disentangle the impact of size on the pure decision to hedge and the hedging volume.

4.6 Institutional environment and corporate governance

On a first sight it might be confusing that the two distinct topics “institutional environment” and “corporate governance” are considered in the same section. The institutional environment is a field of country-level factors whereas corporate governance is measured on the firm level. I am aware of this conflict but nevertheless decide to discuss both topics together. The reason is simple: In some papers country-level indicators are used to estimate corporate governance characteristics on the firm level – and be it only in robustness tests. Therefore separating both topics would imply a redundant discussion of similar findings. But I will try to be as precise as possible on the question if country or firm-level variables are used in the following papers.

Research on the implications of institutional environment on hedging decisions and thus the impact of country-level characteristics is still very sparse. Bartram et al. (2009) is the most important study to be mentioned here. They find a correlation of four factors on market risk hedging decisions: Derivative market size is positively correlated with derivative usage. Increased financial risk leads to less hedging. Legality and closely held shares in a country show a mixed impact on derivative usage.

This is the only "real" international sample on which the impact of institutional environment has been analyzed. Some other papers building on non-US samples compare their findings with prior research from the US market and, by doing so, help to understand hedging patterns in other countries than the US. Some examples are Judge (2002); Rodt and Schaefer (2005); Berkman et al. (1997); Hakkarainen, Kasanen, and Puttonen (1997); Davies, Eckberg, and Marshall (2011); Hagelin and Pramborg (2002, 2006); Alkeback and Hagelin (1999); Brunzell, Hansson, and Liljeblom (2011); Rodt and Schaefer (2005). But the reasearch on differences between countries that is presented in these papers is still not systematic and no effort is done to attribute the findings to certain country-level characteristics as e.g. market specifications or political and legal environments.

All other following papers that try to explain the impact of institutional environment concentrate on single countries. E.g. Marsden and Prevost (2005) consider the relation between outside directors and hedging for the years 1993 and 1997 and show that companies with outside directors are less likely to use derivatives in 1997 to overcome underinvestment problems. This shows that external influences, here the introduction of a new 1993 company act that increases the responsibility for outside directors, can impact a company's hedging decisions and in addition that corporate governance plays an important role: If directors are incentivized, e.g. through an according law, they increase their pressure on certain hedging related decisions. Similarly, Dionne and Triki (2005) analyze the impact of NYSE rules and the Sarbanes Oxley act on hedging decisions that shareholders should benefit from. Their results show that especially the requirements on audit committee size and independence increase the type of hedging decisions that shareholders benefit from. Other factors as the existence of unrelated directors and accounting-near directors do not prove to have a significant impact.

Borokhovich, Brunarski, Crutchley, and Simkins (2004) consider internal governance factors and their impact on hedging decisions. They find evidence that a better monitoring system is positively correlated with the interest rate derivative positions. Specifically they find a positive correlation between the existence of outside directors and hedging. Lel (2012) broadens this perspective and builds an index using seven separate governance measures. In addition he draws the link to the institutional environment showing that the results are robust against using country-level instrumental variable for corporate governance, the anti director rights index, the creditor and a property rights index. This is a prominent example of a paper in the hedging literature where country-level characteristics are used as measure for firm-level governance. Though Lel (2012) uses a sample of US cross-listed companies, his main focus still lies on corporate governance – the country-level indices are rather used as robustness tests.

A slightly different topic that I still want to subsume in this subsection is the impact of ownership on hedging. Only little has been published on this topic. One reason is probably that many current papers on hedging build on data from annual reports and thus a consideration of privately owned firms is impossible under this approach. One exception is the paper published by Giuli, Caselli, and Gatti (2011) considering a family firm data set covering 187 Italian firms. They find some interesting results that I would like to mention under the present topic of corporate governance: Companies in the third generation after foundation tend to hedge more. In addition companies with a non-family CFO tend to hedge more and companies with an external owner hedge less. These last two findings, though, are of little significance and thus difficult to interpret.

In my analysis, I control for different factors from the institutional environment seperately: For legality I use the *regulatory quality index* from Kaufmann, Kraay, and Mastruzzi (2008). For derivative market rank, I use the *ranked size of FX and IR derivative markets*. This variable both measures the availability of derivatives and consequently also the transaction costs. The latter is difficult to measure directly but the market liquidity is a commonly used proxy for market friction. For *closely held shares* I include the figures taken from Dahlquist, Pinkowitz, Stulz, and Williamson (2003). The overall economic and financial stability is measured through various variables like *inflation* and *GDP per capita*, which are also included. I do not control for corporate governance and ownership on a firm level.

4.7 Hedging and risk appetite

Sinkey and Carter (2000) consider the relation between hedging behavior and the financial structure a company uses. They build on a sample of US commercial banks and show that derivative users tend to have an overall riskier financial structure: They use more notes and debentures and tend to have less equity. In addition, their books show larger maturity mismatches between assets and liabilities. This finding of course inherits an endogeneity problem as one cannot say if the derivative usage is a means to meet the riskier financing structure or another indicator besides the financing structure for a larger risk appetite these companies have.

4.8 Competition and market structure

Another only little studied question considers the impact of competition on the hedging behavior. One could expect to find similar hedging pattern in one industry, as deviating from the strategy of competitors might put a single company at an immense risk. This could be seen in the airline industry, where some companies hedged against rising fuel prices, whereas others did not. As the fuel prices finally rose, some airline industries were confronted with heavy cost burdens and could not increase their ticket prices, as the competition in the market was too high. In case no or all companies hedge at the same time, it might be easier to adapt prices to changes in the cost level. If some players on the other hand have a different cost structure, they might simply use their competitor's cost problems to gain market shares. Another theory predicts that knowledge on hedging in a certain industry can be seen as an asset that diffuses among companies when employees are enticed from the market leader. Overall, both theories suggest that in case one company starts to hedge, the others are likely to follow and thus the hedging activity should increase with the competition level seen in the market. Adam, Dasgupta, and Titman (2007) consider this question in general using a game theoretical approach and show that the number of firms hedging depends on industry characteristics like the number of players in the game and the demand function. Overall one can say that more competition leads to more heterogeneity. However, they do not test the hypothesized relations on an empirical level.

Haushalter, Klasa, and Maxwell (2007) also consider the impact of competition on hedging using a sample of S&P 500 manufacturing firms from 1993 to 1997. They show that firms in less competitive markets tend to hedge more and have higher liquidity stocks. Thus competition, predation risk, as it is called in the relating paper, does not only influence the hedging behavior but several decisions related to the financing structure.

4.9 Implications on the firm value

All papers I have discussed earlier deal with the question of hedging determinants. The next logical step is to ask for the implications of hedging on shareholder value. An excellent overview of the main papers that relate to this question is given by Aretz and Bartram (2010). I refer to this publication for every reader especially interested in this topic.

One preliminary assumption when talking about hedging and shareholder value is the fact that hedging information has been properly disclosed. In case of information asymmetries, the results discussed in the following do not necessarily hold. This topic has been considered in some detail by Raposo (1997).

The probably most important paper to be mentioned with respect to the topic of shareholder value and hedging is Campello et al. (2011), analyzing 2,288 US firms over a period from 1996 to 2002. Using a tax based instrumental variable approach, they show that hedging reduces financing costs and hedgers are less likely to have covenants in their loan agreements. This leads to higher investments for the relevant hedging companies. On the descriptive side they found 50,1 % hedgers, with the probability for IR hedging being significantly higher than for FX hedging.

Graham and Rogers (1999) also found evidence that hedging increases firm value and debt capacity. Analyzing 531 10-K reports from the year 1995 they also found large differences between the industries considered. For instance financial or manufacturing firms show very different hedging patterns compared to companies from other industries.

Jin and Jorion (2006) evaluate hedging activities for 119 US oil and gas producers from 1998 to 2001 and study the effect of hedging on the market value. Though they do not find a significant impact on the firm value they show that hedging reduces the stock price sensitivity to the oil and gas prices.

Clark and Judge (2009) study the impact of FX hedging (derivative based versus foreign currency debt) on the firm value. They find evidence for a value premium in case of derivative usage but no significant increase due to foreign debt measures.

Allayannis, Lel, and Miller (2012) use an ADR sample of 1,546 firm year observations from 39 countries to study the effect of currency derivative hedging on firm value. They find evidence that the derivative usage for firms that have a strong governance (internal or external) leads to an increase in firm Tobin's Q. Carter, Rogers, and Simkins (2006) analyze US airline companies in the years between 1992 and 2003. They chose this industry as the airline business shows some of the assumptions made by Froot et al. (1993): Airline investment opportunities correlate positively with jet fuel prices (which in return correlate negatively with airline cash flows). Therefore hedging future cash flows is advisable for airlines that want to grow. The results show that fuel hedging leads to higher firm value – the corresponding hedging premium can be up to 10 %.

Mackay and Moeller (2007) study oil refiners over the time horizon from 1985 to 2004. They also include the theory on non-linearity of cost curves (see 4.1) in their research. Modeling quarterly costs and revenues on higher moments, they show that managing concave revenues and leaving open concave costs can add value in the magnitude of 2 – 3 %. Nelson, Moffit, and Affleck-Graves (2005) study the stock performance of 1,308 companies US firms between 1995 and 1999. They find a relatively low probability of derivative usage and a strong size effect. The stock performance of hedgers proved to be 4.3 % higher than other stocks.

Bartram, Brown, and Conrad (2011) consider companies from 47 countries to study the impact of hedging on firm value. The same sample has been used in other publications, e.g. Bartram et al. (2009). Overall they find several results concerning the topic: Hedging leads to an increased firm value, generates abnormal returns and especially secures revenues in times of downturns. A problem to be mentioned here is the fact that the sample does not include an upturn period to compare the results to. The pure concentration on a downturn phase incorporates some risks that the results might be biased in a way one cannot control for.

Other researchers try to prove the increased shareholder value through hedging by considering the cash flow gains from derivative positions. Here, the risk reduction and thus the lowering of costs of financing is left unobserved and the analysis simply focuses on speculative gains through derivative usage. From my point of view it is unclear, if these considered effects can be treated as increases of shareholder value through hedging or if the gain must be attributed to a speculative position that is surely inherent in most derivative transactions and thus also a side effect of hedging itself. One example of this research branch is Adam and Fernando (2006) studying 92 gold mining firms in North America between 1989 and 1999. They find evidence for significant cash flow gains through derivative usage.

5 Hedging data and main control variables

The following chapter is largely based on descriptions of the sample that are used in the papers Lievenbrueck and Schmid (2014, 2013)

In this chapter I will describe the relevant data that is used in all following multivariate regressions. This is information on hedging activities and financial and accounting data that mainly serves to control for financial theories on hedging. In addition I will present the main country-level control variables for the business environment. As two later chapters in this work will deal in more detail with the two topics “culture” and “production technology”, I will not introduce the corresponding data on these two topics in the present chapter but in the relevant later sections. By this means, I hope to improve the readability of the later chapters and leave this chapter for consultation in case of questions regarding my main data sample.

I will in the following give an in-depth description especially for the process of hedging data collection, as the variance in results from prior studies has shown the importance of adequate data quality and documentation of the chosen method. But before turning my attention to this descriptions I will start with some general thoughts on the peculiarities of the energy sector. First, I will discuss some fundamental topics when studying the hedging behavior of energy companies. In particular, I will consider the difference between derivative hedging and risk management. I will also address the question if regulation in the energy sector is likely to affect my analyses. I then describe the construction of the sample. As mentioned earlier, I build on a hand-collected dataset with hedging information. The process of data collection is described in detail in the following. Furthermore, I describe the source of other data used in my analysis.

5.1 An industry specific data set

As illustrated, the present work considers several questions regarding hedging determinants for hedging decisions on an empirical data base. One major primary decision I made was regarding the industry I chose to study. While some papers consider several industries, e.g. Bartram et al. (2009), others focus on one single industry. I have already discussed the pros and cons of both approaches in some detail and specifically the reason, why I consider the energy market. Anyways, I will take the liberty to show some examples of well published papers, that build on one single industry from the energy sector, the oil refining sector, which is comparable in a certain way to the power utility industry. Both industries have a very liquid supply market and a less liquid and rather regional sales market. In addition, both markets are capex intense and trades on the supply goods are US Dollar denominated while the revenues may come from local markets. Brown and Toft (2002); Borenstein and Shepard (2002); Haushalter, Heron, and Lie (2002); Mackay and Moeller (2007); Schwartz (1997); Litzenberger and Rabinowitz (1995); Gibson and Schwartz (1990) are some examples of such studies that build on oil refinery samples. Thus the concentration on a single market can be considered a commonf approach for the research on hedging determinants. In addition, the aforementioned fact that there are large differences between the industries especially regarding the exposure structure ought to be considered another reason to concentrate on one single industry (see Bartram et al. (2009) or Graham and Rogers (1999) for information on the differences in hedging activities between several industries).

5.2 Derivative hedging versus risk management

One important topic to discuss when studying derivative based hedging is the relation between hedging (especially derivative based hedging) and risk management in general. As other measures of the overall risk management strategy in a company might be much more important one might even pose the question if derivative based hedging is worth considering. E.g. Guay and Kothari (2003) argue that derivative usage might not be a good measure to consider when studying risk management. They consider sensitivities for firm values when prices for underlyings of derivatives held change and show that the amounts at risk are relatively low compared to the overall value of the company. Consequently, derivatives might not be the strongest risk management tools and thus other risk management instruments and measures might be more important. They propose that the research should better focus on these other measures. However, derivative usage is one of the most commonly used measure in the modern research on hedging and the derivative volumes used by firms have increased dramatically over the last years. In this section, I will spend some lines on the discussion on potential alternatives and pros and cons of the approach used in this work.

From the introductory lines it is obvious that hedging is only one measure used in risk management and that hedging can be done in several ways not only using derivatives. Even insurance can serve as a substitute for hedging. E.g. MacMinn (1987) and Mayers and Smith (1982) introduce a model to show that insurance leads to similar increases in shareholder value as derivative usage for hedging purposes in the presence of costs of distress or underinvestment problems. Thus insurance must be considered a valid alternative to hedging. But there are even more alternatives. Miller (1992) outlines the structure on the various risk types an international company faces. Besides the financial hedging, considered in this work, he mentions five alternative categories of risk management: Avoidance, control, cooperation, limitation and flexibility (see Miller (1992) page 321). Also Aretz and Bartram (2010) argue that derivative based hedging is just one means of a large portfolio of risk management measures that firms use. A common alternative measure used in the energy sector for instance would be to invest into tangible assets (e.g. an upstream integration into a gas field to hedge a short position in a gas fired power plant) or to use degrees of freedom in the financial structure (e.g. foreign currency borrowings to mitigate an exchange rate risk). E.g. Kedia and Mozumdar (2003) find evidence that US companies use foreign denominated debt to hedge their currency risk exposure. Thus derivative usage, which will be the focus of the present study, is by no means the only measure that can be applied to mitigate risks. And this work, like all prior studies on hedging, has to accept the accusation of leaving an integral part of the risk management unconsidered and by this incur some mismeasurement problem in the analyses as companies choosing to rely on other hedging measures than derivative hedging are classified as non-hedgers. But to consider all these additional measures would mean to define a comprehensive approach to assess a company's risk management. This has so far not been the focus of present research (Giuli et al. (2011) is one of few exceptions); it would make the usage of survey data necessary and include the common disadvantages of this method: The data quality heavily relies on the willingness and the ability of each firm to correctly answer sometimes complex and confidential questions and the participation quota especially in complex and international surveys varies strongly. To the best of my knowledge, the only paper that undertakes an in-depth analysis of the risk management strategy of a firm and thereby concentrates on one single company is Brown (2001). He includes not only detailed information on more than 3,000 derivative transactions but also considers discussions with managers, other internal firm documents, the company's competitive situation and internal contracting processes. Interestingly this more detailed approach does not yield completely different results and the impact factors he finds are similar to the ones presented in studies that focus on derivative hedging only: Accounting rules, derivative market liquidity, exchange rate volatility and recent hedging outcomes. Vickery (2008) considers small non-public firms and finds proof that a major tool to manage interest rate risks is to simply borrow fixed rate debt. However he views this as a difference between small and larger companies.

Overall, I decide to purely build on annual reports and the published information on the usage of hedging derivatives. This approach of preferring public reports over survey data and focusing on derivative hedging is in line with the ongoing research on hedging (Campello et al., 2011). This approach is also partly legitimated by the findings of Clark and Judge (2009) studying the impacts of FX derivative usage versus foreign currency debt. They show that foreign currency debt is mainly used for long-term investments (e.g. fixed assets in foreign countries). Thus, I expect that hedging in the liquid time horizon is mainly done by using derivatives over more long-term hedging measures. In addition, Fok, Carroll, and Chiou (1997) find evidence that operational hedging is rather used as a complement to derivative hedging than as a substitute. This shows that derivative hedging can clearly not draw a complete picture of all hedging activities a company undertakes but that it is likely to be observed in case the company also uses other measures of hedging. Thus the risk of completely misclassifying a company when only considering derivative hedging is relatively low.

5.3 Regulation – a distinctiveness of the energy sector?

One topic that is clearly important to consider when regarding the energy sector is the regulatory framework. Often energy providers are excluded from empirical financial research as the industry is regulated and this might influence the results (Nelson et al., 2005). I am aware of this fact but believe that the regulation does not touch the questions at hand. This is what I want to discuss in the following.

Energy regulation focuses on certain topics. First, the mechanisms of matching power supply and demand are regulated in many countries. This can be done for instance by means of capacity auctions, where all market participants give a bid/ask for the capacity they want to sell/buy. This process is often regulated to ensure that the vital product of power is provided in the quantity that is needed by the society even if some market participants do not deliver or take as much as they claimed in the auction. A second major part of the regulation deals with the handling of all infrastructural assets. The grid for example is essential for the power delivery and must thus be maintained properly. Furthermore all infrastructural assets offer an advantageous position if they are concentrated in the hand of a single energy supplier. To ensure a discrimination- and interference-free access to these assets they must be spinned off into independent companies often called system operators. Summarizing, the energy regulation is mainly concerned with ensuring security of supply and free access to all important assets for all market participants. All these regulatory rules do not touch a company's decision to use derivatives to hedge its market risk exposures. A financial regulation similar to banking regulation has so far not been implemented, though during the recent financial crisis a discussion has been started on further regulatory needs in the energy sector.

Thus, one can say that the energy sector is regulated like many other industries. But the regulation does not touch many financial questions like hedging decisions. As a good example of a similar case the pharma sector can be mentioned, which is also regulated but commonly not excluded from financial research, as the regulation mainly affects pricing and the product development processes. In this I do not see a fundamental difference to the regulation in the energy sector – both should not affect hedging decisions. Therefore I believe that insights from hedging in the energy sector can be taken as proxies for worldwide hedging behavior in several other industries.

5.4 Construction of the sample

Our sample covers energy utilities from all over the world. For the compilation of my base sample, I start combining lists of active and inactive utility companies from OneBanker and Datastream, both products of Thomson Reuters. I focus on stock market listed utilities because reliable data for unlisted firms is often not available. The first year for which I obtain the necessary data on the firms' hedging policies is 2001. The last year available is 2009. Hence, the sample is organized as unbalanced panel and covers the years 2001 to 2009. Several steps are necessary to ensure the adequacy of this sample for my purposes: First, I match both company lists and remove duplicates. Second, I eliminate all firms without a primary security classified as equity. Third, all companies that were never active in the 2001 to 2009 period are excluded. Fourth, I check the industry classification of all utilities to ensure that my sample only covers companies that focus on the generation of electricity. For this, I mainly rely on their SIC and ICB codes. Fifth, I obtain annual financial data from the Worldscope database. My final sample covers 3,800 firm-year observations from 651 firms, located in 57 countries[11].

5.5 Hedging data

For the above defined sample hedging information for the years 2001 to 2009 was gathered using a similar method as Campello et al. (2011). In contrast to this approach, some – especially earlier – papers use survey data. This is due to the fact that in the 90s no reliable hedging information was available in the annual reports. E.g. Nance et al. (1993) and El-Masry (2003) do not build on annual reports. As the reporting standards have changed since

[11] Please note that I cannot use all observations in all regressions because other variables might be missing. Also the availability of hedging volumes and information on the instruments used is lower than the number observations where hedging dummies are available. Especially in all regression models concerning the influence of production technology, I will only be able to use a small fraction of the here presented data points.

then, I purely rely on published information. In the following I will give a detailed overview of the method used in this process and explain the assumptions that had to be made.

5.5.1 Sources for hedging information

As mentioned earlier only few ready-to-use data sets on hedging information exist. One example from the gold mining industry has been studied by Adam and Fernando (2006). Most studies build on proprietary survey data or information taken from annual reports. As discussed, I will rely on report data. In the following the process of data gathering shall be described.

Based on the above defined sample the data extraction process was initiated. For all firms the annual reports for the years 2001 to 2009 were downloaded from the Internet. The web search used both the company websites and a free web search. The latter resulted in some extra reports from free investment research company web pages like e.g. Morningstar, where annual reports were not available on the company's investor relation portals anymore. Only partly published reports, e.g. on investment company web pages, were not taken into account as the risk for wrong interpretations due to missing information from the report was considered too high.

In several cases annual reports did not appear in the Internet which made an inquiry necessary to why this could be. Cross checking e.g. on Bloomberg or Businessweek sometimes gave way to information if the company had been delisted or the names changed, e.g. in the case of the company "Hong Kong Electric Holdings Limited" which changed its name to "Power Assets Holding Limited". Only after considering this new name annual reports could be found.

The availability of reports in the Internet turned out to be highly correlated with the continuity of the firm's operations. To avoid a survivorship bias, reports were downloaded both from company websites and from the ThomsonReuters filings database, which also includes reports from inactive companies. Unfortunately, many reports especially in Asia were only available in foreign languages and could not be used in my analysis. In general, only reports in English, German, French, Spanish, Portuguese, Swedish, Russian, and certain other Slavic languages where taken into account.

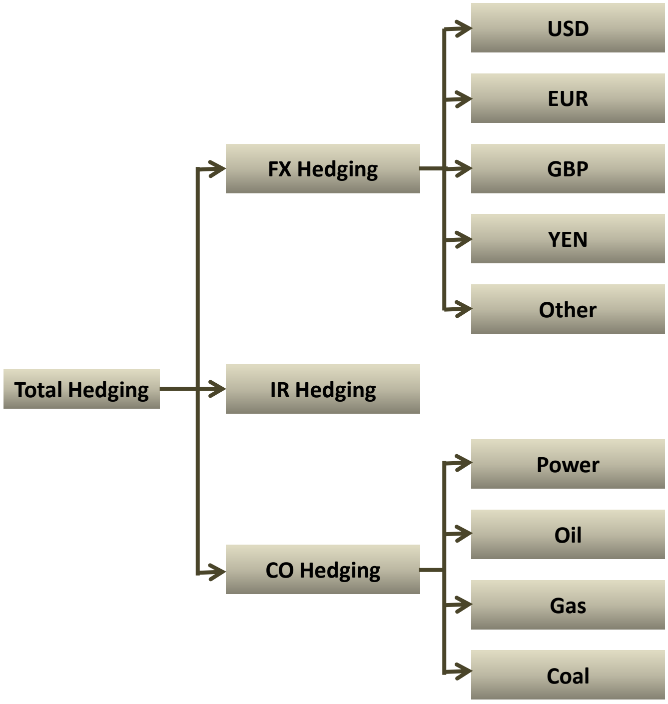
In addition to the just mentioned framework for the collection of annual reports, the following conventions were applied:

- Some reports were neglected due to language specifications.
- For the US market the 10-K reports were preferred to annual reports, limiting the use of the latter to clarification needs.
- In case of hierarchical ownership structures, i.e. availability of an annual report for both the group and a group owned energy company, both reports were incorporated into the sample.
- Assignation of fiscal years to the calendar years was made based on the end of the reporting period. Due date for this decision was July 1st of each year.
- In case no annual report for a certain year could be found, but a report for the following year published numbers for the previous year (the year under consideration), these figures were used instead. In the opposite case, where numbers both in the annual report for the corresponding year and in the report from the next year were issued and these numbers did not coincide, the figures from the annual report corresponding to the observed year were always preferred. This case was frequently observed when companies changed the way of handling optionalities and choices in the applied accounting structure.

5.5.2 Structure of the hedging data

I already discussed the reason why this analysis focuses on market risks. Thus the hedging data that has in the following been gathered comprises

Figure 5.1: Structure of considered market risks



The above displayed figure presents the structure tree for the market risks considered in this study. Corresponding data on hedging activities was collected on all of the below demonstrated levels of detail (depending on availability).

the risk areas of commodity prices, exchange and interest rate risks. Commodity price and exchange rate risks where further splitted into the different primary and secondary energy sources power, oil, gas and coal and the currency exposures USD, GBP, EUR, YEN and other respectively. Figure 5.1 visualizes this structure tree.

For all of these risk types three questions were addressed and answered separately:

- Does the company hedge the corresponding risk?
- Does it use asymmetric or symmetric derivatives (options vs. futures, forwards or swaps)?
- Which volume has been secured through hedging contracts?

In the data collection process, hedging was always interpreted as the usage of any derivative contract intended to eliminate or reduce an open market risk position in one of the three considered risk types (FX, IR and CO). Here the classification of derivatives as hedging positions was introduced based on the mentioning of the firm's intention to use these as hedging instruments in the annual report. This explanation is worth making as one might also consider the definition for hedging instruments given by the accounting standards. This classification of derivatives as "hedge accounting" versus "held for trading" is based on the definitions taken from US GAAP and has been introduced in several accounting standards worldwide. Unfortunately two reasons exist not to build on this definition. First, the standards still vary largely across countries, which makes comparison difficult. Some countries even do not have any hedge accounting rules installed in their local standards. Second, hedge accounting classification does not always comply with the company's intention for holding a derivative position. The accounting standards have strict rules e.g. for the match and the effectiveness of a hedge in order to be classified as a hedge accounting-wise. As the necessary assessments for this classification are complex, some companies do not even try to apply the rules and classify all hedging positions as "held for trading". The present work is meant to improve the understanding of the strategies companies follow with regard to hedging. Thus the intention of a company to secure risks is more relevant to the analysis than the effectiveness of its hedging activities and the accounting method applied. Hence I focused on any information relating to the use of contracts and left all accounting typifications unobserved. A more thorough discussion of this problem and the requirements for hedge accounting under IFRS is given in chapter 3.

5.5.3 Extracting information from annual reports

To extract hedging information, the reports have been searched for the following keywords (accordingly translated for non-English reports):

Keywords: "hedg", "risk management", "derivative", "expos", "financial instrument", "forward", "future", "option", "swap", "market risk", "commodit", "interest rate risk", "exchange rate risk", "currency risk", "floating", "variable rate", "notional", "nominal", "contracted value", "principal value", "exposure", and "IBOR".

I tried to search for all different translations of the terms mentioned above in case more than one translation can be used in certain languages. The corresponding sections where one of the keywords was found have then been read and interpreted.

To answer the general and first question if a company hedged a risk or not, I built a dummy variable: If the use of hedging contracts was explicitly mentioned in the annual report, the value "1" was applied; if the report explicitly stated that hedging in the corresponding risk was not applied or no information was given on the usage of derivatives, the company was given a "0" and thus classified as non-hedger. For robustness tests, a second hedging dummy variable was built, where a more strict classification for non-hedgers has been applied. First, all companies that expliciteIy state not to use derivatives for hedging purposes are classified as hedgers. Second, all companies that report the usage of derivatives to hedge certain risks but do not mention any hedging activities for other risks, are classified as non-hedgers for these other risks. Third, all companies reporting under the international accounting standards US GAAP and IFRS have been classified as non-hedgers, in case they did not report to hedge the corresponding risk. The latter classification build on the accounting rule, that all derivative positions have to be documented properly under IFRS and US-GAAP. One can argue that even in other accounting standards like e.g. Indian Accounting Standards hedge accounting rules have been installed similar to the ones in US GAAP or IFRS, but local accounting boards admit that even today many companies do not apply these rules properly. This leads to a data base that classifies all companies as hedgers or non-hedgers for all three risk types seperately. Finally a fourth hedging dummy has been created, where all companies that hedge at least one risk type have been classified as hedgers and all others as non-hedgers.

In addition to a hedging dummy, which has often been used in prior studies (e.g., Geczy et al., 1997; Allayannis and Weston, 2001; Adkins, Carter, and Simpson, 2007; Campello et al., 2011), I also construct a variable measuring if asymmetric derivatives have been used to characterize a company's hedging strategy. It equals "1" if an explicit comment on the usage of options or other derivatives with optionalities was found and "0" otherwise. The use of asymmetric derivatives has so far only been considered separately from other characteristics of hedging activities, for instance by Huang, Ryan Jr., and Wiggins III (2007). The relevant derivatives with a symmetric risk profile were futures, forwards and swaps. In contrast options or swaptions were identified as asymmetric derivatives. Once again the classification was described using the triadic structure mentioned above. Here a later change in the first classification was not needed.

When answering the third question, i.e. searching the volumes to which risks were secured, I considered only notional values. The notional value hereby is defined similar to Smithson, Smith, and Wilford (1998) page 147: "principal [...] that is not paid or received at contract maturity but is instead used only to calculate the cash flows paid and received". The decision to use these notional values was based on prior discussions on the use of hedging figures: Following (e.g., Campello et al., 2011; Graham and Rogers, 2002, 1999; Nguyen, Mensah, and Fan, 2007), fair values do not reflect the amount that has been secured through a contract but rather the market value of the underlying risk for the issuer and thus cannot be compared among each other easily as they differ depending on the contract characteristics and largely depend on the market situation. Similar value interpreted figures like sensitivity analyses or values at risk given in the reports were ignored as well based on comparable considerations. The corresponding final volume variable is winsorized at the 1 % and 99 % level. Taking into account the three risk types I consider (FX, IR and CO risks), this leads to a total number of nine dependent variables.

5.5.4 Conventions for hedging volumes

In the following I will explain further conventions that have been applied when collecting the hedging volumes. The reader may forgive the lacking structure in the merely listed following items – most conventions were developed over time during the process of collection when special cases emerged and do not have a logical link to each other.

- In some cases figures had to be converted from foreign currencies (in few cases even from energy related units) to US Dollar. Where positions were given in different currencies, year-end exchange rates from OANDA were used to transfer these figures into US Dollar. All energy related units were converted into US Dollar using spot prices.
- Often companies did not enclose information on netted derivative positions and just gave notional amounts for each position separately. In this case positions with inverse sign, e.g. a gas put option and a concurrent long gas swap, have not been netted, as the contractual characteristics are scarcely disclosed in annual reports and thus the given derivatives may differ e.g. in time and place of delivery and hence not be exact offsetting items. Netting without detailed information on the positions would draw a wrong picture as two not exactly offsetting derivatives double the risk rather than mitigating it. A similar approach has been applied for exchange and interest rate contracts. For the latter only floating to fix positions were taken into account as fixed rate debt was considered risk free with respect to interest rate fluctuations for the purpose of this analysis. This assumption is further corroborated by the evidence given in Bodnar et al. (1995) that 96 % of the investigated sample exchanges floating

to fixed interest rate to secure floating rate exposure. If no distinction between floating and fixed rate derivatives was made, the whole amount was taken as hedging volume.

- In some cases derivatives were used that hedge more than one risk, e.g. cross currency swaps which both close an open exchange rate and an interest rate position. In this case the position was evaluated for both risks to the same amount and thus shows up for both risk volumes.

- Many companies do not distinguish between the commodity risk positions due in the corresponding year and the ones that will become relevant in the future. Therefore all hedging positions have been counted equally regardless of their due date and thus the year in which they will offset a correspondent risk position. The risk of not only measuring the volume to which a company closes its open positions in a certain year but also the time horizon of hedging is therefore clearly inherent in the data but can hardly be avoided based on information from annual reports.

- Embedded derivatives are incorporated into a so-called host contract, resulting in a hybrid instrument. Due to the derivative nature of this financial instrument some or all cash flows of this contract are dependent on an underlying. This explanation shows that embedded derivatives should be treated as derivatives apt to hedging purposes. But as they cannot be considered separately and only as an integral part of the overall contract, they were not included in the analysis. In addition these derivatives are only reported in few cases and would bias the perspective if accounted for in only these outliers.

- Power purchase agreements (PPA) are legal contracts between two parties, where the seller, often an independent power producer, normally supplies the electricity and the buyer, commonly a utility, buys the capacity produced. Often the buyer of the PPA, the utility, supports the seller in various ways; financing of the respective power plant or know-how transfer to operate the plant are quite common. By this means PPAs go beyond normal forward contracts and are as such not included in my analysis. In addition not all companies report the use of PPAs which could result in a bias in case they were considered in the few cases where information is available.

- Cap, floor and collar contracts have been interpreted as hedging instruments. Though they do not secure the whole risk of interest rate changes but only limit it to a certain amount or in a certain direction, they are introduced by a company to control certain risks and thus qualify as hedging positions.

- Swaps between two currencies distinct from the domestic currency of a company have been treated as two separate swaps, e.g. a Japanese company owning a euro to dollar swap has been identified as holding a euro to yen and a yen to dollar contract in its books.

- In addition I tried to separate proprietary trading from pure hedging activities. Though many risk management decisions include speculation in a certain way (e.g. when it comes to the timing – for a further discussion see e.g. Faulkender (2005)) I try to reduce my observations to those where firms do not primarily focus on proprietary trading. In the case of dummy variables only those companies have been classified as hedgers that clearly report hedging activities – the pure appearance of derivatives on the balance sheet was not counted for as a hedging activity if the report did not additionally mention that the company does not involve in speculation. In the case of volumes the separation between hedging and speculation is more difficult, as a firm can both hedge and trade and thus easily earn the dummy variable “1” characterizing it as a “hedger” but still report only one figure showing the derivative volume for the sum of hedging and trading contracts. If these amounts have been reported separately, only the hedging volumes were taken for the forthcoming analysis, but very often distinguishing between the different motivations for holding certain derivatives was not possible and thus collected hedging volumes also include trading positions.

Finally I aggregated all volume figures for certain risks on the corresponding higher risk levels: This way e.g. an electricity option has been added to the volumes for other energy hedging contracts resulting in a figure for commodity hedging – the information on the commodity hedging has then been consolidated with the information on interest and exchange rate hedging to an overall hedging dummy. Here the above mentioned convention to assume all hedging relevant activities have been reported if at least one was mentioned applies again. An overall hedging volume has not been calculated, as the volumes for commodity, interest and exchange rate hedging differ too much and thus I considered the risk to just create a meaningless number by consolidation as being too high.

Overall it must be admitted that very often the interpretation and conclusion, if or not and to which extend a company hedges or how large an exposure is, will always depend on the personal perspective. One example may give the reader an idea of how easily ambiguities can occur even in the most simple cases: Companies often publish a certain range for their long-term loans (e.g. 3 % to 5 %). This can either be interpreted as loans with fixed rates between 3 % and 5 %, or loans with floating rates that vary in the range of 3 % to 5 %. If no further information was enclosed in such a situation, numbers could not be used as the risk of misinterpretation was too high.

5.6 Exposure figures

To make the volumes comparable, information on the exposure was needed to normalize hedging volumes. In the literature normally total assets is used for the purpose of volume standardization. I followed this approach in my analyses as well. In addition I used the uniqueness of the energy sector to build estimated for the exposure to the three observed risk types. These estimates have been included separately. This allows for a comparison of the impact of risk exposure to e.g. cultural indices and thus an interpretation of the economic relevance of the effects studied in the following. This implies that if not stated elsewise all hedging volumes are standardized by total assets – as e.g. done in Campello et al. (2011). Before doing so I tried a different approach which is perhaps more obvious and surely leads to more accurate results. This approach shall be briefly mentioned and explained in the following though the corresponding numbers could not be used as the availability was too low.

To be more accurate in the way I relate hedging volumes to risk exposures, I extracted exposure figures (notional amounts of the positions exposed to a certain risk type). With regard to interest rate exposure I only used the book value of debt with floating interest rate in accordance with the figures for hedging volumes – fixed rate debt has been interpreted as risk free with respect to interest rate changes and thus been excluded from exposure considerations. For the exchange rate exposures I used reported FX exposure figures in the reports or summed up the listed asset and liability positions denominated in foreign currencies if published. A more accurate consideration would also try to take the floating end exchange rate positions inherent in other contracts into account. But as the required information is not given in the reports, I excluded this point from my analysis. This approach however did not generate sufficient observations and correspondingly, my data set would have been reduced to only few company years. Therefore I decided to rely on estimates for the risk exposures which will be introduced in the following:

- FX exposure, as measured in my analysis, uses the fact that the utilities' input factors are mainly primary energy sources for power plants like oil, gas, or coal. These primary energy sources are usually denominated in US Dollar. On the other hand, a utility sells the power it produces on the local market in local currency. If this local currency is not US Dollar, the company faces an exchange rate risk as it incurs all costs of goods sold (COGS) in another currency than the one in which it sells its products. Thus, my proxy for the FX exposure is COGS divided by total assets for non-US companies, and "0" for US companies.

- CO EXPOSURE is defined as COGS plus sales divided by total assets. This relates to the fact that COGS of energy utilities mainly cover the prices that have to be paid for primary energy sources. Sales for electricity providers are mainly generated through selling power and consequently increase the commodity risk.
- IR EXPOSURE is approximated by the firm's leverage. I hereby assume that interest rates are normally not (totally) fixed in a company's debt.

5.7 Accounting and financial data

As already mentioned this work shall analyze the hedging strategies measured through hedging data as described above with respect to firm- and country-level indicators. The variables on the firm-level have been chosen to allow a critical examination of the hedging theories on costs of distress, underinvestment and economies of scale, that have been explained in detail in the prior section. In addition I included some further variables into the analyses to control for influences unpredicted by current hedging theories.

All the firm-level variables were extracted from the Thomson One Banker database. As the control variables differ between the different subsections / research questions, at this point I will abstain from giving a detailed information on the variables used but refer to the variables tables in each of the following subsections.

5.8 Data on production technology

To measure the impact of production technology on hedging, Platts WEPP data base for the years 2002 to 2009 (Platts (2012)) has been matched to the hedging information. This data base is the most comprehensive worldwide source of information on power plants, providing a.o. data on ownership, construction years, beginning production, fuels and capacities. The relevant data used will be introduced in the chapter 8 in more detail.

5.9 Country-level variables

Country-level variables control for additional business environmental characteristics, such as the size of derivative markets, the regulatory framework, the size of privately held shares, the inflation and the GDP per capita. Similar to the firm-level variables I refer to each subsection for a detailed description of the firm-level variables used.

Cultural variables are a special case of the country variables used in my analyses, as they have so far not been considered in the research on hedging decisions. For my analyses I use the cultural dimensions from Hofstede (2001), which shall be discussed in more detail in the relevant section.

6 Global patterns in derivative hedging

The following chapter is largely based on the paper Lievenbrueck and Schmid (2013)

In the following, the results from analyzing different hedging determinants shall be presented. As discussed in the introduction, I will begin this analysis with some descriptive observations concerning hedging in the energy markets and differences between hedging patterns across countries. The corresponding results shall be presented in the present chapter. Afterwards, I will turn my attention towards multivariate regressions to study firm- and country-level determinants in further detail in the following chapters.

6.1 Motivation for hedging

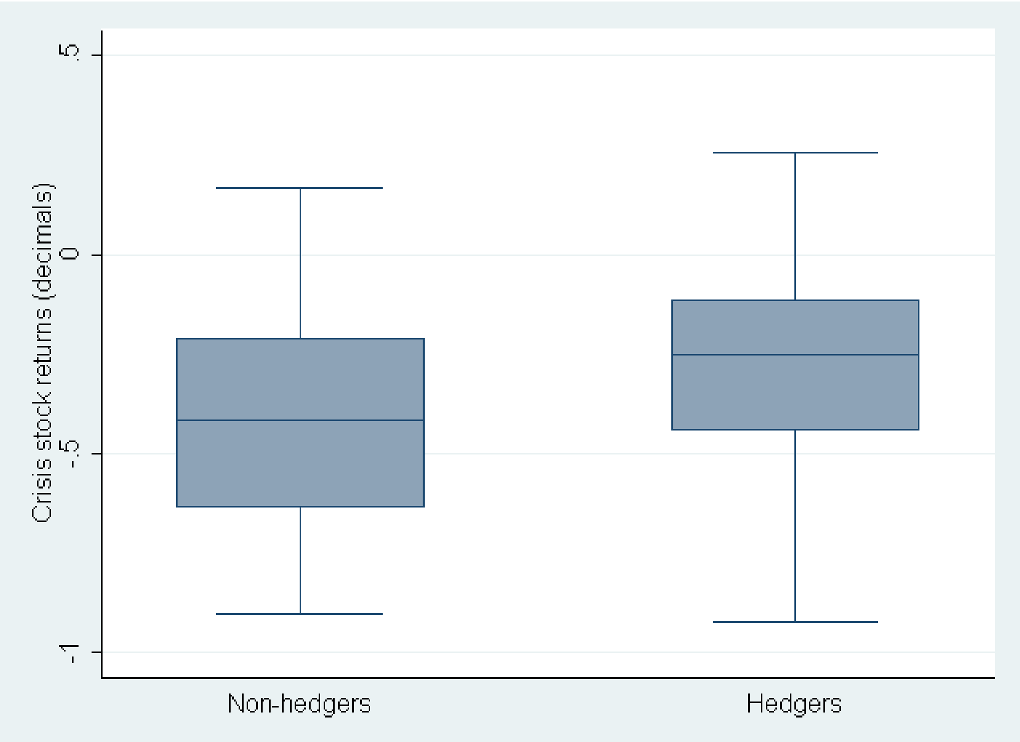
I want to begin my considerations by regarding the development of hedgers and non-hedgers during the financial crisis of 2008. Figure 6.1 shows the range of stock returns for both groups (companies not using derivatives to hedge any market risk type and companies hedging at least one risk type) in the time from September 2008 to January 2009. While hedgers on average lost little more than 28 % in the relevant time interval, non-hedgers lost approximately 42 %. In addition the standard deviation in returns is slightly lower for hedgers (below 24 %) than for non-hedgers (above 26 %).

The just presented effect is in line with my expectations and prior findings on the impact of hedging (Bartram et al., 2009): Hedging reduces the market risk a company faces and thus the stock price volatility especially in turbulent times. In addition, hedging creates value in the presence of market imperfections as discussed in much detail e.g. in Smith and Stulz (1985). One of the most important articles studying this effect empirically is the research done by Campello et al. (2011) which proves that firms hedging their exposures have lower costs of debt and are less likely to have covenants in their financing contracts. Gay, Lin, and Smith (2011) consider the influence of hedging on costs of equity using a self constructed measure for the future cost of capital that build on the Fama French factors. Their findings indicate that firms using derivatives to hedge have lower costs of equity. Some other publications study the relation between hedging and Tobin's Q. One example here is the article by Allayannis et al. (2012) building on a global sample covering 39 countries which proves that hedging leads to a significant market value premium for firms with strong internal or external governance. Bartram et al. (2011) analyze the effect of hedging on firm value using a sample of companies across 47 countries and find a similar impact on Tobin's Q.

As we will see later that hedging patterns look very different in the United States and vary strongly with firm size, I check the above mentioned descriptive results for the effect of hedging on abnormal returns during the crisis for robustness against exclusion of US companies and against segmentation into subsamples for company size. In addition, I regard different time horizons, e.g. only the first month in the crisis, September 2008. In each case I find similar results.

Overall, hedging has been proven to increase shareholder value and effectively manage market risks. Thus, one would expect to find many companies use derivatives at least to a certain degree to hedge against market risks. This expectation however fails in reality – in more than a third of all company years, as we will soon see, the relevant company did not use any derivatives to hedge. This leads to the question what drives hedging in the energy market. I will begin my analysis with some general descriptive results from the sample that present the differences in hedging patterns that can be observed.

Figure 6.1: Crisis stock returns hedgers vs. non-hedgers



Stock returns for hedgers and non-hedgers between September 1, 2008 and January 1, 2009. Numbers are given in decimals. The plot shows maximum and minimum (upper and lower single line), upper and lower quartiles (upper and lower limit of the box) and the median.

6.2 Data used in the following analyses

As mentioned, I will give some general overview of my data set on hedging information in the global energy market. This implies that I will not use other accounting or country-level variables and thus the sample will not be restricted by further data availability. The full sample I consider here consists of 3,762 observations from 57 countries. A further detailed perspective on the whole data sample will be given in the remaining part of this chapter.

6.3 Methodology

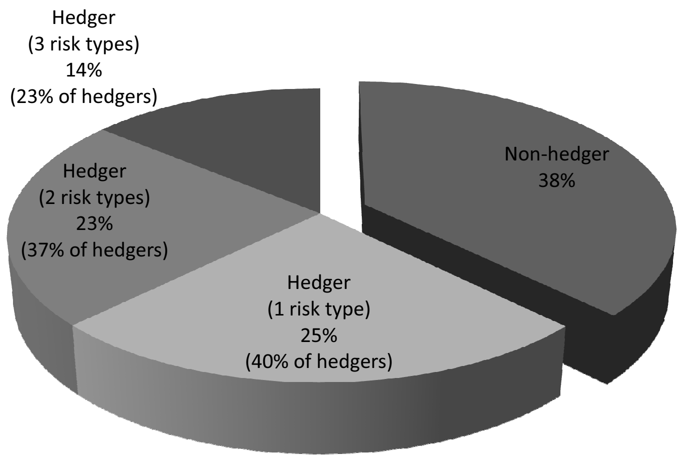
The objective of this chapter is to describe the hedging data sample from different perspectives and identify some patterns that can be seen. Therefore I will purely rely on descriptive methods in this chapter and leave multivariate models for the following analyses.

6.4 Differences in hedging patterns across countries

I consider three market risk types: exchange rate (FX), interest rate (IR) and commodity price (CO) risks. Relevant commodities here are oil, gas, coal and of course power. In 38 % of the cases it was observed that none of these risks has been hedged. This is a relatively low number of non-hedgers compared to earlier studies: e.g. Bodnar et al. (1996) find 41 % hedgers in their sample. In a later study by Bodnar et al. (1996) the share of hedgers is 53 %. These numbers are representative for the figures presented in publications in that time. Thus it seems that hedging activities have increased over the last decades. Among the remaining 62 % of hedgers in my sample, in most firm years only one risk type was hedged and in only 14 % of all cases a company reported to hedge all three risk types.

This is interesting in the context of the ongoing discussion if hedging one risk type also conditions securing other risk types and consequently if hedging always has to be modeled simultaneously for all market risks. I do see a 60 % chance that a hedging company uses derivatives to secure more than

Figure 6.2: Number of risks hedged per observation



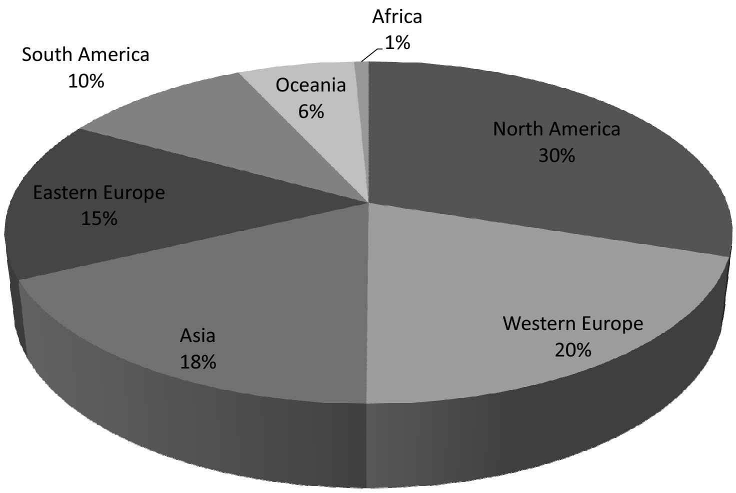
Share of observations by number of risk types hedged for the whole sample. The relevant risk types are FX (exchange rate), IR (interest rate) and CO (commodity prices). It has not been distinguished which risk has been hedged, only the number of risk types hedged is presented. Numbers in brackets present shares of companies hedging one, two or three risk types relative to hedgers overall and excluding all non-hedgers.

one risk, but still around 40 % of all hedging companies concentrate their actions on a single risk type. This means, I do find a correlation between the probabilities for hedging certain risk types but the effect is less strong than one could expect.

As mentioned, the sample consists of 3,762 panel observations on the hedging behavior of utilities across the world. One can see in figure 6.3 that North America makes up the largest share in the sample: Approximately 30 % of all companies are headquartered in the US or Canada. North America is followed by Western Europe and Asia (each around 20 % of all companies). The by far smallest share of utilities (less than 1 %) in the sample comes from African countries.

A total of 57 countries is represented in my analyses. Figure 6.4 shows a

Figure 6.3: Distribution of firms in full sample across countries



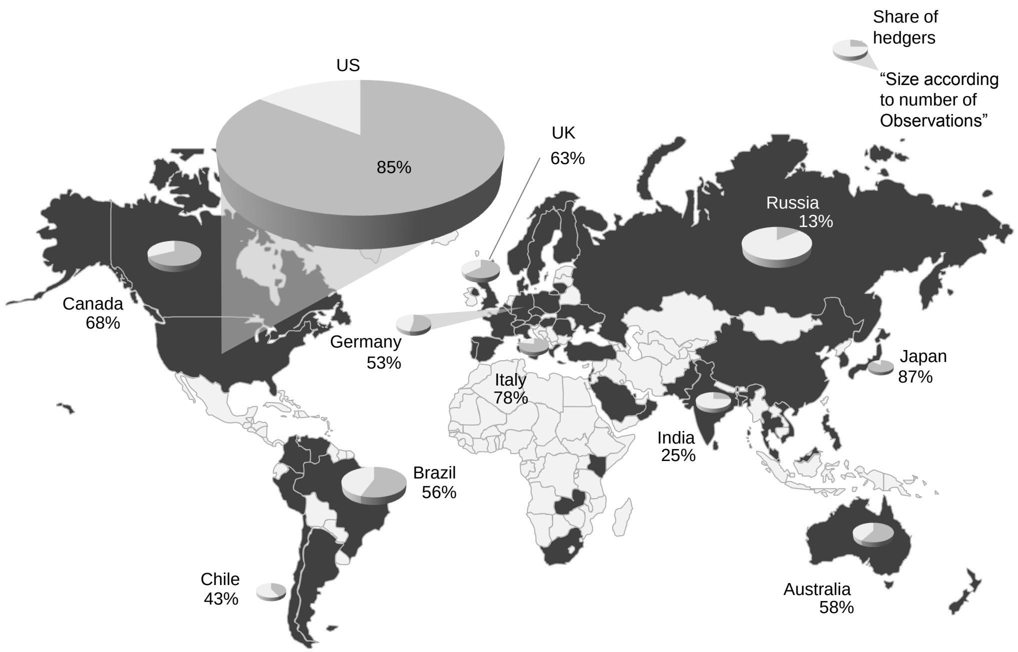
Share of firms by different regions in the sample. The illustration ignores the number of observations per firm. Regions cover the following countries: North America (Canada, US), Western Europe (Austria, Belgium, Channel Islands, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom); Eastern Europe (Czech Republic, Hungary, Lithuania, Poland, Romania, Russia, Turkey, Ukraine); Asia (Abu Dhabi, Bangladesh, China, Hong Kong, India, Israel, Japan, Jordan, Malaysia, Oman, Pakistan, Palestine, Philippines, Qatar, Saudi Arabia, Singapore, South Korea, Sri Lanka, Thailand, Vietnam); South America (Argentina, Brazil, Chile, Colombia, Peru, Venezuela); Oceania (Australia, New Zealand); Africa (Kenya, South Africa, Zambia).

global map with a dark shading for those countries that are covered by the data. For the major countries in the sample the share of hedging companies is shown on a pie chart. “Share of hedgers” here means the number of observations where the company was classified as hedger compared to the overall number of observations in that country. The relative number of observations in this country compared to the overall sample is illustrated by the size of the pies. The United States clearly make up the largest share of observations (with 1080 firm years) followed by Russia (270 observations). In some larger countries like China only few companies could be considered as annual reports are often still issued in local languages and not available in English [12].

One can see that in some developing and emerging markets the share of hedging companies is still lower than in industrialized countries. In Russia or India only 13 % respectively 25 % of all utilities use derivatives to hedge their exposures. A clear exception to this rule is Brazil with a relatively high share of hedgers of around 56 %. In comparison, only 53 % of all utilities in Germany use derivatives to hedge. The highest share of hedgers can be found in Japan and the US. Here more than 80 % of all companies reported the usage of derivatives for hedging purposes.

[12]For details on the languages considered in my analyses see section 5 on the data gathering process.

Figure 6.4: Countries covered by full sample



World map showing countries considered in the sample (gray shading). Pie charts present the share of hedging companies for major countries. The size of the pie charts is proportional to the number of observations from the respective country in the sample (e.g. 1080 observations from US).

Driven by the high share of hedgers in the US and Canada it is not surprising that North America has the highest overall hedging probability (above 80 %) compared to other continents, as can be seen in figure 6.5. Pair wise similar percentages of hedgers can be found in Oceania (consisting of Australia and New Zealand) and Western Europe (each slightly below 70 %), South America and Asia (around 50 %) and in Eastern Europe and Africa (around 20 %).

Analyzing the share of hedgers separately for the different risk types shows a more differentiated picture: The high North American share of hedgers is mainly driven by a high chance for commodity hedging (slightly below 80 % compared to 34 % in Western Europe and 24 % in Oceania).

On the other hand, FX risk hedging is less common in North America than in other continents. Less than 20 % of all companies in North America hedge exchange rate risks compared to 45 to 49 % in Oceania and Western Europe. FX hedging is also quite common in South America and Asia (37 to 41 %) and only in Eastern Europe and Africa the number of hedgers is lower (11 resp. 7 %) than in North America.

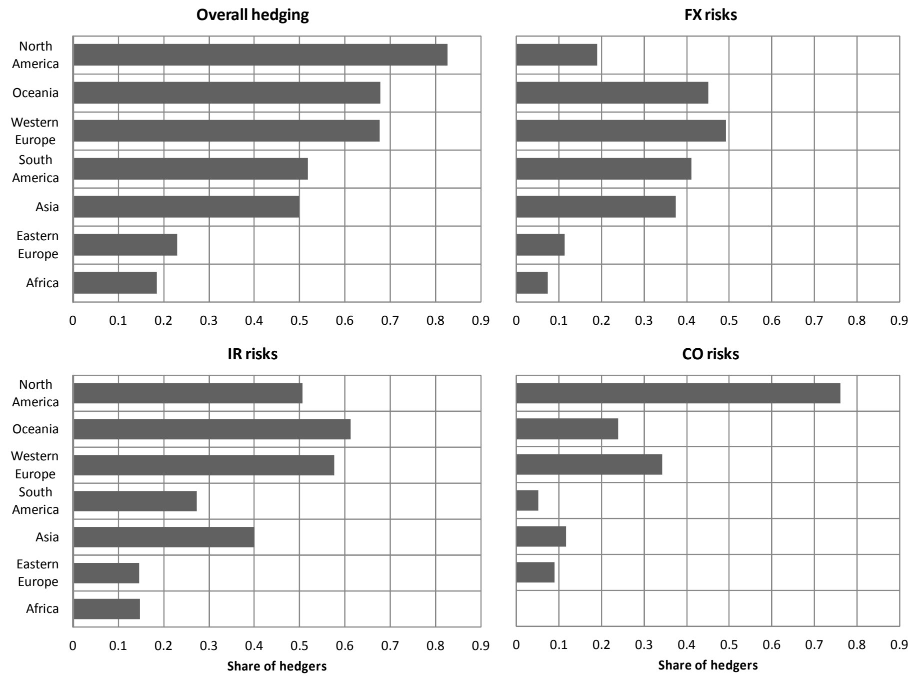
To explain this it is necessary to recap some properties of commodity markets. As discussed earlier, some commodities are traded globally (like oil, coal or uranium), some others (like gas or power) heavily depend on local grids and are thus mainly sold locally (exceptions like LNG still make up only a small fraction of global trades). For these commodities only local exchanges provide derivatives for hedging purposes. But local commodity markets are currently only developing and thus just in few countries the liquidity is reasonably high in order to allow derivative based risk management. Here the US (Henry Hub) and UK (NBP) are examples for liquid gas markets – the Scandinavian countries (Nord Pool) and Central European countries (EEX) are among the most liquid electricity markets. Though mainly locally sold, gas, like all other primary energy sources, is often denominated in US Dollar. Electricity on the other hand, which is also bound to a local grid, is always denominated in local currency. This introduces an exchange rate risk to electricity suppliers which are not located in the US, making FX risk management an integral part of their strategy. Of course US companies are not subject to this risk, which explains the low FX hedging probability in the US dominated North American subsample and the high FX risk hedging probabilities in other regions in the world. The FX denomination of primary energy sources also directly impacts commodity hedging which can be found more frequently in North America, as for US companies trading in primary energy contracts does generally not involve taking an FX risk and is thus easier. In addition, the US gas market around Henry Hub is among the most liquid in the world.

For interest rate hedging I see a slightly different picture compared to FX hedging. Although the number of IR hedgers is still higher in Oceania and Europe than in the US, the difference is not as large as it is for FX hedging: In all three regions the share of hedging companies lies above 50 % (in Oceania even slightly above 60 %). IR hedging is also quite common in Asia (around 40 %) but less probable in South America (below 30 %) and Eastern Europe and Africa (both around 15 %).

The distribution of hedgers and non-hedgers for all three risk types on a country-level can be found in Appendix A.

When regarding the development of hedging behavior over time, I do not see a strong change – neither for the overall hedging nor for the three separate risk types. The corresponding numbers can be found in figure 6.6. Also the financial crisis, which is covered by the time horizon of my sample, can hardly be seen in the data. The only effect in the relevant years (2007 to 2009) is an increase of FX hedging by approximately 3 percentage points (though the resulting level of FX hedging is still below the 2002 figures). Similar pictures occur if one considers regional subsamples like US only, Western Europe or the BRIC states. In all of these cases changes in the level of hedging during the financial crisis are in the same order of magnitude as the developments before 2007 and no clear trend can be seen. This is interesting as the energy market was well affected by the crisis, as power consumption is assumed to be correlated with GDP development. Nevertheless I do not see an increasing share of hedging companies in this time.

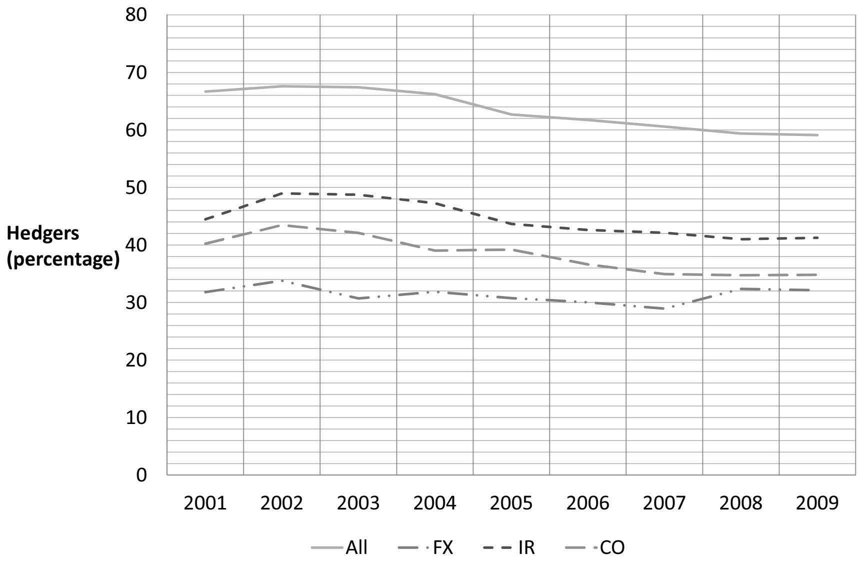
Figure 6.5: FX, IR and CO hedging across regions



Share of hedging companies for different regions and risk types. Assignment of countries to regions as defined in figure 6.3.

This finding suggests two hypotheses: First, the financial crisis does not seem to have a strong impact on the probability for derivative usage for hedging – neither did the hedging probability increase as market risk perception grew nor did it decrease as a reaction to market reports of losses on derivative positions incurred by speculators or companies applying inefficient hedging. This means that hedging must be driven by other facts than the overall market risk development. Second, there is no strong catch-up race on hedging activities by emerging markets like the BRIC states. I do currently not see overwhelming high growth rates in derivative usage for

Figure 6.6: Development of hedging over time



Development of share of hedging companies for the whole data sample over time.

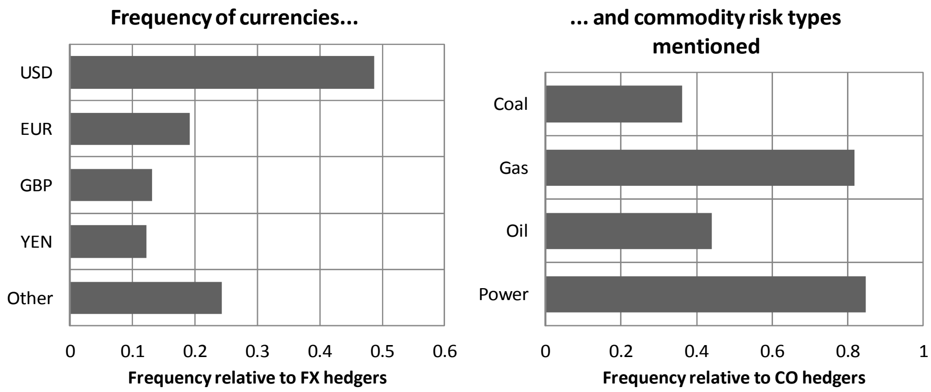
hedging purposes in these countries. This might be attributed to the fact that it takes some time for derivative markets to develop.

In addition to analyzing hedging of the three risk types FX, IR and CO, I have gathered information which of the sub risks in FX and CO hedging (power, oil, gas or coal in the case of CO and USD, EUR, GBP, YEN or other currencies in the case of FX risks) are covered by the derivatives. The relevant numbers can be seen in figure 6.7.

The first and most obvious finding is the high share of US Dollar hedging compared to other currencies. This confirms the earlier discussion on global commodity markets and the natural US Dollar exposure for utilities. The probability for US Dollar hedging is approximately twice that of other currencies.

Taking a look at CO hedging, I find a high probability for power and gas price hedging. Though coal and oil are also very common production tech-

Figure 6.7: Details on currencies and commodities hedged



Graph showing the share of FX resp. CO hedgers securing certain sub risks. Currencies are USD, EUR, GBP, YEN. Commodities are coal, gas, oil and power.

nologies, they are only hedged in approx. 40 % of the reported cases compared to gas hedging in more than 80 %. The high share of gas hedgers poses the question for the drivers underlying this trend. This will be discussed in more detail in chapter 8. The reason, as we will see there, is a high chance for cross hedging power using gas derivatives in the US. The high share of power hedging compared to oil and coal is in line with my expectations: Every electricity supplier has a power exposure, but not all of them necessarily need to have an oil or coal exposure. The exposure to primary energy sources depends on each company's unique production portfolio.

6.5 Conclusion

Overall I think that hedging might be influenced by more factors than considered in prior research, especially on the country-level. I see strong regional differences in the hedging behavior of energy companies. On the one hand, the US Dollar denomination of most primary energy sources leads to a very low exchange rate hedging probability in the US. On the other hand commodity hedging seems to be strongly correlated with market liquidity, which leads to an overall high hedging probability in North America compared to for instance Asia or Eastern Europe. In general I find evidence for the assumption that hedging is correlated to economic development: Higher developed countries show a higher hedging probability. Interestingly, no significant development over time could be found, neither for the whole sample nor for subsamples like Western industrialized countries or BRIC. One open question that must be studied further is the high chance for gas hedging in the sample.

This implies that in the following analyses it will be advisable to control for the difference in the hedging patterns in the US compared to other countries, the liquidity and economic development.

7 Firm financials and hedging

The following chapter is largely based on the paper Lievenbrueck and Schmid (2013)

We have discussed earlier that hedging seems to have a positive impact on costs of financing. As mentioned, this yields the question why certain companies do not hedge while others do. I will in the following try to explain these patterns using the aforementioned theories on economies of scale, costs of distress and underinvestment problems.

7.1 Preliminary considerations

Most prior studies on hedging use data from US companies to analyze hedging determinants. Unfortunately results are not always in line with the theoretical predictions. While for example Graham and Rogers (1999) and Graham and Rogers (2002) find evidence that hedging volumes are higher for firms with higher leverage and profitability, Mian (1996) finds that hedging is inconsistent with the cost of distress theory. Similarly again Mian (1996) does not find evidence for the underinvestment theory, whereas Nance et al. (1993) prove that hedging firms in their sample face more convex tax functions, have a lower coverage ratio for their fixed claims and have more growth opportunities. Overall, only one determinant proves to be influential across all major studies: firm size. The larger a company, the more it hedges.

This is the next topic I discuss: How does firm size impact a company's hedging behavior and are there other firm financials that influence hedging? In contrast to all prior works, I separately consider the three hedging dimensions, the hedging decision, the hedging volume and the hedging instruments used. My hypotheses regarding firm size are as follows:

Hedging dummy: Starting to hedge involves fixed costs as knowledge has to be bought and several new risk and modeling capabilities are needed besides a proper market access. Thus larger companies profit from economies of scale and are more likely to introduce hedging in their risk management. This hypothesis has already been shown in various prior studies. Thus I posit:
Hypothesis 1a: Larger companies are more likely to hedge.

Hedging volume: Once hedging has been established, economies of scale should only play a minor role in the decision on the hedging volume. But smaller firms face higher costs of distress and should thus hedge a larger share of their exposure. Thus, it is more likely that in relation to a company's total assets the overall notional volume of hedging instruments is larger for smaller firms. I posit:
Hypothesis 1b: Larger companies have lower hedging volumes (notional volumes of hedging instruments) relative to their total assets.

Hedging instruments: Options are necessary when a company faces volume risk or wants to hedge real options that are at the money (I will discuss this in more detail in chapter 8). The larger a company, the more likely it is to face these risks in its portfolio. Thus I posit:
Hypothesis 1c: Larger companies have a higher probability to use options.

For simplicity reasons, I do not number the hypotheses on all other firm variables for all three hedging dimensions. Instead, I will present the rationales for their impact in continuous text in the following table.

Table 7.1: Predicted influence of firm-level variables on hedging decisions

Variable	Hypotheses
Size	See *hypotheses 1a - 1c*.
FX/CO exposure	I expect companies with a higher exposure to show a higher hedging probability and to hedge higher volumes. In addition, I expect them to be more likely to face optionalities or volume risks in their portfolios and thus use options more frequently.
Leverage	Leverage can either be an estimate for the costs of distress (the higher the leverage, the higher the probability of default and the higher the costs of distress) or it can simply be a measure for the IR exposure (the more debt, the higher the interest rate exposure). In the first case, one would expect to find higher hedging probabilities and volumes for all three risk types, the higher the leverage. This can be explained by arguing that hedging every risk type helps harmonizing cash flows and thus reducing the probability of distress. In the second case, leverage will probably only affect the IR hedging probability and volume (again with a positive correlation). The argument in this case is similar to the ones given for FX and CO exposure.
Market-to-book	Market-to-book ratio is often used as a proxy for investment opportunities. Following the underinvestment hypothesis I would expect market-to-book ratio to have a positive influence on the hedging decision and the hedging volume. The underlying argumentation goes as follows: Hedging harmonizes cash flows and reduces the cash flow volatility. By this, less liquidity is needed and thus financing for investment opportunities is easier.

Table presenting the list of firm-level variables with associated hypotheses and rationales for the influence on the hedging decisions.

Table 7.1

Variable	Hypotheses
Profitability	More profitable companies are expected to have a lower need to harmonize cash flows in order to avoid underinvestment problems or higher costs of distress. Hence profitability should have a negative influence on both the binary and continuous hedging decisions. Unfortunately I cannot include the Z-score or a similar variable into my analyses, but the profitability is one driver for this variable and thus my argumentation is similar to a potential hypothesis on the impact of a Z-score.
Free cash flow	Companies generating a high free cash flow are more likely to be able to finance their investments internally and thus have a lower need to harmonize cash flows using derivatives.
Dividend	The dividend dummy is not linked to any hypothesis concerning hedging and has been chosen purely as a control variable. Therefore no significant influence on the decisions is expected. This variable is purely included to control for yet unknown impacts on hedging.

Table presenting the list of firm-level variables with associated hypotheses and rationales for the influence on the hedging decisions.

7.2 Data used in the following analyses

In a first step I will use accounting data in addition to the already presented hedging information. The main focus will here lie on company size and some control variables. Overall I will use the following variables in addition to the hedging information:

- Company size is defined as normal logarithm of total assets in thousand US dollars.
- FX exposure is defined as COGS divided by total assets for non-US companies and zero for US-companies.
- CO exposure is defined as COGS plus net sales or revenues divided by total assets.
- Leverage is total debt divided by sum of total debt and the market value of common equity.
- Market-to-book approximates a firm's growth opportunities and is measured as market capitalization divided by the book value of common equity.
- Profitability is defined as EBIT divided by total assets.
- Free cash flow is defined as cash flow from operations minus capex divided by total assets.
- Dividend is defined as a dummy being one if the company pays a dividend in the corresponding year and zero otherwise.

For some of the firm-level characteristics, alternative variables or calculation methods were used in robustness tests, e.g. when prior research was not consistent in the choice of the respective variable. For the purpose of examining the costs of distress hypothesis, the leverage was introduced into the model. As a variable total debt divided by the sum of total debt plus market value of equity has been chosen as default variable. For robustness tests market value of equity has been substituted by book value of equity and in another analysis total debt was substituted by long-term debt. For analyzing the underinvestment theory, the firm's investment opportunities were approximated by the ratio of market-to-book value and in a robustness test substituted by R&D expenses.

As market-to-book ratios from Datastream differed from corresponding values found in the Thomson One-Banker database, the former have been used in a robustness test as substitutes for the latter. In addition the following control variables were varied as follows: Profitability (measured as EBIT divided by total assets and in the robustness tests EBITDA divided by net sales or revenues) and dividend payout (either as dummy variable or as the ratio of dividend paid to net income available to common equity).

Finally, all results using the hedging dummy (the binary variable on the decision to hedge) have been tested using the alternative definition with a stricter classification of non-hedgers that has been presented in chapter 5.

7.3 Methodology

In this chapter I approach the research on hedging determinants using multivariate analyses. I will implement pooled probit and linear OLS regressions for the dummy variables and continuous variables respectively. In addition, I use standardized variables and report marginal effects when the hedging dummy is involved to enable the reader to interpret the numbers in terms of their economic relevance. For further information on the econometrics of panel data, OLS regression models and probit models, I refer to Stock and Watson (2012); Baum (2006); Hayashi (2000); Spanos (1998); Wooldridge (2010). For the marginal effects I calculate, Cameron and Trivedi (2010); Greene (2012); Stock and Watson (2012) may serve as sources for further information.

All ratios are winsorized at the 1 % and 99 % level to restrict the impact of outliers. T-Statistics reported in the tables are based on robust

Huber/White standard errors clustered at the firm level. In general, regressions assume that all predictor variables in the model are independent. In my data however, I consider firm years over time. It is possible that each firm has its own specific probability of hedging. Thus the model has to be extended by introducing a firm-specific intercept (Demidenko, 2004). ***, ** and * indicate significance on the 0.1 %-, 1 %- and 5 %-levels, respectively.

I undertake only few robustness checks in this chapter. The findings are mainly known and proven in several prior papers – except for the impact of size on hedging volumes. The reported figures though are robust for different definitions of company size (number of employees en lieu of total assets) different definitions of accounting data, especially profitability and leverage and a lagging of all accounting data by one year. As mentioned I also include a different stricter definition of the hedging dummy.

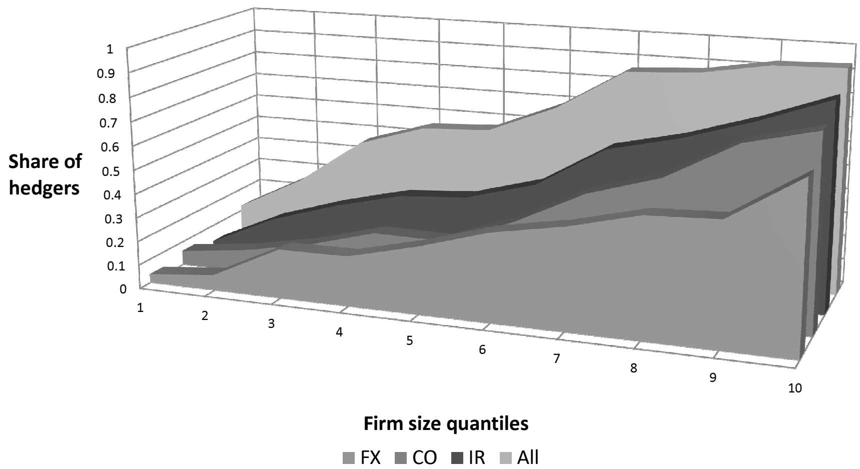
7.4 Evidence for the impact of firm size and firm financials

In figure 7.1 one can see the magnitude of the influence of size on hedging. While hedging occurs in over 90 % of the cases in the largest 10 % of companies in the sample, only around 10 % of the smallest firms reported derivative hedging. Considering the risk types separately draws a similar picture though the absolute levels differ.

Interestingly the growth rate is more or less linear which supports the common approach of linear regression of hedging probability against size. On the other hand, the impact is so strong that splitting samples into quantiles for further analyses might also seem to be an appropriate approach.

Multivariate analyses give a similar picture. The corresponding results are shown in table 7.2. Again, we see that firm size increases the hedging

Figure 7.1: Hedging probability and firm size



Share of hedging companies split into 10 % size-quantiles for the whole sample.

probability across all three observed risk types. I also find a positive impact of the risk exposure on the hedging probability. As the table shows marginal effects based on standardized variables, one can interpret the numbers in terms of economic relevance: Size coefficients are for all three risk types the largest coefficients in the model, thus size is also economically the most important factor. Therefore, I can confirm my *hypothesis 1a* on the positive impact of firm size on the hedging probability.

Regarding the other firm financials, I do only find little evidence for the hypotheses presented in the preliminary considerations and discussed in many publications on hedging determinants. FX and CO exposure increase the probability for hedging the corresponding risk types significantly. Leverage only increases the probability for IR hedging – the other impacts are not significant or inconsistent. Thus I rather attribute the positive impact of leverage on the IR hedging probability on the fact, that leverage is a good estimate for the IR exposure, than take it as a proof for the costs of distress theory. As discussed earlier, higher costs of distress should increase the hedging probability for all risk types. I also find only little additional evidence for the costs of distress theory based on the impact of profitability. The influence is as expected for the FX risk but not significant for the two other risk types. I therefore conclude that there is only little evidence for the costs of distress theory in my data.

Table 7.2: Firm-level determinants and hedging decision

	FX	IR	CO
Size	0.46***	0.49***	0.62***
	(11.2)	(10.0)	(11.9)
FX exposure	0.049**		
	(2.03)		
CO exposure			0.17***
			(6.17)
Leverage	-0.0025	0.10***	-0.12***
	(-0.10)	(3.54)	(-3.98)
Market-to-book	0.062**	0.050**	-0.037
	(1.96)	(2.19)	(-1.24)
Profitability	-0.17***	-0.061	0.073
	(-2.77)	(-1.59)	(0.74)
Free cash flow	0.037	0.051	-0.044
	(0.82)	(1.03)	(-0.91)
Dividend	0.013	0.036	-0.14*
	(0.26)	(0.58)	(-1.94)
Observations	2,593	2,678	2,336
Pseudo R2	0.37	0.39	0.56

The dependent variable is the hedging dummmy that equals 1 if the company hedges in the corresponding year and 0 if the company does not hedge. The models are marginal effects for pooled probit based on standardized variables. Thus coefficients indicate the change in hedging probability if the relevant variable changes from mean to mean plus one standard deviation (mean to mean + 1 SD) while all other variables are held at their means. A detailed description of the variables can be found in Appendix B. All regressions include time and country dummies and a constant. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

The impact of market-to-book is as expected for FX and IR hedging. Unfortunately, the coefficient for CO hedging is not significant. In addition, I do not find significant load factors for the free cash flow, which should lead to less hedging in case the underinvestment theory holds. I therefore conclude that there is also only little evidence for the underinvestment theory.

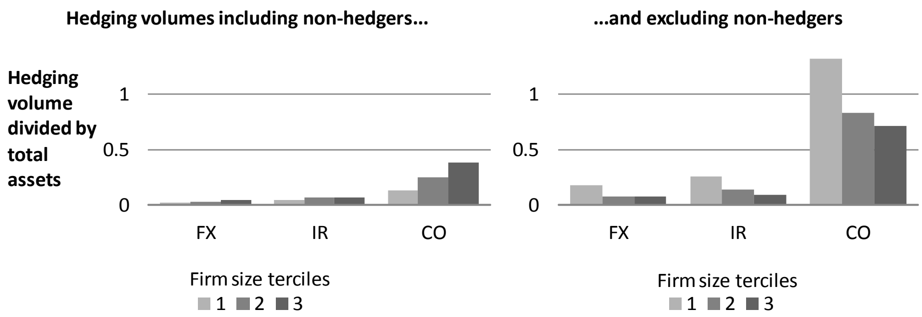
In many prior studies either a binary hedging dummy or hedging volumes have been considered. In the latter case it is not always clear from the results if the decision to hedge or the decision which volume to hedge is measured and in how far both decisions infer with each other in the analysis. Figure 7.2 reports the relation between size and hedging volumes both including and excluding non-hedgers (left and right hand side). On the left hand side, the non-hedgers are included as data points where the hedging volume is simply zero. On the right hand side, I exclude all non-hedgers from the analysis to see the effect of size on the hedging volume[13].

One can see that hedging volumes decrease relative to total assets if the analysis concentrates on hedgers only as has been hypothesized earlier. Only in this setting one can study the effect of company size on hedging volumes. If non-hedgers are included, the impression arises that hedging volumes increase over firm size, which is not the case. In this setting, one simply measures the stronger effect of hedging probability increasing over firm size which superposes the weaker effect of decreasing relative hedging volumes.

The corresponding regression models confirm that the size effect on hedging volumes is not the same as on the hedging dummy. Table 7.3 presents these results. The coefficients for firm size are negative though only on a low significance level. The missing significance is not totally explained by the lower number of observations in the regression. Due to the missing significance on my results, I cannot confirm my *hypothesis 1b*.

[13]On the first look it might be confusing that the hedging volumes for commodity risks exceed total assets. But volumes are measured in notional amounts of the contracts hold and can for commodity risks (in contrasts to other risk types) cover several future years.

Figure 7.2: Hedging volume and firm size



Volumes hedged for the different risk types across size terciles. In the left graph non-hedgers have been included, in the right graph only hedgers have been considered.

Table 7.3: Firm-level determinants and hedging volume

	FX	IR	CO
Size	-0.012	-0.011*	-0.14
	(-1.50)	(-1.74)	(-0.60)
FX exposure	0.012		
	(0.54)		
CO exposure			0.54
			(1.23)
Leverage	0.012	0.20***	-0.45
	(0.29)	(3.08)	(-0.33)
Market-to-book	0.0070	0.0035	-0.0057
	(1.04)	(0.70)	(-0.047)
Profitability	0.0047	-0.062	3.63
	(0.030)	(-0.52)	(0.85)
Free cash flow	0.020	-0.053	-1.22
	(0.17)	(-0.46)	(-0.51)
Dividend	0.011	-0.0097	-0.0067
	(0.61)	(-0.51)	(-0.0077)
Observations	599	783	362
R-squared	0.407	0.468	0.235

The dependent variable is the hedging volume (notional amount of hedging instruments divided by total assets). The models are pooled linear regressions. A detailed description of the variables can be found in Appendix B. All regressions include time and country dummies and a constant and are limited to hedgers only. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

I also do not find additional evidence for the aforementioned financial theories on hedging – no variable shows significant and consistent load factors for the three hedging volume variables. I can therefore neither conclude that companies facing higher exposures tend to hedge higher volumes, nor can I prove that underinvestment problems or costs of distress increase a firm's hedging volumes.

On the other hand, the number of observations in these analyses is rather low. I will therefore refrain from purely considering the hedging volumes in the upcoming analyses and rather use the combination of volumes and hedging dummies as an additional robustness test for studying the hedging probabilities.

In a last step I now turn my attention towards the hedging instruments used. Table 7.4 shows the corresponding results.

One can see that firm size increases the probability for the usage of options across all risk types. Unfortunately, the significance for FX risk is very low. This might as well be due to the low number of observations in the regression. Obviously firms tend to rather rely on linear instruments when hedging FX risks. Overall, I find evidence that confirms my *hypothesis 1c*.

Other impacts are again mixed: On the one hand, a higher CO and IR exposure (leverage) leads to a higher chance for IR and CO option usage. On the other hand, the impact of FX exposure on the usage of FX options points into the opposite direction. Most other control variables are insignificant or inconsistent across all three risk types. Overall, the financial variables do not seem to have a high explanatory power for the decision to use non-linear derivatives.

Table 7.4: Firm-level determinants and hedging instruments used

	FX	IR	CO
Size	0.11	0.40***	0.30***
	(1.29)	(3.46)	(3.40)
FX exposure	-1.28**		
	(-2.57)		
CO exposure			0.55***
			(3.42)
Leverage	-0.17	1.35**	0.83
	(-0.29)	(2.05)	(1.05)
Market-to-book	-0.11*	0.031	0.0062
	(-1.82)	(0.69)	(0.10)
Profitability	-2.98	3.96*	0.22
	(-1.40)	(1.90)	(0.14)
Free cash flow	0.18	-1.16	0.55
	(0.13)	(-1.03)	(0.40)
Dividend	0.36	-0.053	0.047
	(1.30)	(-0.14)	(0.17)
Observations	695	1,012	837
Pseudo R2	0.23	0.23	0.19

The dependent variable is the decision to use asymmetric hedging instruments. All models are pooled probit regressions. The sample is restricted to hedgers only. A detailed description of the variables can be found in Appendix B. All regresions include time and country dummies and a constant. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Overall I find evidence that size strongly increases the hedging probability and the chance for option usage of a company. The impact on the hedging volume on the other hand is less significant and the coefficient negative, indicating that the hedging volumes decrease with firm size. Thus fixed costs of hedging versus economies of scale are a major obstacle for smaller firms to start hedging, lowering the overall share of hedging companies from 90 % among the largest to only 10 % of the smallest companies.

I see two major implications of this finding: First, as smaller firms tend to hedge less but also profit from hedging, an easier and perhaps more standardized access to derivative markets could add value for these market participants. Second, a more thorough separation between analyzing the decision to hedge and analyzing the decision on the hedging volume could be advisable, as both influences might be opposite to each other.

7.5 Robustness of results

The above mentioned findings are robust for the usage of other measures of firm size, e.g. number of employees, in place of total assets. Furthermore, the results are robust against lagging of all financial variables and the usage of other hedging dummies, as discussd in the section on the methodology applied.

7.6 Conclusion

In line with earlier studies I find a very strong relation between company size and hedging probability. This impact ranges from 10 % hedging probability among the smallest companies in the sample to a 90 % chance for hedging activities in the subsample of the largest firms. In contrast to prior research, I do not find proof that larger companies also hedge higher relative volumes. This may however be a result of the fact that in contrast to other studies, I exclude non-hedgers from my analysis on the hedging volume and thus ensure that the strong impact of firm size on the hedging probability does not superpose the influence on the hedging volumes.
In addition, the chance for option usage increases with company size. This may be due to the higher chance for optionalities or volume risks in a larger company's portfolio.

I do only find very weak evidence for the underinvestment or costs of distress theory – the corresponding coefficients are mainly not consistent across all three risk factors.

I do find proof that smaller companies seem not to be able to use derivatives for hedging in the way larger companies do. But there is no economic reason why smaller companies should profit less from derivative hedging. Actually they are believed to have on average higher costs of distress and thus hedging should be more important for them. Here regulation could try to ease the access to derivatives markets for smaller companies. This topic is also relevant in the current debate on the role of renewables in my future energy mix: An increase in the share of renewables will likely lead to more smaller companies that have a very different hedging behavior and consequently also credit risk than their larger peers.

In addition I believe that the low evidence for the frequently considered financial theories on hedging (costs of distress and underinvestment) suggest to turn the attention towards new and yet unconsidered impact factors like production technology or business environmental characteristics. My sample allows to study these new factors. First, production technology is more easily measurable for energy providers than for most other companies. Second, the global panel structure gives the opportunity to consider regional characteristics like e.g. culture.

I will in the following approach these two topics and begin with the firm-level production technology. To reduce the number of variables to a reasonable quantity, I skip the free cash flow and the dividend dummy for all further analyses, as these variables were least significant across all regressions.

8 The impact of production technology

The following chapter is largely based on the paper Lievenbrueck and Schmid (2013)

In the next step, I consider the impact of production technology, a firm-level determinant which has so far not been a focus. As I expect no impact on the risk hedging for FX and IR, I purely focus on the CO hedging in this chapter.

8.1 Preliminary considerations

Hedging in the absence of volume risks or optionalities is rather straight forward and linear instruments suffice for the hedging purposes. I show that production technologies have an impact on e.g. optionalities and thus affect the hedging purposes on a company level. Hereby, I use the share of base to peak load technologies and two additional flexibility measures to control for the optionality of a production portfolio. I argue that power plants can be considered as real options on the spread between the fuel and the power price. As some fuels are more expensive than others (mainly the peak load technologies), these "options" are generally not as deep in the money as for instance the base load power plants. This theoretical consideration will be used in several ways in the following.

The first topic I consider is the relation between the optionality and the commodity hedging volume. Utilities use a delta hedging approach to hedge their exposures. This implies that deep-in-the-money options (base load power plants) lead to a higher delta and thus a higher hedging ratio, while at-the-money options (peak load technologies) lead to a lower delta and thus a lower hedging ratio. I assume to find this relation in the commodity hedging ratios of utilities. Thus, my first hypothesis regarding production flexibility is:

Commodity hedging volume: Companies with a higher share of base load technologies will hedge higher commodity volumes. I posit:

Hypothesis 2a: The higher the share of base load technologies, the higher the commodity hedging ratio.

Secondly, I consider the instruments used for hedging purposes. Again I start by considering the optionality of a power plant. Base load plants are deep in the money compared to peak load power plants. Deep-in-the-money options show a lower derivative of the hedging delta with respect to the price of the underlying (here the spread between the fuel and the power price). This second derivative (called Gamma) signifies the change in the delta when the underlying changes. Thus a higher Gamma leads to a stronger change in the delta when the price of the underlying changes. This results in a more frequent rebalancing in the derivative position for delta hedgers when hedging options that are at the money compared to options that are deep in the money. Consequently, I assume that peak load plants require more frequent changes in the delta hedging position. This leads to higher transaction costs and makes the hedging more complex. An alternative is to use options (more accurately selling a call on the spread) instead of buying or selling the underlying in a delta approach to reduce the transaction costs. These options are usually structured e.g. by investment banks and have to correspond to the specific characteristics of a power plant. Consequently, it is not easy to find a counterparty willing and able to structure these options. Nevertheless I expect to find a higher probability for option usage in case of a higher share of peak load technologies. My second hypothesis regarding the production technologies is:

Option usage: Companies with a higher share of peak load technologies will be more likely to use options for hedging purposes. I posit:

Hypothesis 2b: The higher the share of peak load technologies, the higher the probability for option usage.

As just discussed, I assume that options make especially sense in the presence of peak load technologies. In addition, they are often tailor-made products and thus the premium a utility has to pay the counterparty structuring these options is rather high. I now consider the effect of option usage on shareholder value. I assume that option usage is only positively accepted by shareholder in case they are used to hedge peak load power plants. Thus, if a company has no significant share in peak load technologies, I assume to find a negative impact on the firm value, as these costly derivatives are not necessary for the purposes of hedging deep-in-the-money base load technologies. My last hypothesis for the impact of production technologies on the hedging decisions is:

Tobin's Q: Firms with a significant share of peak load technologies in their production portfolio can increase their firm value through option usage while value decreases if firms concentrating on base load technologies use options. Thus I posit:

Hypothesis 2c: Option usage in the presence of peak load technologies increases firm value.

8.2 Data used in the following analyses

In the current chapter I will use accounting data plus information on production technology to study hedging patterns. The main focus will here lie on the production technology. As financial and accounting data I will rely on the variables presented in chapter 7.

To measure the impact of production technology on hedging, Platts WEPP data base for the years 2002 to 2009 (Platts (2012)) has been matched to the hedging information. This data base is the most comprehensive worldwide source of information on power plants, providing a.o. data on ownership, construction years, beginning production, fuels and capacities. In the year 2009 the database contains information on 116,664 power plants with a combined installed capacity of 4,732 GW compared to 4,957 GW reported by the International Energy Agency in its 2011 "World Energy Outlook" (International Energy Agency, 2011). A manual matching method has been used and final numbers have been cross-checked with published figures in annual reports. Overall information on production technologies for 2,183 company years have been gathered. 52 % of installed capacity and 28 % of all power plants can be matched. This number occurs small on first sight. But the sample only covers listed electricity providers. Hence all privately owned companies and energy-near firms possessing own power production capacities (like steel mills) are not included. This hypothesis is also supported by the difference between the larger share of matched capacity and the lower share of matched number of power plants: Obviously smaller plants are not matched in the sample. These can for instance be renewable power plants owned by private project developers or PE firms and power plants meant to provide electricity to a production side only.

The technologies considered in my sample are (in alphabetical order): Bio gas, bio mass, coal (lignite), coal, gas, CCGT, geo thermal, nuclear, oil, other, solar, waste, water (running river), water (pump storage) and wind.

I use the installed capacities (in MW) for each technology to define the following variables. Besides the variables "Share of base load", "Share of mid load", "Share of peak load" and "Share of stochastic", I use measures for the average "Run-up time" and "Ramp-up cost" of a company's portfolio in robustness tests. These variables measure the flexibility of a company's portfolio. As the position of a power plant in the merit order does both signify its production costs and its production flexibility, these additional measures are very similar to the classification of a power plants as base, mid or peak load, except that the production flexibility measures can be quantified whereas the classification of the position in the merit order is just qualitative. I will use them as alternative measures for the the share of peak load in robustness tests on the aforementioned hypotheses. To create these numbers, I simply use the capacity weighted estimates for the run-up time (ramp-up costs respectively) of each production technology. The classification of production technologies to base, mid and peak load and the estimates for a production technology's run-up time and ramp-up costs can be found in Appendix C. The table and the data set I use has been taken from Reinartz and Schmid (2012).

Overall the following variables are used in the upcoming analyses:

- Company size is defined as normal logarithm of total assets in thousand US dollars.
- Leverage is total debt divided by sum of total debt and the market value of common equity.
- Market-to-book approximates a firm's growth opportunities and is measured as market capitalization divided by the book value of common equity.
- Profitability is defined as EBIT divided by total assets.
- Tobin's Q is defined as normal logarithm of total assets minus book value of equity plus market capitalization divided by total assets.
- Share of base [resp. mid or peak] load is defined as installed capacity of base [resp. mid or peak] load technologies divided by total installed capacity.
- Ramp-up costs is defined as the capacity weighted average ramp-up costs of a company's production portfolio.
- Run-up time is defined as the capacity weighted run-up time of a company's production portfolio.

8.3 Methodology

In this chapter I approach the research on hedging determinants using a yet unstudied firm-level variable: production technology. The multivariate analysis methods I use are similar to the ones implemented in the prior chapter. I will use pooled probit and OLS regressions for the dummy variables and continuous variables respectively. Again Stock and Watson (2012); Baum (2006); Hayashi (2000); Greene (2012) may serve as sources for further information.

All ratios are winsorized at the 1 % and 99 % level to restrict the impact of outliers. T-Statistics reported in the tables are based on robust Huber-White standard errors clustered at the firm level. ***, ** and * indicate significance on the 0.1 %-, 1 %- and 5 %-levels, respectively.

Though in this chapter I will have the overall lowest number of observations in my models and thus the expected robustness is relatively low, I will undertake some robustness checks. All results are widely comparable when changing the definitions of accounting variables like company size (number of employees en lieu of total assets), profitability or leverage. Also lagging of the variables does not change the outcomes significantly. The major robustness check is testing the hypothesized relations by substituting the share of base, mid or peak load technologies by the two other flexibility measures obtained: ramp-up costs and run-up time. The corresponding results are presented in the relevant tables.

As the methodology is rather straight forward I will restrain from presenting a separate robustness section at the end of this chapter.

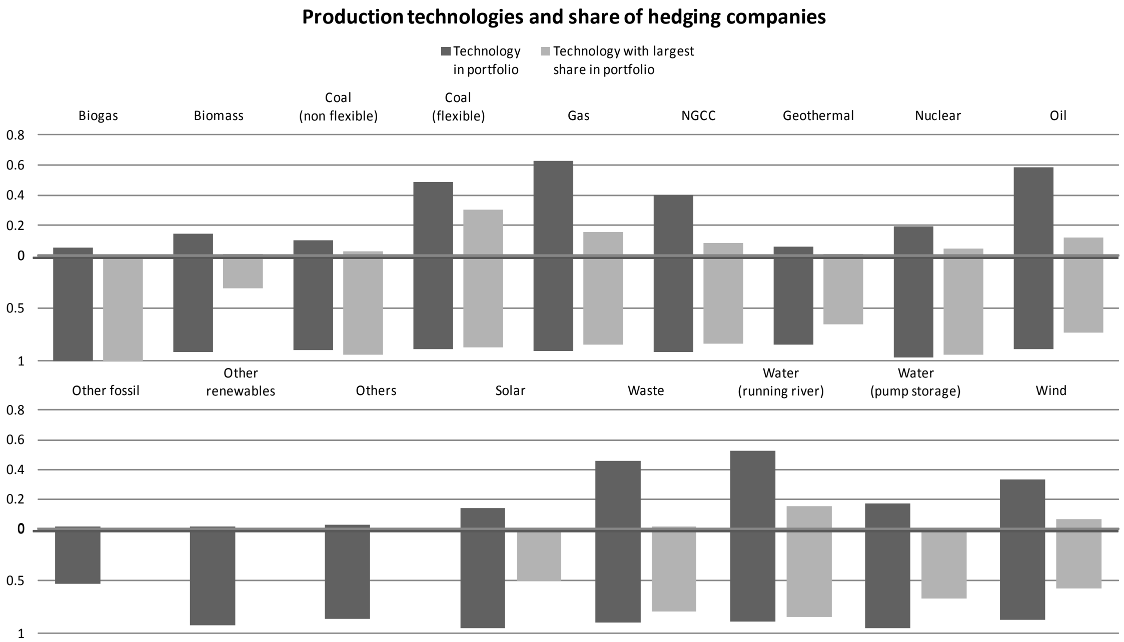
8.4 Production flexibility and hedging ratios

I now present the results for the impact of production technology on commodity hedging decisions. In figure 8.1 the share of companies using certain technologies (left dark gray bar) and the share of companies where the corresponding technology makes up the largest part in the production portfolio (measured in installed capacity and presented in the right light gray bar) are illustrated. For both groups the share of hedgers is shown below the axis.

Gas, oil and coal are the most common fossil technologies. Among the renewables, running river and waste can be found most often in the portfolios. Renewable technologies can only rarely be found making up the largest share in a company's portfolio. E.g. around 35 % of all companies have wind parks, but the number of utilities where wind is the biggest technology is close to 5 %. In contrast, coal followed by gas is the most frequently found technology – approximately 30 % of all companies focus on coal as the most important technology in their portfolio.

From a first view, only few clear trends in the relation between certain production technologies and the hedging probability can be seen. The only interesting finding here is a sharp decrease in the overall hedging probability when a company's portfolio concentrates on some renewable technologies like biomass, solar and wind. But this must be interpreted on the background of the earlier finding on the impact of size. One can show that the companies with a higher share in renewables are smaller firms, and as I discussed, smaller firms have an overall lower probability to hedge. Thus the relation between a high share of renewable and a lower hedging probability must be attributed to the size effect and is not explained by a first-order influence of the production technology. This can also be seen by drawing the share of hedgers against the share of stochastic technologies separately for size quantiles. Though not presented here, the positive trend between the share of renewables and the hedging decision vanishes.

Figure 8.1: Overview of production technologies



Distribution of production technologies (in alphabetical order) in the sample. The positive Y-axis gives the relative share of companies that use the relevant technology (left bar) and the share of companies for which the technology is the largest in their portfolio (measured in installed capacity) in the right bar. The lower (negative) Y-axis shows the share of hedging companies for the respective subsample (e.g. 84 % of all companies with gas plants as major technology use derivatives to hedge at least one of the considered risk types). Coal (non flex) represents all lignite power plants, coal (flex) represents all other coal fired power plants.

As has been discussed in the preliminary considerations, all power plants can be viewed as options. Option theory tells us that the perfect hedging ratio for an option using the delta hedging approach is higher when the option is deeper in the money and lower, when it is at the money or even out of the money. As discussed, base load power plants are generally deep in the money in contrast to at-the-money peak load plants. Thus I consider the impact of the share of base load on the commodity hedging volumes. Interestingly no significant proof of the relation assumed earlier can be found on the full worldwide sample. When regarding subsamples though, I find evidence that a less flexible portfolio leads to higher hedging ratios in the liquid European power markets. Table 8.1 show the corresponding results. One can see that a higher share of base load leads to higher commodity volumes which I assumed as a result from the delta hedging.

As a robustness test, I repeat the regression using my two flexibility measures instead of the share of base load. The relevant coefficients are less significant but still the direction meets my expectations. I also control for the share of stochastic technologies in the model. I control for multicollinearity by regarding the variance inflation factors. These are all below 3 in the corresponding models.

Table 8.1: Base load technologies and commodity hedging volume

	CO Hedging volume		
Share base load	4.24**		
	(2.15)		
Ramp-up costs		0.022	
		(0.90)	
Run-up time			0.13*
			(1.77)
Share stochastic	1.23	0.80	1.03
	(1.25)	(0.68)	(1.06)
Size	-0.20	-0.081	-0.23
	(-1.03)	(-0.43)	(-1.18)
Leverage	0.62	-0.47	0.62
	(0.39)	(-0.29)	(0.35)
Market-to-book	-0.27	-0.38	-0.40
	(-1.05)	(-1.25)	(-1.45)
Profitability	12.1	9.69	10.2
	(1.03)	(0.78)	(0.89)
Observations	86	86	86
R-squared	0.271	0.208	0.255

The dependent variables is the CO hedging volume normalized by total assets. The models are pooled linear regressions. The sample has been restricted to commodity hedgers and liquid European power markets only. A detailed description of the variables can be found in Appendix B. All regresions include time dummies and a constant. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

As mentioned earlier this result can only be found in the most liquid power markets (i.e. Europe). The significance levels e.g. in the US is lower – though the direction of the coefficients is still as expected. In the following, I will try to give an explanation for this.

8.5 Cross hedging power exposures

We will now consider two topics that have been mentioned earlier. First, the high share of gas hedgers, and second, the missing link between the share of base load and the commodity hedging volume in non-liquid power markets. These two topics do not obviously relate to each other but might be explained by the same effect that can be found in global energy markets: Cross hedging power volumes. To shed more light on this topic, it is important to recap some properties of price setting in the energy market and peak power production.

In some power markets gas is a price setting technology. This means that in peak times gas is the last (meaning the most expensive) technology used to produce electricity. In that case, using all cheaper technologies (e.g. nuclear, lignite and coal and perhaps renewables, in case they are in some way subsidized) would not produce enough electricity to satisfy the current demand and gas plants are switched on to serve the needed surplus. In many markets, prices are set following the rules of the marginal cost curve: The most expensive technology used to satisfy the demand dictates the price and the relevant plant operators earn only a fixed operator margin on their power plant, while operating a plant using a cheaper technology generates surplus earnings based on the cost difference between this and the marginal technology. This means that, in case gas is the marginal technology, it determines the power spot price and the spark spread (the spot price difference between power and gas) should be more or less constant during peak times. This would allow a market participant to hedge peak power prices using either power or gas derivatives.

I discussed earlier that not all countries have liquid power markets but some have liquid gas markets (e.g. US and UK). If in addition gas is the peak price setting technology in these markets, it might be possible that participants choose to cross hedge their power exposure using the more frequently traded gas derivatives. On the first view this would result in the paradox of companies not hedging their physical exposure but an exposure that is physically not existing. But economically these exposures are comparable and thus a market participant can choose which one to hedge. All this could yield an explanation for the high probability of gas hedging I observe.

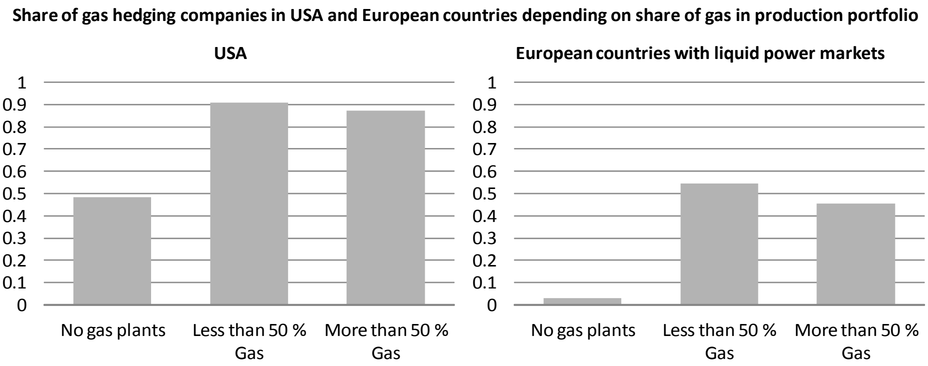
To study the effect further, I consider the US American market in which gas is a peak price setting technology. This market has some liquid power trading, especially in the PJM grid region, but also areas that do not benefit from a liquid power market. On the other hand the US gas markets with Henry Hub as the major trading point are perhaps the most liquid in the world. If my theory on subsidizing power by gas hedging has some explanatory power, I should see gas trading activity even for power producers without gas fired power plants in their portfolios.

Figure 8.2 shows on the left hand side the corresponding numbers. Here I split the US sample into the utilities that do not have any gas plants whatsoever, the utilities whose share of gas is below the median and finally the group of producers whose share is above median. I see that even those companies that do not have gas in their portfolio use gas derivatives in approximately 50 % of the cases.

To control for other influences, I compare these figures with similar numbers from liquid European electricity markets (which can be seen on the right hand side of the same graph). The countries used here are the Nord Pool countries Norway, Sweden, Finland and Denmark, the Central European countries Germany, Austria, Switzerland, France, Luxembourg and Belgium and the Western European markets in Spain and Portugal. In these markets utilities have no need to cross hedge their power exposure as the electricity market liquidity is high enough to directly hedge their physical exposure. Once again I compare gas hedging between producers with and without gas fired power plants in their portfolios. This time, I see only little gas derivative usage among those who do not have gas plants, but a substantial level of derivative usage among those who have – showing that in a situation of liquid power markets gas hedging is not needed as a substitute to electricity hedging.

Overall my findings suggest that peak load technology hedging can be and is used as a substitute when power trading is difficult or not possible (e.g. in case of low trading liquidity). This gives a direct explanation for the hedging probability of gas in my sample (approx. 30 % of my companies are located in the US where cross hedging obviously occurs quite often).

Figure 8.2: Gas hedgers in US and liquid European power region



Share of companies hedging gas in the US and the liquid Western European power region. The liquid Western European region has been defined to cover the countries Norway, Sweden, Finland, Denmark, Germany, Austria, Switzerland, France, Luxembourg, Belgium, Spain and Portugal. Numbers are relative to companies hedging commodities. The sample has been split by share of gas (as sum of gas and gas combined cycle) in the company's production portfolio.

Secondly, this affects the hedging ratio I see for commodity hedging. Option theory suggests that the optimal hedging ratio among others depends on the correlation between the underlying of the tradable derivative and the asset option (here the power plant). The higher this correlation, the higher the optimal hedging ratio (see e.g. Hulley and McWalter (2008) or Ankirchner and Heyne (2012)). The corresponding formula for the optimal hedging ratio of a European call on the non-tradable underlying U using a position in the tradable asset S and assuming a constant correlation ρ between U and S is hereby given as:

$$\text{Optimal hedging ratio} = \rho \, \frac{\text{Volatility}_U}{\text{Volatility}_S} \, \text{Asset delta} \tag{8.1}$$

This means that in cross hedging markets, the optimal hedging ratio also depends on the correlation between the power and e.g. the gas price and the volatilities of these prices. This may partly explain why I only find the aforementioned relation between base load and the commodity hedging volume in the most liquid European power markets.

Overall, I find mixed evidence for my *hypothesis 2a*. In liquid markets I see a significant relation between the share of base load and the commodity hedging volume – in non-liquid power markets, I do not find significant evidence for it.

One has to be cautious with the fact that base load technologies (e.g. nuclear or lignite) are more difficult to hedge on the input side than peak load technologies (e.g. gas or oil), as nuclear is less liquidly traded than oil or gas and lignite is not traded at all but mainly sold using LTCs. This effect though is actually contrary to my assumptions – it should lead to lower hedging volumes for base load technologies compared to peak load. Thus it makes the finding of a significant positive relation between base load and the hedging volume in European power markets even more meaningful.

8.6 Production technology and option usage

As discussed in the preliminary thoughts, I anticipate that production flexibility should lead to more option usage to reduce high transaction costs. Table 8.2 shows the relation between three power production flexibility measures and the probability for option usage in a company. One can see that companies with an overall less flexible production portfolio tend to use significantly less options for their hedging purposes.

All three results are in line with the earlier discussion on hedging in the presence of optionalities: The higher the share of peak load, the higher the need for non-linear products. Thus I can confirm the *hypothesis 2b*. The results are even more pronounced when using the alternative measures ramp-up costs and run-up time in robustness checks as can be seen in the same table.

One other interesting result can be inferred from the table: Obviously, the probability of using options increases when the company has a higher share of renewables in its portfolio - here called stochastic production technologies. This can easily be explained as renewable production technologies do not guarantee a certain power output. The production depends on weather and thus a company selling its capacity regularly on the power market always needs to match its uncertainty on the production side with a variable selling capacity. This result might also be interesting in the ongoing discussions how to steer power markets in times of high shares of renewable and decreasing usage of highly flexible conventional power plants. One very often discussed idea is the compensation of companies offering flexible capacities via capacity markets. As we see in these results, an alternative might be to oblige companies feeding in power from renewable production capacities to guarantee a fixed amount beforehand, as is common for conventional capacities. When this approach is coupled with liquid option markets for power, the companies could hedge their volume risk using options. This would also increase the transparency of costs related to renewable energy production. I leave a further discussion of this topic to future research.

Table 8.2: Peak load technologies and option usage

	Hedging instruments		
Share mid and peak load	1.19**		
	(1.99)		
Low ramp-up cost (1 - Ramp-up cost)		0.018***	
		(2.63)	
Low run-up time (1 - Run-up time)			0.071***
			(3.20)
Share stochastic	1.87***	0.30	0.68*
	(2.78)	(0.66)	(1.65)
Size	0.45***	0.51***	0.54***
	(5.15)	(5.53)	(5.73)
Leverage	-0.19	-0.17	-0.41
	(-0.34)	(-0.30)	(-0.74)
Market-to-book	-0.042	-0.056	-0.053
	(-1.18)	(-1.63)	(-1.59)
Profitability	0.73	0.90	0.72
	(0.58)	(0.67)	(0.56)
Observations	1,103	1,103	1,103
Pseudo R2	0.24	0.25	0.26

The dependent variable is the decision to use asymmetric hedging istruments. The models are pooled probit. The sample has been restricted to hedgers only. A detailed description of the variables can be found in Appendix B. All regresions include time and country dummies and a constant. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

I have also discussed earlier that hedging does not in general create value. In a perfect market only the reduction in costs of distress or the provision of financing for investments can lead to a higher firm value. In reality however, I see that shareholders tend to “reward” or “punish” certain strategic decisions companies make. E.g. some studies find a discount on firm value if companies diversify (Lins and Servaes, 1999; Berger and Ofek, 1995; Lang and Stulz, 1994). I now consider a comparable topic: the usage of derivatives that are less necessary for hedging and thus might signify that companies forego speculation purposes. I test if this leads to a lower firm value at the example of option usage depending on the share of peak load technologies in a firm’s portfolio: I regard the impact of option usage on Tobin’s Q for companies with a high share of peak load technologies (where options are a valid measure to hedge the power plant) and those with a lower share (where linear products suffice for hedging purposes). The corresponding results can be seen in table 8.3. One can see that the firm value decreases for companies with only a low share of peak load technologies when options are used – an effect that cannot be seen for the control group. Similarly I interact the option usage dummy with a dummy being one, in case the company's share in peak load is above the median and zero otherwise. While options in general decrease the firm value, they create value when the company is a strong peak load player. Thus, I can confirm *hypothesis 2c*.

Table 8.3: Option usage and Tobin's Q

	High share of peak	Low share of peak	Full sample
Option usage	-0.0079	-0.11**	-0.12***
	(-0.19)	(-2.49)	(-2.81)
High share of flexibility dummy			-0.068
			(-1.31)
Option usage*high share of flexibility			0.11*
			(1.90)
Share of stochastic	-0.0025	0.011	-0.062
	(-0.0065)	(0.085)	(-0.72)
Size	0.043	0.016	0.032
	(0.78)	(0.28)	(0.84)
Leverage	-0.18***	-0.14***	-0.16***
	(-5.03)	(-4.55)	(-6.95)
Profitability	0.26*	0.075	0.23
	(1.78)	(0.30)	(1.52)
Salesgrowth	-0.025	0.044	0.0098
	(-0.59)	(0.85)	(0.23)
Observations	446	307	753
R-squared	0.530	0.666	0.563

The dependent variable is Tobin's Q. All models are pooled linear OLS regressions. In the first two models the sample has been split into companies with share of peak load above and below average. The third model is based on the full sample and includes the interaction term between the option usage dummy and a dummy being one in case the company's share of peak load is above (resp. below) median. All variables except Tobin's Q are lagged by one year. A detailed description of the variables can be found in Appendix B. All regressions include a constant, time dummies, and country dummies. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

This finding is robust for changing the subsamples (e.g. considering the companies with 15 %, 20 % or 25 % peak load compared to the remaining companies). In all cases, the impact presented in the table stays the same.

8.7 Conclusion

In this chapter I have studied the impact of production technology. I find evidence that companies with a higher share in base load and a less flexible portfolio tend to hedge larger shares of their commodity exposures. This finding however only holds for liquid power markets. Furthermore, my results show that the share of base load decreases the probability for the use of non-linear derivatives. Finally, I find evidence that the use of options is only approved by shareholders, when the relevant company has a high share in peak load technologies. In this case options are likely used for hedging purposes, whereas the usage of options in case of pure base load portfolios is not necessary from a hedging perspective and thus probably attributed to speculation purposes. In this case the firm value decreases.

I see two major implications of these findings. First, in some regions the optimal hedging strategy for commodity risks must be adapted, as the markets are not liquid and companies have to cross-hedge. In this case the risk management and following the shareholders and end users would benefit from an increase in market liquidity. Thus regulation should attempt to find measures to increase the liquidity in all necessary risk markets. Second, I show that hedging strategies (volumes and instruments) differ depending on the technology used. This is interesting in the ongoing discussion on the optimal future energy mix: E.g. a scenario of the combination of renewables and peak load plants requires a higher availability of energy options. This topic so far only plays a minor role in the discussion on requirements for our future energy supply.

One additional finding covers the point of compensation for flexibility in modern power markets. As discussed in the relating section, I find a higher probability of option usage for companies with high shares of renewables in their portfolio. Based on these results I suggest liquid option markets to trade production flexibility as an alternative to the mainly discussed capacity markets, in which states compensate companies for offering flexible power production via conventional capacities. Obliging companies with renewable production to guarantee thei volumes as is common for conventional capacities and leaving it open for these companies to hedge their volume risk on option markets could be a valid and more transparent alternative.

As the number of observations where both hedging and production technology data is available is quite low, I will in the forthcoming analyses abstain from controlling for the production technology.

9 Country-level determinants

In the prior chapters I have discussed the impact of already known firm-level determinants on hedging patterns (size, underinvestment problems or costs of distress) and a new one in the form of the production technology. The next logical step will be to leave the firm-level and search for hedging determinants on the country-level. The main and final goal will be to study the influence of the yet unconsidered impact factor "culture". But again, I will start considering impact factors already dealt with in previous papers and try to confirm the respective findings in the present chapter before introducing the new factor "culture" in the following chapter. As mentioned, there are currently only two international studies on the impact of country-level variables on hedging which I can use as a starting point: Bartram et al. (2009) and Lel (2012). Lel (2012) studies the influence of corporate governance and uses country-level indicators for shareholder rights and creditor rights as instrumental variables that impact corporate governance on the firm-level. As corporate governance shall not be my main concern, I rather focus on the paper published by Bartram et al. (2009) to approach the study of cultural impacts. Bartram et al. (2009) look upon a broad range of environmental characteristics and try to find the variables that have the strongest influence on hedging from this large "variable pool".

I will follow a similar approach by identifying the variables that best match the factors implemented by Bartram et al. (2009) and then use several uni- and multivariate models to confirm their significance. The already studied financial theories on hedging thereby only play a role in defining firm-level control variables. The focus lies on the country-level variables and their potential impact on hedging decisions. As has already been stated, my data set covers only one specific industry, namely the energy sector, which allows me to control for the risk exposures in a more direct way than Bartram et al. (2009) do.

In a first step I will introduce the variables used and derive my hypotheses that are very similar to the ones followed by Bartram et al. (2009). I will then give some descriptive results for the variables and the sample that I use in this subsection and finally present the multivariate regression tables.

9.1 Preliminary considerations

The research on country-level variables impacting hedging decisions is still rather young – as mentioned, Bartram et al. (2009) must be considered as the first international paper on this topic. Therefore I will in the following give some detailed introduction into the hypotheses on the impact of certain variables. I will thereby stick close to the structure and the theories presented in Bartram et al. (2009). I recommend the reader familiar with this paper and the results to continue his reading in chapter 10 where I will present my own, new approach to study the impact of country-level variables on hedging.

As mentioned, the firm-level variables have been studied in sufficient detail in the prior chapters. I will therefore abstain from repeating the hypotheses on their impact and directly turn my attention towards the country-level variables. The corresponding hypotheses are presented in table 9.1.

Table 9.1: Predicted influence of country-level variables on hedging decisions

Variable	Hypothesis
Trading volume	The trading volume should have a positive impact on the exchange rate hedging decision, as it indicates stronger trading activities with other countries and could potentially signify that also utilities are stronger involved in global commodity trading and are thus more exposed to exchange rate risks. I therefore expect to find a positive correlation on the FX hedging probability and volume. Bartram et al. (2009) expect a positive impact for all three risk types - no such impact materializes in the relevant regressions.
Energy import	In net energy importing countries the tendency to start hedging commodity prices should be higher as these commodity markets can be expected to be more volatile due to the dependency on additional foreign market developments.
Regulatory quality	This variable is included to control for regulatory impacts, which are important especially in energy markets. I do not expect a consistent impact on hedging behavior across all risk types.
Rule of law	The rule of law index measures the confidence in the legal system. In accordance with findings made by Bartram et al. (2009), I expect to see more hedging in countries with a higher scoring on this index.
Political stability	Brouthers, Brouthers, and Werner (2002) state on page 497 that political instabilities have an impact on business decisions. In politically instable countries the need for hedging is expected to be higher. Especially the decision to start hedging should be influenced negatively by increasing stability of a country. Bartram et al. (2009) expect a similar effect, though do not find proof for this hypothesis.

The table presents the list of country-level variables with associated hypotheses and rationales for the influence on the hedging decisions.

Table 9.1: Predicted influence of country-level variables on hedging decisions [continued]

Variable	Hypothesis
Derivative market rank	Supply constraints of FX and IR derivatives are expected to reduce especially the FX and IR hedging probability and volume. Bartram et al. (2009) expect and find a positive impact of this variable.
Lender protection (CRI)	Lender protection can be expected to increase the bank's bargaining power in credit negotiations, making it easier for banks to push for more hedging from which they benefit in every case (efficient hedging will always decrease a firm's probability of default). Thus all hedging decisions for all relevant risk types should be positively influenced. Bartram et al. (2009) expect a positive impact of this variable though, again, this cannot be confirmed based on regression analyses.
Shareholder protection (ADRI)	Shareholder protection should in general force managers to behave according to the shareholder's expectations. If this leads to more or less hedging cannot be predicted easily. On the one hand, financial theory suggests that volatility leads to higher value for shareholders. In addition, in a perfect capital market, shareholders can diversify on their own, which means that they do not have to rely on a company's risk management. Thus, hedging should not be in the interest of shareholders. Consequently, higher shareholder rights should lead to less hedging activities (both probability and volume). On the other hand, following the costs of distress and underinvestment theory, hedging can harmonize internal cash flows and by this means reduce both the costs of distress and the need for costly external financing. According to this reasoning, it is in the interest of shareholders to hedge certain risks and increased shareholder rights should lead to more hedging. The influence of shareholder protection on hedging is thus undetermined. Bartram et al. (2009) do not expect a consistent effect of this variable.

The table presents the list of country-level variables with associated hypotheses and rationales for the influence on the hedging decisions.

Table 9.1: Predicted influence of country-level variables on hedging decisions [continued]

Variable	Hypothesis
Closely held	In line with Bartram et al. (2009) I expect a positive impact of this factor as closely held shares indicate ownership concentration and lower diversification that might go hand in hand with the goal to hedge higher volumes. This hypothesis however cannot be confirmed based on the analysis of dummy variables.
Inflation	This variable is integrated to control for economic and financial stability in the countries. I expect to find a negative impact of this factor similar to the findings made by Bartram et al. (2009), where companies in financially less risk-exposed countries tend to hedge less.
GDP per capita	This variable is included as an additional control for the economic and financial stability and development. Again, I assume to find a lower need to hedge and thus a lower hedging probability in more stable countries.

The table presents the list of country-level variables with associated hypotheses and rationales for the influence on the hedging decisions.

9.2 Data used in the following analyses

In the following analyses, I will use the well known firm-level variables introduced in the chapter 7 and the country-level variables presented above. Overall, these factors will be used:

- Company size is defined as normal logarithm of total assets in thousand US dollars.
- FX exposure is defined as COGS divided by total assets for non-US companies and zero for US-companies.

- CO exposure is defined as COGS plus net sales or revenues divided by total assets.
- Leverage is total debt divided by sum of total debt and the market value of common equity.
- market-to-book approximates a firm's growth opportunities and is measured as market capitalization divided by the book value of common equity.
- Profitability is defined as EBIT divided by total assets.
- Trading volume is defined as normal logarithm of country wide imports plus exports, each standardized by GDP.
- Net energy import is defined as energy import minus export divided by energy consumption.
- Regulatory quality is an index measuring the soundness of regulatory means and rules.
- Rule of law is an index measuring to which extend agents have confidence in and abide by rules of society.
- Political stability is an index measuring the overall political stability of a country.
- Derivative market rank is defined as rank of daily averages of FX and IR derivative market turnover divided by GDP.
- Lender protection (CRI) is defined as creditor rights index from Djankov, McLiesh, and Shleifer (2007).
- Shareholder protection (ADRI) is defined as the revised anti director rights index from Djankov, Porta, de Silanes, and Shleifer (2008).
- Closely held is the percent of market capitalization closely held.
- Inflation is defined as annualized inflation.

- GDP per capita is defined as normal logarithm of GDP per capita in thousand US Dollars.

In contrast to the firm-level variables that have been considered before, the country-level variables are taken from a variety of sources. I will therefore include a table presenting the sources of each variable in the Appendix.

As one can see, I try to mirror the variables used by Bartram et al. (2009) as good as possible. In particular I use the following variables to control for all factors in the paper by Bartram et al. (2009): “Trading volume”, “derivative market rank”, “lender and shareholder protection”, “rule of law” and “closely held” are identical to the corresponding variables used by Bartram et al. (2009). I substitute the variables for financial, economic and political risk by “inflation”, “GDP per capita” and “political stability”. Legality is mirrored by the index “regulatory quality”. The market capitalization of my sample is not included in this analysis. As I only consider one industry, controlling for the total market capitalization of my sample does not make sense. As one additional variable I use the “net energy import” to control for the dependency of a country on external (primary and secondary) energy sources. I will now give a description of some variables whose calculation is not straight forward.

The derivative market ranks are calculated based on a report issued by the Bank For International Settlements on IR and FX derivative market trading volumes for the years 1998, 2001, 2004, 2007 and 2010 (Bank for International Settlement, 2010a) and linearly interpolated for the years in between. This report builds on a survey of 53 central banks and monetary authorities conducted in 2010. The percentage of shares closely held in a country is taken from Dahlquist et al. (2003) and assumed to be constant over time. These numbers combine US holdings of foreign long-term investments published by the US Treasury Department in 2000 and market portfolio data from the 1998 Emerging Markets Fact Book of the International Finance Corporation (IFC), data from the Fédération Internationale des Bourses de Valeurs (FIBV), the World Bank and the Salomon Guide to World Equities of 1999. All other country-specific information has been downloaded from the World Development Indicators Online (WDI) database. Appendix G shows all country-level variables including the sources and calculation rationales.

Here one convention applied related to the definition of the term “domestic” for each company. I have defined the domestic country as the country in which a company is headquartered in contrast to the country in which a company is listed on the stock market. This decision was made under the assumption that the country hosting the headquarter is a better estimator where most business activities of a company take place and thus which economic and political background is most relevant for the operations. Legal affairs can of course be influenced by the listing country, e.g. when a company is bound to certain accounting rules. But the risk of a systematic error through this convention was considered lower than in the case of using the listing country as a proxy for currency and political risks a company is exposed to.

9.3 Methodology

To disentangle the impact of different country-level variables on the hedging behavior, I concentrate on the two hedging variables, hedging dummy and hedging volume. The latter includes the non-hedgers and is meant to serve as a robustness check for the analyses on the hedging dummy rather than a standalone analysis of a second hedging dimension. Here, one has to be cautious when in- or excluding all non-hedgers (see also the discussion in the chapter 7). For the hedging dummy I use pooled probit models. The hedging volume as a continuous variable is modeled using pooled OLS regressions. For a general discussion on the econometrics of panel data, OLS regression models and probit models, I again refer to e.g. Stock and Watson (2012); Baum (2006); Hayashi (2000); Spanos (1998); Wooldridge (2010).

In a robustness test, I simultaneously regress the three different risk parameters FX, IR and CO. This method is explained in Greene (2012), Stock and Watson (2012) or Cameron and Trivedi (2010). The Stata package used for this approach is taken from Cappellari and Jenkins (2006). For the marginal effects I calculate, Cameron and Trivedi (2010), Greene (2012) or Stock and Watson (2012) may serve as a source for further information. Unless otherwise noted, all regressions include time dummies to control for changes over time and a US dummy.[14] All ratios are winsorized at the 1 % and 99 % level to restrict the impact of outliers. T-Statistics reported in the tables are based on robust Huber-White standard errors clustered at the firm level.

Overall I consider too many variables to include all of them in one regression model. I will therefore use a correlation table to define a reasonable subsample. In addition, I will control the variance inflation factors not to be higher than 3.0 to make sure I do not have a multicollinearity problem in my models. ***, ** and * indicate significance on the 0.1 %-, 1 %- and 5 %-levels, respectively.

As robustness checks I will introduce the hedging volumes and apply a simultaneous regression model for the three risk types to control for the probably related hedging decisions between these. Finally, I will include my measures for risk exposure into the model.

[14]This dummy controls for the fact that US companies make up approximately 30% of my sample and that US firms are substantially less exposed to exchange rate risks. As discussed in chapter 2, the core business of a utility involves buying primary energy on global US Dollar denominated markets and selling power in local currency on the home market. As the home market currency of US firms is the US Dollar, their FX exposure is far smaller compared to the risk non-US companies face.

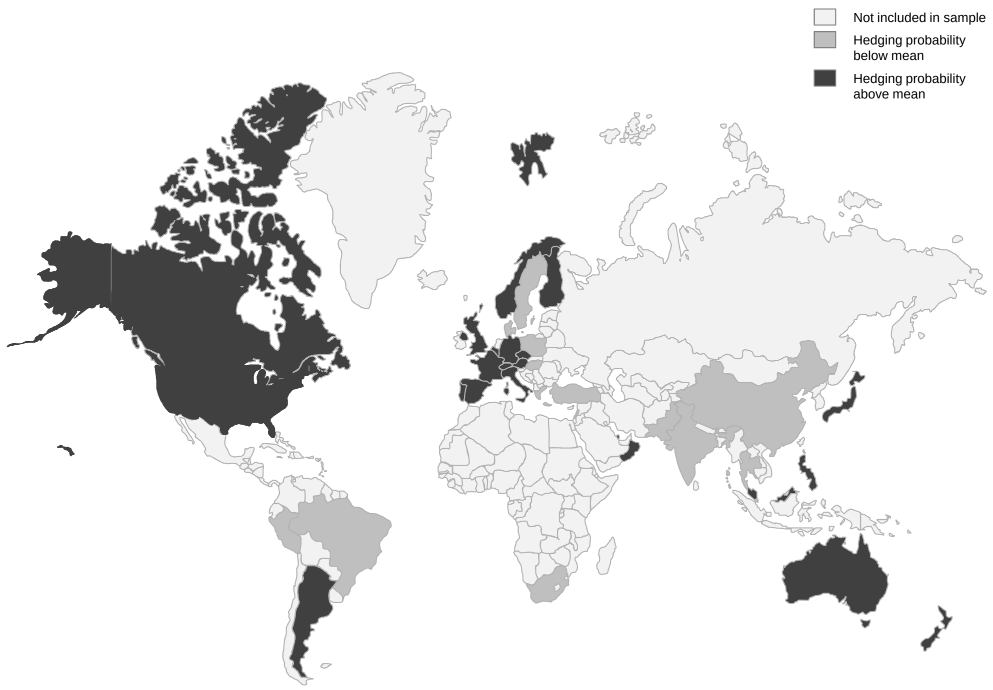
9.4 Evidence for country-level determinants

9.4.1 Descriptive statistics

As mentioned earlier the sample covers all major regions in the world. In this analysis a total of 39 countries enters the following regressions. Figure 9.1 shows the corresponding countries including the differentiation between countries with hedging probability above or below mean.

Obviously several countries are not included in the full sample, as certain variables are not defined on all countries. This could be avoided by performing robustness tests, leaving out the corresponding variables. However, this chapter is meant to find the best set of control variables to be used in the following analysis on cultural impact on hedging. In addition I want to consider the research done by Bartram et al. (2009) and their paper faces the same regional restrictions due to the similar set of variables. Therefore I will not spend time on defining robustness tests to increase the geographical reach. I will neither test the following results on robustness when including controls for the country development. This however seems appropriate when considering the presented map: Obviously, developed countries show an overall higher probability for hedging than their less developed peers. This is a fact that has to be considered in more detail in the following chapter on cultural impacts, though.

Figure 9.1: Country-level determinants: Geographic reach of sample



The map shows all 39 countries included in the sample. Shadings signify hedging probability above or below median.

Means and standard errors for hedgers and non-hedgers are presented in table 9.2. The Wilcoxon p_values show the overlap of the two distributions (hedgers and non-hedgers) for all variables. As predicted, hedgers have a higher leverage and are in general larger companies. However, counter to predictions is the hedgers' higher profitability. This however might be explained by the rising commodity prices we have seen in the past decade. Interestingly, market-to-book does not significantly differ between hedgers and non-hedgers as the Wilcoxon rank sum test shows. Here I assumed to find a higher market-to-book for hedgers following the rationale of the underinvestment theory.

Coming to the country-level variables, dependency on energy imports, a stronger developed derivative market, a higher regulatory quality and the economic development (GDP per capita) and stability (low inflation) lead to more hedging, while shareholder and creditor rights decrease the hedging probability. Especially the latter is very interesting as one would assume to find more hedging in countries where banks can stronger impact a company's risk management decisions. Furthermore, closely held decreases the hedging probability. The results for political stability cannot be interpreted, as the rank sum test indicates only a low probability for a difference in distribution.

Table 9.2: Country-level determinants: Summary statistics

	Hedgers		Non-Hedgers		Wilcoxon rank sum p_value
	Mean	Std. Err.	Mean	Std. Err.	
Size	15.21	0.04	12.07	0.10	0.00
Leverage	0.43	0.00	0.26	0.01	0.00
Markt-to-Book Value	2.00	0.05	2.64	0.15	0.82
Profitability	0.06	0.00	-0.07	0.02	0.00
Trading Volume	3.81	0.02	4.04	0.03	0.00
Energy Import	19.13	1.47	14.68	2.63	0.00
Regulatory quality	1.25	0.01	1.03	0.03	0.00
Rule of law	1.25	0.01	0.99	0.04	0.02
Political Stability	0.48	0.01	0.35	0.04	0.12
Derivative Market Rank	33.62	0.31	31.36	0.70	0.00
CRI	1.70	0.03	1.95	0.05	0.00
ADRI	3.61	0.02	3.66	0.05	0.00
Closely held	0.31	0.01	0.40	0.01	0.00
Inflation	2.83	0.07	3.45	0.15	0.00
GDP per capita	3.22	0.02	2.77	0.05	0.00

The table presents means and standard deviations for all firm- and country-level variables for the hedging and non-hedging companies and Wilcoxon rank sum p-values indicating the probability for differences in distribution.

Correlations between the different factors and the hedging strategies followed by a company are shown in table 9.3. One can see directly that size has the strongest (positive) impact of all firm characteristics. This is in line with my expectations, the prior findings above and all other studies that have found a strong relation between economies of scale and hedging probability. The positive influence of leverage can directly be explained through the cost of distress theory and is also in line with my expectations, though above presented regression results have revealed that this impact might not display in multivariate analyses.

Counter-predictive is the fact that market-to-book value has a negative impact on hedging. Here the underinvestment theory forecasts a positive influence as companies facing many investment opportunities have a higher incentive to harmonize their cash flows. In addition, the impact of profitability should also be negative as discussed earlier.

When it comes to country-level variables I observe consistent impacts for the following variables: Energy imports show a positive influence on FX and CO hedging, which I assumed earlier. And GDP per capita leads to higher hedging probabilities.
On the other hand, many other country variables do not yield the expected results: The trading volume, derivative market rank, CRI, ADRI, political stability and regulatory quality as well as closely held and inflation do not show correlations consistent across all risk types and consistent with my expectations and/or earlier findings by Bartram et al. (2009). Of course this must be validated based on multivariate regression analyses, to which I will turn my attention in the following.

Table 9.3: Country-level determinants: Correlations for dependent and independent variables

	FX	IR	CO
FX	1.00		
IR	0.44	1.00	
CO	0.15	0.36	1.00
Leverage	0.10	0.26	0.19
Size	0.39	0.49	0.48
Profitability	0.10	0.12	0.10
Market-to-Book Value	-0.03	-0.09	-0.05
Trading volume	0.13	0.01	-0.30
Energy import	0.02	0.03	0.10
Derivative market rank	-0.03	0.19	0.31
CRI	0.15	0.08	-0.20
ADRI	0.18	-0.06	-0.27
Rule of law	-0.00	0.22	0.41
Political stability	0.12	0.20	0.18
Regulatory quality	-0.02	0.24	0.41
Closely held	0.18	-0.12	-0.49
Inflation	-0.05	-0.19	-0.20
GDP per capita	0.01	0.26	0.46

The table shows correlations between independent variables and risk hedging dummies for the three observed risk types.

When considering the correlations between the different independent variables, one can see that some factors are highly dependent (correlation coefficient above 0.6). This will potentially cause multicollinearity problems, where one independent variable can be represented as the linear combination of other independent variables. Consequently, the regression coefficients will not be unique any more and thus an interpretation of regression results in the presence of a multicollinearity problem is impossible. Therefore I reduce my set of variables from the initial pool taken from Bartram et al. (2009) and presented above. More precisely, I drop the variables "political stability", "rule of law", "regulatory quality", "trading volume" and "GDP per capita". By this means I can control for multicollinearity.

Table 9.4: Country-level determinants: Correlations between all independent variables

	Leverage	Size	Profitability	Market-to-Book Value	Trading volume	Energy import	Derivative market rank	CRI	ADRI	Rule of law	Political stability	Regulatory quality	Closely held	Inflation	GDP per capita
Size	0.43	1.00													
Profitability	0.16	0.39	1.00												
Market-to-Book Value	-0.33	-0.23	-0.36	1.00											
Trading volume	-0.21	-0.13	0.04	-0.04	1.00										
Energy import	0.07	0.27	0.08	-0.05	0.13	1.00									
Derivative market rank	-0.11	-0.06	-0.16	0.08	0.17	-0.06	1.00								
CRI	-0.12	-0.11	-0.01	0.02	0.56	-0.04	0.33	1.00							
ADRI	-0.06	-0.07	0.06	0.03	0.23	-0.10	0.01	0.38	1.00						
Rule of law	-0.09	-0.01	-0.17	0.08	0.06	-0.11	0.89	0.20	-0.12	1.00					
Political stability	-0.08	-0.01	-0.11	-0.00	0.23	-0.12	0.66	0.27	-0.09	0.76	1.00				
Regulatory quality	-0.08	0.00	-0.15	0.07	0.10	-0.04	0.88	0.21	-0.12	0.94	0.76	1.00			
Closely held	-0.07	-0.09	0.15	-0.10	0.40	0.03	-0.63	0.16	0.27	-0.63	-0.24	-0.60	1		
Inflation	0.04	-0.08	0.07	-0.01	-0.11	-0.02	-0.45	-0.11	0.09	-0.49	-0.50	-0.48	0.298	1	
GDP per capita	-0.02	0.08	-0.16	0.06	-0.09	-0.01	0.78	0.04	-0.27	0.88	0.74	0.90	-0.629	-0.498	1.00

The table shows correlations between all independent variables in the regression on country-level influence factors.

9.4.2 Multivariate analysis

In the following I will present the results from the multivariate regressions. This will start with a consideration of the hedging dummy.

Table 9.5 shows the results from the main probit regressions for all three risk types. One can see that in line with the predictions, the leverage has a strong influence on the decision to hedge interest rate risks. However as no significant impact on hedging decisions for the other risk types can be seen, this finding should again be interpreted as a proof for the assumption that debt is a good predictor for the interest rate exposure and not as a support for the costs of distress theory. As mentioned earlier, pressing costs of distress, which are clearly higher the more leverage a company has, should lead to the overall need for cash flow harmonizing and thus hedging of all risks. In addition the already expected positive impact of company size is also inconsistent with the costs of distress theory. As predicted based on the descriptive results and prior chapters, the influence of economies of scale seems to overrule all other impacts like the costs of distress considerations. Profitability is the third predictor related to the costs of distress theory. Following the hypothesis, higher profitability should be negatively correlated with hedging activities as the distress risk might be lower for highly profitable companies than for their less profitable peers. My results though do not show a significant influence of this factor, which is the third indicator that the costs of distress theory must be neglected based on my findings. Again, it is doubtful that costs of distress play an important role for hedging decisions – economies of scale seem to be much more influential in this respect. Taking a look at the underinvestment theory, I do not find significant proof for an impact of the market-to-book value on any of the three hedging variables. Therefore my results do not support the theory outlined in the literature chapter 4.

Some of the country variables seem to have a stronger impact on hedging than most firm-level factors. Unfortunately only few of these impacts are consistent across all risk types. I find proof that a higher dependency on energy imports leads to less hedging. This is counter to my aforementioned predictions. I expected the relevant net importing markets to face more volatile energy prices due to the dependency of these prices on additional and foreign market factors. Thus it would be plausible to expect firms in these countries to be more eager to hedge the corresponding risks - especially as the drivers behind these price risks do not purely originate in their "home" market, which they surely better understand than foreign markets. Overall this finding is counter to my predictions and an explanation shall be left for future research. I do, though, believe that in addition to the variables used in Bartram et al. (2009), a proper controlling for dependency on foreign markets and countries (by including e.g. an indicator for foreign trading volumes and net imports) would be advisable.

Furthermore, I find evidence for the impact of derivative market liquidity. Similar to the results of Bartram et al. (2009), my analyses show that higher derivative market liquidity leads to more hedging. Again the coefficients are significant across all three risk types, though strongest for IR and CO risks.

All other variables turn out not to be significant or consistent across all risk types. In particular, I do not find proof for the consistent impact of "closely held" or the legal rights indices. Overall, I conclude that only two of the studied country-level factors show an impact on the hedging decision.

Table 9.5: Country-level determinants and hedging decision

	FX	IR	CO
Size	0.43***	0.43***	0.42***
	(11.1)	(10.8)	(9.69)
Leverage	-0.019	0.083***	-0.045
	(-0.90)	(3.32)	(-1.48)
Market to book	0.041	0.020	-0.0044
	(1.46)	(0.93)	(-0.17)
Profitability	-0.11*	-0.012	0.083
	(-1.96)	(-0.24)	(0.95)
Energy import	-0.061**	-0.094***	-0.065**
	(-2.42)	(-3.61)	(-2.01)
Derivative market rank	0.062*	0.19***	0.22***
	(1.74)	(4.15)	(4.16)
CRI	-0.012	0.028	-0.026
	(-0.50)	(0.93)	(-0.72)
ADRI	0.032	-0.067**	-0.079***
	(1.42)	(-2.34)	(-3.10)
Closely held	0.030	0.062	0.065
	(0.74)	(1.27)	(1.06)
Inflation	-0.013	-0.094*	-0.090
	(-0.38)	(-1.87)	(-1.14)
Observations	2,556	2,556	2,556
Pseudo R2	0.3	0.29	0.48

The table presents marginal effects for pooled probit regressions on the impact of firm- and country-level variables on the hedging decision. Note that all variables except for the dividend dummy have been standardized. Thus coefficients can be interpreted as the change in probability of hedging a certain risk type, when the respective variable changes from its mean by one standard deviation while all other variables are kept fix at their mean. All regressions include time dummies and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

9.4.3 Robustness of results

In addition to the just presented models on the hedging dummies, I have tested other definitions for the variables used, as mentioned in the section on the data used. All these changes do not much alter the picture drawn in the earlier discussion on the results.

Furthermore, I introduce three additional models to test for robustness. For simplicity reasons, I shall in table 9.6 only present the coefficients for the two significant country-level variables “energy import” and “derivative market rank” in these three robustness tests. The full tables can be found in Appendix D, Appendix E and Appendix F.

The first robustness test presents coefficients for OLS regressions on the hedging volume for the three risk types. The non-hedgers have been left in the sample, thus this model must be considered a robustness test for the hedging decision rather than a separate new variable (see also the discussion in chapter 7). One can see that the two earlier discussed relations between energy import and derivative market rank to hedging largely lose their significance. In addition the signs change in several considered models.

The second table shows the coefficients for a simultaneous regression on the hedging decisions. Here the earlier results stay robust – again energy imports decrease the hedging probability while derivative market liquidity increases the probabilities.

Finally, I present probit regression coefficients from models including the earlier defined exposure figures for the three market risk types. These were the following:

- *FX exposure* – COGS divided by total assets for non-US companies and zero for US companies. The underlying rationale is the fact that utilities mainly incur costs by buying primary energy sources in US Dollar. Thus if the US Dollar is a foreign currency for them, they face a foreign exchange rate risk represented in their COGS.
- *IR exposure* – Leverage. Information on the share of debt with fix rate versus floating rate debt is not always accessible. Thus I assume that the main part of debt is not purely linked to a fixed interest rate. Following, debt serves as an estimate for the interest rate exposure.
- *CO exposure* – COGS plus net sales or revenues divided by total assets. Pure energy players incur costs by buying primary energy sources (COGS) and selling electricity and heat (net sales or revenues). Thus

the sum of COGS and sales can be used as a proxy for their commodity exposure.

Again the coefficients for the two country-level variables are stable under this robustness test.

Overall, the earlier found relations between two country-level variables and the hedging decision are mainly stable under robustness test.

Table 9.6: Robustness tests on country-level determinants [partly presented]

	FX	IR	CO
Linear regression coefficients for hedging volumes			
		Firm-level variables	
Energy import	0.000097	-0.00028*	0.00098
	(1.50)	(-1.90)	(1.20)
Derivative market rank	0.000050	0.0017**	-0.0047
	(0.089)	(2.29)	(-0.50)
		Other country-level variables	
Observations	1,615	1,498	1,148
Pseudo R2	0.144	0.200	0.065

Simultaneous estimation of probit regression coefficients for hedging decision			
		Firm-level variables	
Energy import	-0.0026**	-0.0032***	-0.0027**
	(-2.47)	(-3.46)	(-2.18)
Derivative market rank	0.0097	0.028***	0.034***
	(1.59)	(4.12)	(4.14)
		Other country-level variables	
Observations	2,556	2,556	2,556

Probit regression coefficients for hedging decision including exposure controls			
		Firm-level variables	
Energy import	-0.064**	-0.094***	-0.078**
	(-2.41)	(-3.61)	(-2.28)
Derivative market rank	0.061*	0.19***	0.23***
	(1.70)	(4.15)	(4.17)
		Other country-level variables	
Observations	2,495	2,556	2,494
Pseudo R2	0.31	0.29	0.5

The table presents results from three different robustness tests. Only the coefficients for the variables "energy import" and "derivative market rank" are presented. The first table presents pooled linear OLS, the remaining two tables pooled probit regressions. The dependent variable is the hedging volume in the first table and the hedging decision in the last two tables. All regressions include time dummies and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

9.5 Conclusion

In this chapter I consider the hypotheses presented in the first international paper on hedging determinants, Bartram et al. (2009). I try to stick relatively near to the methodology used in that publication and test if the few findings made by Bartram et al. (2009) can be confirmed or even strengthened when applying the models on my data sat. Unfortunately, I cannot confirm all results from this paper. I do find a significant relation between the derivative market rank and the hedging probability: The more liquid the derivative markets, the greater is the probability of hedging in the companies. This result is robust against two of three applied robustness tests. Of course this relation is not very surprising when thinking about the two tested variables. Reformulating this finding, one can say that the more companies use derivatives in a country, the more derivatives are used in that country.

All further variables tested by Bartram et al. (2009) and used in this paper do not yield significant results – neither the variable "inflation" used as a proxy for the financial stability of a country, nor "closely held" or the variables on the legal environment present strong relations to the hedging decision. I therefore conclude that the corresponding findings made by Bartram et al. (2009) cannot be confirmed based on my sample.

In addition to the variables used by Bartram et al. (2009) I include an extra variable to control for the dependency of a country on external energy sources: "Energy imports". This variable is strongly correlated to the hedging decision. The more energy a country imports, the less companies tend to hedge. This is counter-intuitive on the first sight. One would expect to find the relevant firms hedge even more, because the drivers under the energy risks are partly foreign and thus more difficult to manage. One potential explanation might be that in countries relying on energy imports, companies rather focus on the downstream part of the energy value chain and hedge all risks not related to the core of their business by long-term contracts with international energy companies.

Overall, I see two major implications from the analysis. First, I conclude that the country-level variables considered by Bartram et al. (2009) are only little significant in my sample. The only exception is a more or less obvious relation betwen the hedging probability and the derivative usage in a country. But I do find a strong relation between the energy imports and the hedging behavior in a country. This relation has so far not been considered in prior publications.

Second, I conclude that future research on country-level impact on hedging decisions should aim to consider new, yet unstudied determinants. By analyzing the relation between culture and hedging, I will present one example of these unconsidered determinants in the following chapter. In this analysis, I choose the above used country-level factors “Energy import”, “Derivative market rank”, “Creditor rights”, “Shareholder rights”, “Closely held” and “Inflation” as control variables for my regression models.

10 The relation of culture and hedging

The following chapter is largely based on the paper Lievenbrueck and Schmid (2014)

In this chapter I will consider a new and yet unstudied country-level driver for hedging: a country's culture. I will begin by reflecting upon the impact of culture, describe the cultural dimensions I use, give an overview of the methodology I apply and then discuss my results.

10.1 Why should culture impact hedging?

> "Energy regulator CRE recently concluded a month-long program [...] to create a 'hedging culture' in Mexico."
> *Platt's Oilgram News, September 25, 2000*

> "[The Russian] market suffers from [...] the absence of a hedging culture among executives. [...] The reasons for keeping off hedging are trite. There is an old-fashioned faith for the market not to change or to drive in the 'right' direction."
> *FOW Magazin, December 2005*

> "We also don't have a hedging culture in Australia, whereas businessmen in other countries have been actively hedging key risks in

> their businesses for generations."
> *WA Business News, January 21, 2010*

> "I think airlines have been reluctant to hedge because corporate culture views futures as a gambling tool [...]. But they've been reluctant to their own detriment. If you're an airline without a significant hedge, you're in a difficult spot."
> *Stephen Schork, cited in Bloomberg Businessweek, May 7, 2008*

These comments show something long accepted by practitioners: Culture has an impact on financial decisions. Research on this topic is catching up. There is a young but growing literature on the influence of culture on corporate decisions in financial economics. Among others, Siegel, Licht, and Schwartz (2011) analyze the influence of differences in culture on cross-national bond and equity investments. Similarly Ahern, Daminelli, and Fracassi (2013) study the impact of cultural differences on international merger volumes. Other recent studies are Hwang (2011) or Giannetti and Yafeh (2012). Thus the impact of culture on financial decisions gets more and more accepted by academics. Hereby national cultural indices do not only give an estimate for a country's cultural characteristics but can also be understood as proxies for firm culture. Therefore culture might also provide an explanation for hitherto rather inconclusive results in the context of hedging because it is a factor that is neither captured in financial variables nor perfectly covered by national legal rules, as will be discussed later.

To the best of my knowledge, most non-descriptive analyses on hedging determinants so far focus on a single country and can thus not consider culture as a country-level variable. The only two exceptions are the two articles published by Bartram et al. (2009) and Lel (2012). The advantages and disadvantages of the samples used in these two articles have been discussed earlier on in the introduction and the section on the literature. Important in this context is the fact that although both Bartram et al. (2009) and Lel (2012) find several country-specific factors that have an impact on hedging decisions, they do not consider a possible influence of a country's specific culture.

The results of my multivariate regressions can be summarized as follows: *First*, I find that culture has an influence on the firms' decision to hedge. In particular, my results indicate that companies in long-term oriented cultures are less likely to hedge. Even more, they hedge a lower fraction of their exposure. This effect is strong, both from a statistical and economic point of view. If I consider marginal effects based on standardized variables, I find that the importance of long-term orientation for the hedging decision is among the highest for all variables observed – only firm size is consistently more important. *Second*, in masculine societies firms tend to use less asymmetric derivatives for hedging. Thus, they use less options and build their hedging activities rather on futures, forwards, or swaps. Interestingly, I do not find consistent evidence for uncertainty avoidance to impact hedging decisions.

10.2 Culture and its influence on corporate financial decisions

Culture is "the collective programming of the mind that distinguishes the members of one category of people from those of another" (Hofstede and Bond, 1988, p.6). The relevance of this "programming" in the context of reason-based decision making gets more and more accepted in modern economic research. Williamson (2000) defines a four stage model for informal and formal constraints relating to each other in which culture is one of the factors considered. More precisely it belongs to the embedded informal institutions that are the basis for all formalization in rules and that take the longest time to change and adapt to environmental progress. Thus according to Williamson (2000), culture influences decision making in two ways: First, culture shapes the formal institutional environment in a country. Among others, Licht, Goldschmidt, and Schwartz (2005) show that a country's legal rules are systematically related to its cultural framework.

But no legal framework can completely prevent stakeholders from opportunistic acting (Aggarwal and Goodell, 2009). This leads to the second, direct way in which culture influences decision making: via informal rules and standards. By showing that similar formal rules lead to different outcomes in different countries, North (1990) argues that those informal rules are more than appendages to formal frameworks, but constitute their own importance in decision making processes. Therefore formal frameworks like legal rules can never totally cover the influence of informal conditioning through e.g. culture. Consequently I expect some of the cultural impact to be translated and thus covered in formal frameworks, which means that legal and governmental indices could also have an impact on hedging. Nevertheless a certain part of this impact cannot be covered by the formal rules as the findings of North (1990) show. I therefore also expect to find an additional impact of culture on hedging even if indices for formal frameworks are included in the analysis. The degree to which culture "directly" affects hedging besides the formal rules is one of the questions I want to study in the following.

Though culture has so far not been considered as a determinant for corporate hedging decisions, it has proven to be an important factor in other financing-related topics. Two examples have already been mentioned earlier: Siegel et al. (2011) and Ahern et al. (2013) analyzing the influence of culture on international bond and equity investments including cross-national mergers. Booth, Aivazian, Demirguc-Kunt, and Maksimovic (2001) study the capital structure on an international level and find that though financial theory can explain differences in capital structure even in developing countries, certain differences between the countries still have to be explained. Though they do not attribute their finding to a cultural influence, it clearly is due to a country-wide factor that has the characteristics of a cultural impact. Chui, Lloyd, and Kwok (2002) show that culture impacts the corporate debt structure. Zheng, Ghoul, Guedhami, and Kwok (2012) build on this insight and find a relation between culture and the debt maturity structure. Similarly, Shao, Kwok, and Guedhami (2010) use culture to explain differences in the dividend policy of firms. Other examples for research on the impact of culture on corporate financial decisions are Li, Griffin, Yue, and Zhao (2011) analyzing the relation between national culture and leverage decisions, Schuler and Rogovsky (1998) studying the impact of culture on human resource management (especially compensation), Shao et al. (2010) considering culture and corporate dividend policy and Han, Kang, Salter, and Yoo (2010) researching managers' decision to exercise earnings discretion in relation to their cultural background.

10.3 Measuring culture

These aforementioned findings raise the question if culture may also help to understand patterns of yet (largely) unexplained hedging behavior. But the question how to measure culture as a rather "soft" factor remains. One of the first to address this question was Geert Hofstede. His set of cultural characteristics (e.g., published in Hofstede (2001)) is one of the most comprehensive sets available. Kirkman, Lowe, and Gibson (2006) discuss in detail the pros and cons of the Hofstede indices and also give a broad overview of articles that use these indices to capture culture. They mention 180 papers working with the Hofstede indices in empirical research (Kirkman et al., 2006, p.289-291). Some examples are: Change management (James, 1993; Eby, Adams, Russel, and Gaby, 2000), HR management (Schuler and Rogovsky, 1998; Early, 1986), negotiation (Wade-Benzoni, Okumura, Brett, Moore, Tenbrunsel, and Bazerman, 2002), entrepreneurship (Thomas and Mueller, 2000; Morris, Avila, and Allen, 1993), Foreign investments (Benito and Gripsrud, 1992; Thomas and Grosse, 2001; Habib and Zurawicki, 2002), Joint ventures (Li and Guisinger, 1991; Pothukuchi, Damanpour, Choi, Chen, and Park, 2002; Luo and Park, 2001). This might give a sense of the importance these indices have in empirical literature.

The first version of the Hofstede indices themselves was collected between 1967 and 1973 with help of a survey among IBM employees in over 70 countries, covering diverse questions about their values. This information from the survey has been used to construct four dimensions meant to capture different aspects of cultural conditioning. Later studies extended the sample to commercial airline pilots, students, civil service managers, "up-market" consumers, and "elites" and added a fifth and sixth dimension to the earlier cultural characteristics. Following prior studies (e.g., Kwok and Tadesse, 2006; Chui and Kwok, 2007; Chui, Titman, and Wei, 2010; Zheng et al., 2012), I combine well known financial determinants for corporate hedging with four of these widely accepted cultural dimensions from Hofstede (2001) to answer my research questions. Hereby national cultural indices do not only approximate a country's cultural characteristics, but can also be interpreted as measures for a firm's culture.

10.4 Hypotheses on the impact of culture

General cultural impact on hedging: My first and main hypothesis is that culture impacts hedging decisions. This hypothesis shall be studied by considering different cultural dimensions. I regard this hypothesis to be proven if at least one of these dimensions shows a consistent impact on hedging across all three risk types that I consider. I posit:

Hypothesis 1: Culture has an impact on firms' hedging behavior.

In the following I will give more detailed hypotheses on each of the Hofstede cultural indices used in my analysis. I will combine this with a short description of the dimensions but neither aim to in-depth discuss them nor give a valuation of these indices compared to other cultural measures as this paper is not meant to prove or question the Hofstede cultural indices. I rather use them as the most commonly applied measure for cultural dimensions that can be found.

Long-term vs. short-term orientation (LTO): Short-term oriented cultures are characterized by appreciating quick results and showing low willingness to wait for future outcomes. The relation to risk management might not directly be clear but hedging can help to achieve early results when derivatives are used to lock in future gains. By doing so one can make the "real" value of a certain balance sheet position transparent and avoid waiting for this value to materialize through future cash flows. Consequently, one can expect to see more hedging in short- than in long-term oriented cultures. On the other hand one could argue that managers in long-term oriented cultures are more precautious and overvalue the long-term survival of their company. This would lead to more hedging in long-term compared to short-term oriented cultures. I do not expect an impact on the usage of asymmetric derivatives. Thus, I posit the two conflicting hypotheses:

Hypothesis 2a: LTO leads to less hedging.

Hypothesis 2b: LTO leads to more hedging.

Uncertainty avoidance (UAI): People in uncertainty avoiding societies feel uncomfortable with the fact that the future is unknown and try to implement controls for this uncertainty. One control might be the usage of derivatives to mitigate future risks. I expect that high scoring on this dimension will be correlated to stronger risk management and thus more hedging activities. I posit:

Hypothesis 3: UAI leads to more hedging.

Power distance (PDI): This dimension measures the acceptance of unequal distribution of power by less powerful subjects in a society. Higher scoring along this dimension (i.e., more acceptance for the position of power) could be correlated with more "room for maneuver" for CEOs and less need to justify decisions and potential negative outcomes. This freedom could lead to CEOs being less risk averse and consequently using less hedging, especially less derivatives with asymmetric instruments. Thus, I posit:

Hypothesis 4: PDI leads to less hedging and less usage of asymmetric derivatives.

Masculinity vs. femininity (MAS): This dimension measures in how far the dominant and important values in a society are "masculine". Examples for masculine values are assertiveness and competitiveness. In masculine societies, men are supposed to be tough and focused on material success. In feminine societies both men and women are supposed to be modest, tender and concerned with the quality of life. Some examples might provide a feeling of the underlying reasoning: According to Hofstede, Japan is the most masculine country. This sounds plausible as Japanese people are known to highly value success and to be accustomed to assertive behavior in a quite hierarchically organized society. On the other hand Sweden and Norway are the least masculine countries. These countries are indeed known to highly value personal evolvement besides economic success. I expect that firms in masculine countries are less likely to be willing to spend money on premiums for additional security. Thus I believe to find less option usage in masculine countries. I posit:

Hypothesis 5: MAS leads to less usage of asymmetric derivatives.

10.5 Data used in the following analysis

Though the relevant data has already been described earlier, I will briefly repeat the variables that can be found in the following regressions:

I include several control variables chosen based on findings from prior research (e.g., Bartram et al., 2009; Lel, 2012) and my results from earlier chapters. The firm-level control variables, which are constructed with data from Worldscope, are:

- Company size is defined as normal logarithm of total assets in thousand US dollars.
- FX exposure is defined as COGS divided by total assets for non-US companies and zero for US-companies.
- CO exposure is defined as COGS plus net sales or revenues divided by total assets.
- Leverage is total debt divided by sum of total debt and the market value of common equity.
- Market-to-book approximates a firm's growth opportunities and is measured as market capitalization divided by the book value of common equity.
- Profitability is defined as EBIT divided by total assets.

I also include several control variables on a country-level. This helps to mitigate concerns that my cultural measures are mainly proxies for a country's legal or regulatory framework. Please note that I cannot use country dummies because the variables which are most important for this analysis, i.e., the cultural dimensions, do not vary over time. Thus, I control for the following aspects:

- Net energy import is defined as energy import minus export divided by energy consumption.
- Derivative market rank is the rank of the sum of national daily averages of FX and IR derivative market turnover divided by GDP and adjusted for local inter-dealer double-counting (Bank for International Settlement, 2010a). The derivative market rank is available for the years 1998, 2001, 2004, 2007 and 2010 and linearly interpolated for the years in between. This variable measures the availability of derivatives and consequently also the related transaction costs. The latter is

difficult to measure directly, but the market liquidity is a commonly used proxy.

- Derivative market volume is defined as the log sum of national daily averages of FX and IR derivative market turnover divided by GDP and adjusted for local inter-dealer double-counting (Bank for International Settlement, 2010a).
- Lender protection (CRI) is defined as creditor rights index from Djankov et al. (2007).
- Shareholder protection (ADRI) is defined as the revised anti director rights index from Djankov et al. (2008).
- Regulatory quality is an index measuring the governmental ability to implement sound regulations (Kaufmann et al., 2008).
- Political stability is an index measuring the overall political stability of a country.
- Rule of law is an index measuring to which extent agents have confidence in and abide by rules of society.
- Closely held is the percentage of market capitalization closely held (Dahlquist et al., 2003).
- Annualized inflation measures a country's financial stability (World development indicator database, Worldbank).

An overview of all variables can be found in Appendix S.

10.6 Methodology

To disentangle the impact of culture on hedging behavior, I analyze three hedging related dimensions. Two factors, i.e., the decision to hedge and the decision to use asymmetric derivatives, are binary choice variables. For these, I use a pooled probit model. The hedging volume is a continuous variable which ranges between zero for non-hedgers and one (because I set the variable to one if the hedged volume is larger than the sum of the balance sheet). Here, I use a pooled tobit model with censoring at zero and one. For general information on the models used throughout this chapter, I refer to Stock and Watson (2012); Baum (2006); Hayashi (2000); Spanos (1998); Wooldridge (2010).

Unless otherwise noted, all regressions include time dummies to control for changes over time and a US dummy. All ratios are winsorized at the 1 % and 99 % level to restrict the impact of outliers. T-Statistics reported in the tables are based on robust Huber-White standard errors clustered at the firm level. ***, ** and * indicate significance on the 0.1 %-, 1 %- and 5 %-levels, respectively.

Obviously, a potential bias can occur in my sample because of the selection of observations. Although I searched for annual reports at company websites and the ThomsonReuters Filings database, some could not be found. Furthermore, some annual reports were only available in languages that I could not evaluate, as explained above. Thus, I follow Lel (2012) and control for a possible sample selection bias with help of a Heckman approach. Greene (2012) Kennedy (2008) and Baum (2006) show that the application of a two step Heckman model serves to correct for truncation bias. The first step is a probit model with binary dependent variable that refers to whether the hedging information is available for this firm year or not. The second step is the main regression on the dependent variable of interest (here the hedging dummy) and includes a correction term that has been calculated in the first step. For this purpose, I use the accounting standard and the analyst following as indicators for the probability that a report could be found (and thus the data point be included in my analysis). For analyzing the hedging volume, this approach does not lead to proper results as the ratio of censored to uncensored observations is too low. Similarly, I cannot implement this methodology for the regressions on the usage of asymmetric derivatives as the sample for this analysis has to be restricted on hedgers – a number which is not known for non-reporting companies.

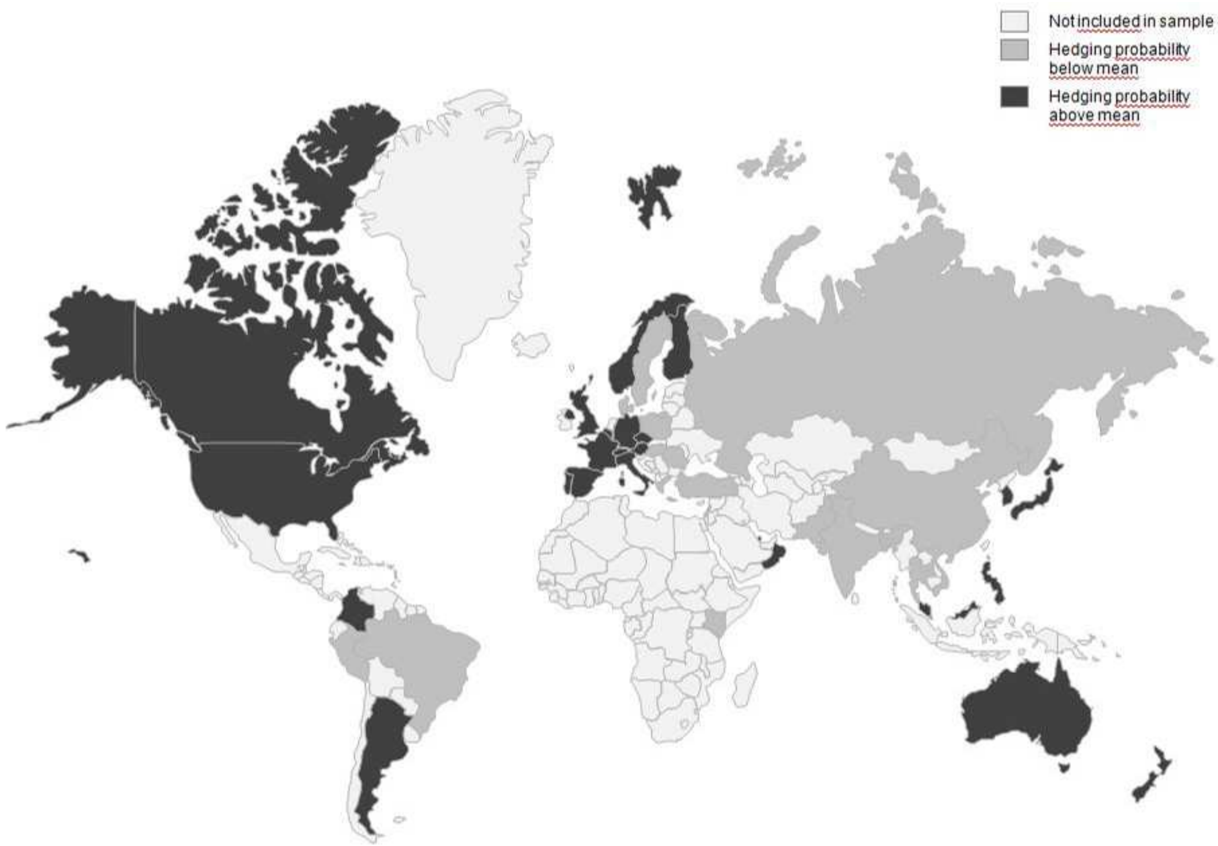
10.7 Evidence for the cultural impact

I begin my analysis with some descriptive statistics. After that, I present the multivariate results.

10.7.1 Descriptive statistics

The map shown in figure 10.1 illustrates the geographical coverage of the sample used for the analysis of culture influencing hedging decisions. Altogether, the subsample that is used in this context includes firms from 46 countries in six continents. The shading indicates if the fraction of firms hedging any risk in a specific country is above or below the sample mean. As can be seen, hedging is most common in Western Europe, North America, and Oceania. In Asia and South America, the probability that a company hedges seems to be generally lower. Most apparent exceptions, like Columbia or the Philippines, may be attributed to the low number of observations in these countries (see also table 10.1). Nevertheless, I see few exceptions where this argument clearly does not hold: e.g. Malaysia with 51 observations, to which I attribute a high probability to hedge. Nevertheless, I see the necessity to control for the level of country development in the section in robustness tests.

Figure 10.1: Culture: Geographic reach of sample



The map shows all 46 countries included in the sample and distinguishes between countries with hedging probability for at least one observed risk type above and below mean.

Table 10.1 shows the percentages of hedgers across major countries in more detail. Altogether, the dataset covers 2,700 observations. US companies do not only represent the majority of observations (approximately 30 % of all firm-years), but they also show a very different risk exposure with regard to FX risk, as discussed earlier. Outside the US, commodities have the lowest probability to be hedged, while exchange rate and interest rate risks are hedged in more than 40 % of all firm-year observations. The numbers are very different in the US. Exchange rate risks are rarely hedged and commodity hedging is much more common than in most other countries, with a hedging probability of above 80 %. Thus, I present total percentages of hedgers with and without US firms.

One can see that the difference between more and less developed countries is most obvious for CO hedging (e.g. in Brazil, China, India, Malaysia or Russia). In contrast, some less developed countries show FX or IR hedging probabilities that are similar to the figures seen in industrialized countries (e.g. probability for FX hedging in Brazil and Malaysia is higher than in Germany). The lower probability of CO hedging in less developed countries might be explained by the fact that electricity hedging requires local, liquid commodity markets, which often do not exist. Thus, electricity hedging via derivatives is not possible for all companies. However, hedging the supply side (which can be assumed to be global and sufficiently liquid for most primary energy sources) and leaving open the demand would increase the risk and thus several companies with insufficient access to local power markets might decide not to hedge commodities at all.

The topic of regional patterns in hedging strategies is discussed in more detail and on the full sample in the chapter 6.

Based on the descriptive statistics shown in table 10.2, I find clear differences between hedgers and non-hedgers. For instance, hedgers are larger, more profitable, and have higher leverage. However, these univariate statistics have to be interpreted with caution. Indeed, most of these differences cannot be confirmed on a satisfactory significance level in multivariate regression analyses.

Table 10.1: Culture: Hedgers and non-hedgers across major countries

Country	FX	IR	CO	Observations
United States	15	54	84	730
Brazil	46	20	1	201
Russian Federation	2	6	7	153
Canada	48	49	51	144
Australia	36	57	19	118
India	29	8	0	114
Germany	43	46	40	108
United Kingdom	58	63	46	98
Italy	48	75	41	95
Japan	84	81	51	86
Hong Kong	37	50	12	78
Spain	74	84	40	62
Switzerland	39	39	33	57
France	49	59	24	51
Malaysia	57	43	4	51
China	17	24	4	46
Turkey	39	32	25	44
Others	37	49	17	464
Total ex US	41	44	22	1970
Total	34	47	39	2700

The table presents the percentages of hedgers for the three risk types for major countries (with at least 40 observations) by order of country observations. The remaining 29 countries are subsumed under Others. To illustrate the impact of US companies in my sample, I show hedgers for both all (Total) and non-US companies (Total ex US).

Table 10.2: Culture: Summary statistics

	Mean				Standard	Quantile		
	Full sample	Hedger	Non-hedger	T-test	deviation	25%	50%	75%
Size	10.59	14.31	2.27	< 0.01	23.84	0.53	2.41	9.67
FX exposure	0.23	0.19	0.31	< 0.01	0.39	0.00	0.11	0.32
CO exposure	0.78	0.76	0.81	0.19	0.88	0.36	0.61	0.93
Leverage	0.39	0.43	0.30	< 0.01	0.23	0.22	0.39	0.54
Market-to-book	2.14	2.00	2.45	< 0.01	2.45	1.10	1.54	2.19
Profitability	0.04	0.06	-0.01	< 0.01	0.20	0.04	0.06	0.09
UAI	56.56	56.11	57.57	0.08	19.23	46.00	48.00	75.00
MAS	58.59	59.45	56.66	< 0.01	12.48	52.00	62.00	62.00
LTO	44.13	41.82	49.29	< 0.01	20.42	25.69	40.81	60.45
PDI	50.38	47.96	55.79	< 0.01	17.72	39.00	40.00	66.00
Energy import	20.22	19.72	21.35	0.50	59.01	12.57	26.60	53.75
Derivative MR	31.53	33.49	27.17	< 0.01	14.45	21.00	35.00	42.00
CRI	1.74	1.70	1.84	0.01	1.04	1.00	1.00	4.00
ADRI	3.67	3.61	3.82	< 0.01	1.00	3.00	3.50	5.00
Closely held	0.35	0.31	0.45	< 0.01	0.23	0.08	0.38	0.51
Inflation	3.26	2.84	4.20	< 0.01	3.80	1.63	2.68	3.83

The table presents descriptive statistics including means for hedgers and non-hedgers (hedging here means hedging of at least one of the three observed market risk types) for the 46 countries included in the analysis. T-tests show the confidence levels for differences in distribution. Size is given as total assets in million US dollar, GDP per capita in thousand US dollar. A detailed description of the variables can be found in Appendix S.

10.7.2 Multivariate analysis

Table 10.3 shows the results of multivariate regressions with regard to the decision to hedge for FX, IR, and CO risk (first three columns). Concerning the cultural indices, I find a strong and negative impact of long-term orientation (LTO). This negative effect is present for all three risk types. This indicates that hedging is implemented to lock in future gains in case the company operates in a culture that strongly appreciates quick results. This finding is in line with my expectations and also confirmed by the findings of Breeden and Viswanathan (1998) on managers with high abilities undertaking hedging to increase the visibility of their management quality. This decrease in information asymmetries is also shown by Dadalt, Gay, and Nam (2002). Building on a sample taken from the 1997 "Database of Users of Derivatives", they find evidence that analysts' earnings forecasts have significantly greater accuracy for firms using derivatives. As expected, I do not find a strong influence of MAS. Although PDI is negative in all specifications, as expected by theoretical considerations, it is statistically not significant for IR hedging. Interestingly, I find no consistent effect for UAI, which I expected to have a strong impact on hedging decisions. Overall, my results provide strong indication that culture, and especially long-term orientation, has a strong influence on a firms' decision for or against hedging. Thus, *hypothesis 1* and *hypothesis 2a* cannot be rejected. By contrast, I find no convincing support for *hypothesis 2b*, *hypothesis 3*, and *hypothesis 4*.

Table 10.3: Culture and hedging decision

	FX	IR	CO
UAI	**-0.00089**	**0.070****	**-0.12*****
	(-0.030)	**(2.02)**	**(-2.96)**
MAS	**0.015**	**-0.046**	**0.060****
	(0.55)	**(-1.53)**	**(2.02)**
LTO	**-0.090****	**-0.17*****	**-0.18*****
	(-2.42)	**(-3.88)**	**(-3.64)**
PDI	**-0.080****	**-0.060**	**-0.25*****
	(-2.47)	**(-1.51)**	**(-4.98)**
Size	0.47***	0.46***	0.54***
	(10.7)	(10.7)	(11.7)
FX exposure	0.064**		
	(2.30)		
CO exposure			0.22***
			(4.56)
Leverage	-0.010	0.089***	-0.038
	(-0.45)	(3.54)	(-1.19)
Market-to-book	0.045	0.022	-0.030
	(1.43)	(1.01)	(-1.04)
Profitability	-0.14**	-0.015	-0.072
	(-2.20)	(-0.33)	(-1.28)
Energy import	-0.024	-0.022	0.048
	(-0.74)	(-0.66)	(1.42)
Derivative MR	0.022	0.18***	0.083
	(0.57)	(3.90)	(1.42)
CRI	-0.0042	0.076**	-0.094**
	(-0.16)	(2.28)	(-2.32)
ADRI	0.054**	-0.084***	-0.018
	(2.15)	(-2.84)	(-0.69)
Closely held	0.035	0.058	0.086
	(0.90)	(1.20)	(1.46)
Inflation	-0.041	-0.17***	-0.24**
	(-1.07)	(-2.87)	(-2.03)
Observations	2,479	2,540	2,478
Pseudo R2	0.32	0.32	0.55

The dependent variable is the decision to hedge. All models are marginal effects of pooled probit regressions based on standardized variables, evaluated at their mean. Thus each coefficient indicates the change in hedging probability if a variable changes from its mean to its mean plus one standard deviation (mean to mean + 1 SD), while all other variables are kept fix at their means. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 0.1%-, 1%- and 5%-levels, respectively.

The impact of culture on the decision to hedge is not only statistically significant, but also economically important. The coefficients in table 10.3 are marginal effects based on standardized variables for the decision to hedge. Thus, the magnitude of the coefficients allows me to compare the economic significance of the variables. The coefficients indicate the change in the hedging probability if the corresponding variable changes from its mean to the mean plus one standard deviation, while all other variables are kept at their mean. Obviously, company size is the most important impact factor. This is in line with prior studies. Interestingly, the most important factor besides size is LTO if all three risk factors are analyzed. No other variable is consistently higher ranked across all three risk types, except size. Furthermore, I compare McFadden's adjusted R2 for the (i) full model, (ii) a model without cultural variables, (iii) a model without country controls besides culture, and (iv) a model without firm controls besides size. The adjusted R2 is highest for the full model. The importance of cultural factors is underlined by the finding that the decrease in R2 is on average most pronounced if the cultural variables are removed, compared to the other two variations. Thus, the explanatory power of cultural factors is on average higher than that of the other country- and firm-specific factors except size. Furthermore, the Bayesian information criterion (BIC) indicates that the model fit becomes better if cultural factors are included. Overall, these findings provide strong support for the view that culture is an economically important determinant of hedging.

Besides the impact of culture, I again see a strong positive influence of firm size. This supports the "economies of scale" theory, and is in line with all prior studies on hedging. Not surprisingly, my measures for the exposure to the different risk factors also have a positive impact. Thus, firms with higher risk exposure are more likely to hedge and they also hedge higher volumes. All other variables turn out to be insignificant or not consistent across the different risk types. Hence, the support for the financial theories concerning hedging is rather weak in my analysis. The impact of leverage and thus of costs of distress is mixed. Only for interest rate hedging, I find a strong, positive impact. But as leverage also serves as a proxy for the IR exposure, I rather attribute this finding to the fact that companies increase their hedging when the underlying exposure grows. This interpretation is supported by the fact that my FX and CO exposure estimates also correlate to more FX respectively CO hedging. The influences of market-to-book and profitability are negligible and/or inconsistent. Other country factors than the cultural dimensions do not show consistent explanatory power. Only inflation is consistently negative for IR and CO risk hedging but insignificant for FX hedging. In particular, I do not find the earlier discussed relation between the dependency on foreign energy and the hedging decision or the correlation between the derivative market in a country and the firm hedging behavior.

As a next step, I analyze the hedging volume. This has the advantage to allow a distinction between firms that hedge only a small part of their risk exposure and those who engage in excessive hedging activities. Unfortunately, this information is often not available, resulting in a smaller number of observations. Results are reported in table 10.4. As before, I find a negative influence of LTO for all risks. Overall, these results support those for the dummy variable indicating if a firm hedges a specific risk factor at all. Interestingly, PDI becomes more significant in this model. The direction is consistent with my expectations. In addition, energy import turns out to be significant and consistent across all three risk types – the hedging volume increases with the energy imports. This is in line with my earlier expectations on the relation between dependency on foreign energy sources and hedging.

Table 10.4: Culture and hedging volume

	FX	IR	CO
UAI	**-0.0016****	**0.00028**	**-0.0083*****
	(-2.46)	**(0.40)**	**(-2.90)**
MAS	**-0.0011**	**-0.0014***	**-0.0057**
	(-1.54)	**(-1.72)**	**(-1.52)**
LTO	**-0.0021*****	**-0.0050*****	**-0.0075****
	(-3.45)	**(-6.39)**	**(-2.36)**
PDI	**-0.0025*****	**-0.0020*****	**-0.017*****
	(-3.58)	**(-2.84)**	**(-3.93)**
Size	0.055***	0.044***	0.18***
	(6.79)	(6.18)	(5.86)
FX exposure	0.032		
	(1.41)		
CO exposure			0.17**
			(2.57)
Leverage	-0.078	0.25***	-0.24
	(-1.52)	(4.70)	(-1.28)
Market-to-book	0.0041	0.0032	-0.0075
	(1.00)	(0.93)	(-0.36)
Profitability	0.27*	0.22**	0.23
	(1.74)	(2.27)	(0.55)
Energy import	0.039***	0.024*	0.19***
	(3.18)	(1.80)	(3.58)
Derivative MR	-0.0011	0.0028**	-0.0033
	(-0.92)	(2.42)	(-0.63)
CRI	-0.012	0.037***	-0.15**
	(-1.21)	(2.63)	(-2.31)
ADRI	0.030**	-0.041***	-0.042
	(2.44)	(-2.79)	(-0.81)
Closely held	-0.027	-0.023	-0.36
	(-0.32)	(-0.24)	(-1.03)
Inflation	-0.0045	-0.011***	-0.044**
	(-1.45)	(-3.03)	(-2.43)
Observations	1,561	1,492	1,094
Pseudo R2	0.89	1.03	0.40

The dependent variable is the hedging volume. All models are pooled tobit regressions with censoring at zero and one. Non-hedgers are set to zero. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 0.1%-, 1%- and 5%-levels, respectively.

Lastly, I analyze the instruments that are used for hedging. In particular, I investigate if asymmetric derivatives are applied for hedging purposes. For this test, the sample is restricted to firms that hedge the specific risk factor. Results can be found in table 10.5. For all three risk factors I find that masculinity (MAS) has a negative influence on the decision to use asymmetric derivatives. Thus, the probability that asymmetric derivatives are used is smaller in materialistic and assertive societies. Instead, firms in these environments mainly use symmetric derivatives which expose a company to a downside risk in case the hedge turns out to be less effective than assumed. One reason for a lower effectiveness of a hedge might be a change in the anticipated need for input factors (here primary energy sources) after the corresponding hedge has been installed. In this case, hedging can even increase the firm's risk. Furthermore, symmetric derivatives have the disadvantage that they must be fulfilled, independent of the market price[15]. The other cultural dimensions turn out to be insignificant. Overall, the results provide support for *hypothesis 1* which postulates a general impact of culture and *hypothesis 5* which predicts the negative impact of MAS.

[15] I have considered earlier the impact of production technology on option usage. In that discussion, options were used to sell the more complex hedging of peak load power plants to counterparties that are more experienced in structuring options. Unfortunately, I cannot control for the production technology in the present analysis, as the number of observations with all necessary information available would be too low. But a certain connection between the motivations for option usage regarded in the earlier chapter 8 and in the current analysis can be drawn as follows: In both cases, options are considered the less risky hedging strategy compared to linear derivatives. In the first case, companies use options in order to leave the more complex and thus risky structuring of power plants with linear products to another counterparty. In the present analysis I argue that options are less risky, because they prevent a downside risk from the derivative position, in case the hedging strategy turns out to be less effective. Thus in the first case I consider the effect that companies sell the hedging to other counterparties when their portfolio calls for a technically more complex hedging. In the present case, I consider the effect, that companies that are overall more risk averse, are more likely to forego this "outsourcing" than less risk averse companies.

Table 10.5: Culture and hedging instruments used

	FX	IR	CO
UAI	**-0.024*** **	**0.0051**	**0.0043**
	(-3.47)	**(0.71)**	**(0.38)**
MAS	**-0.017** **	**-0.024*** **	**-0.041** **
	(-2.25)	**(-2.76)**	**(-2.19)**
LTO	**0.0091**	**0.0079**	**0.018**
	(1.10)	**(1.11)**	**(1.12)**
PDI	**-0.010**	**-0.011**	**-0.058*** **
	(-1.02)	**(-1.15)**	**(-3.34)**
Size	0.21**	0.27***	0.30***
	(2.12)	(3.31)	(3.45)
FX exposure	-0.83**		
	(-2.15)		
CO exposure			0.54***
			(3.64)
Leverage	-1.01*	0.94	0.59
	(-1.79)	(1.63)	(0.84)
Market-to-book	-0.050	0.065	-0.011
	(-1.00)	(1.47)	(-0.18)
Profitability	-4.00**	0.71	0.40
	(-2.04)	(0.56)	(0.27)
Energy import	0.17	-0.069	-0.17
	(1.23)	(-0.50)	(-0.51)
Derivative MR	-0.024**	0.0022	0.036*
	(-2.28)	(0.18)	(1.80)
CRI	-0.26*	0.21	0.071
	(-1.88)	(1.46)	(0.33)
ADRI	-0.11	-0.087	-0.67***
	(-0.87)	(-0.54)	(-2.93)
Closely held	-2.77***	0.067	-1.59
	(-3.12)	(0.082)	(-1.21)
Inflation	0.033**	-0.050	-0.036
	(2.07)	(-0.92)	(-0.53)
Observations	818	1,140	900
Pseudo R2	0.17	0.16	0.22

The dependent variable is the decision to use asymmetric hedging instruments. All models are pooled probit regressions. The sample is restricted to hedgers only. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 0.1%-, 1%- and 5%-levels, respectively.

10.7.3 Robustness of results

In this section, I address some potential concerns with my results.

General tests

I tested if the results are robust to several general concerns. First, I lagged all right-hand side variables by one year. Second, I omitted winsorization of the variables. Third, I included several alternative control variables, e.g., ln employees en lieu of ln total assets to measure firm size or CAPEX en lieu of market-to-book to control for investment opportunities. Fourth, I restricted my observations to years before the financial crisis. However, all these variations lead to similar outcomes as those reported in the last section. With regard to a potential concern of reverse causality, I argue that culture is understood as a long developing characteristic that is influenced by a huge variety of factors. Thus, I do not expect reverse causality to be a problem in my analysis.

Simultaneous regressions

I have mentioned in the earlier section on international impact factors for hedging decisions that in some prior studies hedging dummies on the different risk factors have been estimated simultaneously. Like in the earlier sections I also follow this approach to check if the results change when estimated simultaneously. Appendix H shows the corresponding results for the hedging dummy. As one can see, the numbers do not change significantly and the effects stay strong. Therefore, I assume that the relation of hedging decisions across different risk factors does not impact my findings on the influence of culture.

Regulation of the usage of certain derivatives

As discussed earlier, the energy regulation does generally not deal with financial rules imposed on the energy providers. Anyway, I want to ensure that regulatory constraints on the usage of derivatives in general and options in specific do not explain the differences in derivative usage I see. Therefore I check the results for the first two observed hedging decisions (the hedging dummy and the hedging volume) on the subsample of countries where I find both hedgers and non-hedgers. In these countries obviously hedging is neither forbidden nor dictated by the regulator and thus the decision is left to each company. To avoid measurement errors, I exclude all countries in which hedgers or non-hedgers are less than 10 % of all company years. For the third hedging decision I reduce my analysis to the subsample of countries which have both companies that use and companies that neglect options. Again by doing so I try to mitigate a potential impact of regulatory rules on the usage or non-usage of options. Similar to the first six regressions, I draw the line at 10 % option users or non-users to account for measuring inaccuracies. The results show to be mainly robust against these restrictions and thus do not seem to be driven or strongly influenced by regulation on the usage of derivatives. The model outcome is presented in Appendix I and Appendix J.

Culture and institutional environment

One concern in the context of research on cultural impacts on day-to-day business decision making is the translation of informal institutions (like culture) into formalized frameworks like legal rules. One can pose the question if considering culture adds some extra value to purely considering the legal and governmental environment. As mentioned earlier, North (1990) shows that the informal frameworks cannot be completely covered by formalizations. To ensure that this finding also holds for my present analysis I repeat the regressions on the three hedging decisions while including additional control variables: I include the rule of law, the regulatory quality and the political stability indices taken from Kaufmann et al. (2008). It is worth mentioning that besides these three additional indicators for formalized environmental frameworks the shareholder rights and the creditor rights index are still part of the model. I believe that these five indicators best cover all additional formalized rules and frameworks that can be influencing hedging besides culture. The results are displayed in table 10.6. For simplicity reasons, I only report the coefficients for the cultural dimensions and the five indicators for the legal framework on the hedging decision and the hedging volume here, though the same firm and country controls as in the main models are still included in the regressions. The full model for all three hedging dimensions can be seen in Appendix K and Appendix L. As can be seen, the results for the cultural influence are quite stable under this robustness check. Furthermore I do not find a consistent and significant impact of the newly included legal framework indices. I therefore conclude that culture has a direct impact on hedging and that the indirect impact via legal and formalized frameworks cannot be measured in my sample.

Table 10.6: Culture and hedging decision / hedging volume - legal framework [partly reported]

	Hedging decision			Hedging volume		
	FX	IR	CO	FX	IR	CO
UAI	**-0.0018**	**0.0087****	**-0.016*****	**-0.0018*****	**0.00021**	**-0.0077*****
	(-0.42)	**(2.01)**	**(-3.05)**	**(-2.86)**	**(0.30)**	**(-2.71)**
MAS	**0.0032**	**-0.0037**	**0.019*****	**-0.0011**	**-0.0010**	**-0.0036**
	(0.52)	**(-0.62)**	**(2.67)**	**(-1.46)**	**(-1.15)**	**(-0.87)**
LTO	**-0.014*****	**-0.016*****	**-0.020*****	**-0.0026*****	**-0.0046*****	**-0.0072****
	(-2.77)	**(-3.18)**	**(-3.01)**	**(-4.02)**	**(-5.17)**	**(-2.15)**
PDI	**-0.0077**	**-0.0032**	**-0.019*****	**-0.0022*****	**-0.0019****	**-0.010****
	(-1.51)	**(-0.54)**	**(-2.59)**	**(-3.05)**	**(-2.11)**	**(-2.45)**
Regulatory quality	-0.18	0.69***	0.59	-0.038	0.13***	0.19
	(-0.75)	(2.82)	(1.38)	(-0.75)	(2.68)	(0.87)
Rule of law	0.34	-0.015	0.53*	0.011	-0.094**	0.12
	(1.34)	(-0.052)	(1.79)	(0.23)	(-2.04)	(0.49)
Political stability	0.22*	-0.29**	-0.18	0.052**	0.0089	0.045
	(1.69)	(-1.97)	(-0.67)	(2.10)	(0.32)	(0.31)
CRI	-0.012	0.16*	-0.24**	-0.012	0.031**	-0.14**
	(-0.15)	(1.85)	(-2.24)	(-1.19)	(2.14)	(-2.09)
ADRI	0.16**	-0.24***	-0.11	0.031**	-0.039***	-0.071
	(2.12)	(-3.05)	(-1.45)	(2.39)	(-2.59)	(-1.32)
			Other country controls			
			Firm controls			
Observations	2,463	2,524	2,462	1,552	1,483	1,085
(Pseudo) R2	0.32	0.33	0.56	0.88	1.03	0.41

The dependent variables are the decision to hedge and the hedging volume. The first three models are pooled probit, the last three pooled tobit regressions with censoring at zero and one. Additional variables capturing the legal framework have been included. Here only the cultural dimensions and the indicators on the legal framework are reported - the full model is presented in Appendix K. A detailed description of variables is given in Appendix S. All regressions include time dummies and a US dummy. T-statistics are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Derivative market liquidity

I have mentioned earlier that market liquidity has proven to be of certain importance for hedging decisions in the article of Bartram et al. (2009). My main results thus include the derivative market rank based on standardized IR and FX market trading volumes. But as this factor does not yield a significant and consistent impact in my sample I try a different definition using not the market rank but the market volume of the IR and FX derivative tradings divided by GDP. The results are shown in Appendix M and Appendix N. One can see that the results do not differ and my findings are robust against this change in definition.

Regarding the option usage one can argue similarly stating that option usage might only be driven by the option market liquidity. Though the market liquidity certainly plays an important role, I want to give some evidence that my results on the usage of options are robust against market liquidity changes. I therefore use the numbers on global positions in OTC FX option markets from the report on global foreign exchange market activity in 2010 (see Bank for International Settlement (2010b)) to define a subsample of liquid FX option markets. The countries are the following: USA, Eurozone, UK, Japan, Canada, Australia and Switzerland. The corresponding results for FX option usage in this subsample (presented in table 10.7) are similar to the findings for FX hedging in table 10.5. Of course this does only give evidence on the case of FX option usage leaving IR and CO options unconsidered. But as the findings on FX options are robust under this check, I assume that the case will be comparable for IR and CO markets.

Table 10.7: Culture and option usage - liquid FX option markets only

	FX
UAI	**0.039**
	(0.41)
MAS	**-1.46****
	(-2.05)
LTO	**-0.79**
	(-0.92)
PDI	**-0.30***
	(-1.90)
Size	0.15
	(0.057)
FX exposure	-0.036*
	(-1.72)
Leverage	-0.084***
	(-4.92)
Market-to-book	0.033
	(1.55)
Profitability	0.013
	(0.52)
Energy import	0.23
	(0.47)
Derivative MR	0.0030
	(0.12)
CRI	0.40
	(1.36)
ADRI	-0.58**
	(-2.05)
Closely held	-0.88
	(-0.45)
Inflation	-0.20
	(-1.18)
Observations	470
Pseudo R2	0.28

The model is identical to table 10.5. The sample is restricted to hedgers and countries with liquid FX option markets: USA, the Euro-zone, UK, Japan, Canada, Australia and Switzerland. A variable description is given in Appendix S. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

The influence of economic development

When regarding the map showing the hedging probabilities across countries, one might get the impression that hedging is simply driven by a country's economic development. This assumption is further confirmed by the growth in emerging derivative markets. The Bank for International Settlement (2008) reports an annual growth of 28 % for FX and IR OTC derivative trading in EMEs between 2004 and 2007. To a certain degree this may well be true. To show that the cultural indices have an additional explanatory power, I use the MSCI developed country index to build a subsample of developed countries only on which I repeat my main regressions. The results can be seen in Appendix O and Appendix P. Obviously my main results concerning the cultural effects on hedging are untouched by the sample restriction and thus by the degree to which a country is developed.

Heckman model

As discussed earlier, there might be a selection bias in my sample due to the fact that annual reports could not be analyzed for all companies. This is either because the reports were simply not available at company websites and the ThomsonReuters Filings database or because they could not be used due to linguistic constraints. To control for this bias I have implemented a Heckman model for the decision to hedge. The corresponding results can be found in table 10.8. The additional variables in the selection equation are a dummy controlling for non IFRS/US-GAAP accounting standard and the number of analyst followings. The latter was retrieved from I/B/E/S. The results show that the above discussed findings are not caused by a sample selection bias. Again, LTO is found to lead to less hedging activities. This impact even shows itself stronger when controlling for this bias.

As discussed earlier it is not possible to control for a selection bias in the regressions for the hedging volume and the usage of asymmetric instruments in a similar way. In the first case, the ratio of censored to uncensored observations is too high for the model to converge. In the second case, the analysis must be reduced to companies that are hedgers and, obviously, this figure is unknown for companies whose reports could not be evaluated.

Table 10.8: Culture and hedging decision - Heckman sample selection

	FX		IR		CO	
	(A)	(B)	(A)	(B)	(A)	(B)
UAI	**-0.0041**	**0.00031**	**-0.0044**	**0.0081****	**-0.0046**	**-0.015*****
	(-1.16)	**(0.077)**	**(-1.34)**	**(2.11)**	**(-1.33)**	**(-2.79)**
MAS	**0.0011**	**0.0033**	**0.0015**	**-0.0073**	**0.0017**	**0.012****
	(0.20)	**(0.61)**	**(0.29)**	**(-1.41)**	**(0.31)**	**(2.13)**
LTO	**-0.011*****	**-0.0085***	**-0.0099*****	**-0.014*****	**-0.012*****	**-0.018*****
	(-2.77)	**(-1.83)**	**(-2.71)**	**(-3.28)**	**(-2.88)**	**(-3.12)**
PDI	**-0.015*****	**-0.0084***	**-0.015*****	**-0.0037**	**-0.015*****	**-0.029*****
	(-3.28)	**(-1.73)**	**(-3.44)**	**(-0.77)**	**(-3.22)**	**(-3.27)**
Accounting std.	0.62***		0.67***		0.64***	
	(4.07)		(4.94)		(4.45)	
Analyst following	0.018		0.018		0.015	
	(1.34)		(1.43)		(1.15)	
Size	0.18***	0.44***	0.17***	0.36***	0.19***	0.48***
	(5.18)	(7.09)	(5.20)	(7.57)	(5.42)	(4.98)
FX exposure	0.058	0.28**				
	(0.69)	(2.04)				
CO exposure					0.045	0.36***
					(1.11)	(3.68)
Leverage	0.072	-0.15	0.070	0.87***	0.10	-0.41
	(0.31)	(-0.54)	(0.31)	(3.45)	(0.44)	(-1.15)
Market-to-book	0.0075	0.051	0.0028	0.018	0.0037	-0.032
	(0.47)	(1.43)	(0.19)	(0.83)	(0.24)	(-1.05)
Profitability	-0.24	-0.91**	-0.11	-0.065	-0.26	-0.42
	(-1.48)	(-2.08)	(-0.88)	(-0.25)	(-1.52)	(-1.23)
Energy import	0.00047	-0.0013	0.00060	-0.0011	0.00055	0.0015
	(0.37)	(-0.93)	(0.55)	(-0.99)	(0.45)	(1.09)
Derivative MR	0.0070	0.0012	0.0065	0.023***	0.0086	0.011
	(1.14)	(0.18)	(1.11)	(3.40)	(1.35)	(1.23)
CRI	-0.092	0.0072	-0.11	0.20**	-0.092	-0.23**
	(-1.19)	(0.093)	(-1.44)	(2.54)	(-1.19)	(-2.08)
ADRI	0.43***	0.075	0.44***	-0.27***	0.42***	-0.12
	(7.32)	(0.97)	(7.49)	(-4.02)	(6.81)	(-1.17)
Closely held	0.53	0.33	0.54	0.55	0.67	0.88
	(1.10)	(0.69)	(1.22)	(1.14)	(1.36)	(1.33)
Inflation	0.015*	-0.017	0.015*	-0.054***	0.015	-0.076*
	(1.71)	(-1.24)	(1.78)	(-3.03)	(1.64)	(-1.68)
Observations	3,518	3,518	3,602	3,602	3,517	3,517
Censored obs.	1046	1046	1070	1070	1046	1046

The table shows results from first (A) and second (B) stage Heckman probit regressions. The dependent variable in the first stage regression is a binary variable indicating if information on hedging of the specific risk factor is available. In the second stage, the hedging dummy is the dependent variable. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 0.1%-, 1%- and 5%-levels, respectively.

Alternative estimation techniques

In addition, I have tested the robustness of my results with help of a population-average and a panel probit model. The corresponding analysis for the decision to hedge can be seen in Appendix R. Both tests do not alter the main findings: Size and exposure have strong positive and LTO a negative impact on the hedging decision. Though not presented here, I similarly find robust negative coefficients for masculinity influencing the decision to use asymmetric derivatives. Unfortunately the results for hedging volumes prove to be less robust: Long-term orientation only presents itself to be significantly reducing the IR hedging volume, leading to no significant coefficients for the two remaining risk types.

Country controls

Furthermore, the results prove to be robust against the inclusion of additional countries. This can be achieved by leaving out the variable "closely held" which is not defined for some countries like, for example, Russia. If I do not include this variable, nine additional countries enter into the regression. Appendix Q shows the corresponding results for the decision to hedge and the hedging volume. As can be seen, the results remain robust. Results for the usage of asymmetric instruments are very similar to the outcome shown in table 10.5 and are thus not reported here.

The impact of US firms on the results

Furthermore, the results might be heavily influenced by firms located in the US. As argued before, about one-third of all firms are from the US. Therefore and to account for the peculiarities of US firms with regard to their FX risk exposure, I have included a US dummy in my main regression. However, I also present a robustness test in which I conservatively exclude all US firms. Results are reported in Table 10.9. The results remain rather unchanged, indicating that they are not biased by peculiarities of energy utilities located in the US.

Table 10.9: Culture and hedging decision - excluding US firms

	FX	IR	CO
UAI	**-0.0053**	**0.0075**	**-0.022*** **
	(-0.93)	**(1.16)**	**(-2.83)**
MAS	**-0.0033**	**-0.024** **	**-0.0052**
	(-0.46)	**(-2.49)**	**(-0.63)**
LTO	**-0.022*** **	**-0.034*** **	**-0.032*** **
	(-3.90)	**(-4.59)**	**(-4.10)**
PDI	**-0.021*** **	**-0.017** **	**-0.041*** **
	(-3.16)	**(-2.42)**	**(-4.48)**
Size	0.64***	0.59***	0.68***
	(7.93)	(9.93)	(8.24)
FX exposure	0.40**		
	(2.13)		
CO exposure			0.45***
			(2.95)
Leverage	-0.34	1.42***	-0.38
	(-0.85)	(3.53)	(-0.63)
Market-to-book	0.050	0.047	-0.031
	(1.44)	(1.24)	(-0.68)
Profitability	2.46**	1.92*	-0.61
	(2.00)	(1.88)	(-0.39)
Energy import	0.23**	0.31**	0.41***
	(2.40)	(2.33)	(3.44)
Derivative MR	0.00021	0.025**	-0.0072
	(0.022)	(2.01)	(-0.55)
CRI	-0.13	0.19	-0.21
	(-1.23)	(1.62)	(-1.39)
ADRI	0.17	-0.36***	-0.073
	(1.54)	(-2.72)	(-0.62)
Closely held	-0.47	0.28	0.51
	(-0.68)	(0.31)	(0.50)
Inflation	-0.037	-0.11***	-0.099**
	(-1.56)	(-2.96)	(-2.04)
Observations	1,098	1,061	875
Pseudo R2	0.42	0.52	0.46

The dependent variable is the decision to hedge. The sample is restricted to firms located outside the US. All models are pooled probit regressions. A detailed description of the variables can be found in Appendix S. All regressions include a constant and time dummies. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 0.1%-, 1%- and 5%-levels, respectively.

10.8 Conclusion

In this chapter, I put forward culture as a novel determinant of corporate hedging behavior. Culture is measured by means of four cultural dimensions developed by Hofstede. Similar to the earlier chapters, I analyze not only one aspect of hedging, but focus on the decision to hedge at all, the hedging volume, and the usage of asymmetric derivatives for hedging. These variables are constructed for the three risk factors foreign exchange rates, interest rates, and commodity prices.

My results indicate that long-term orientation (LTO) and masculinity (MAS) have an impact on hedging decisions. In particular, I find that companies in short-term oriented societies where quick results are highly valued are more likely to hedge and tend to hedge higher volumes. If I investigate the economic importance of LTO, I find that this cultural dimension is among the most important determinants. Only firm size has a consistently higher impact. Next, I analyze the usage of asymmetric derivatives, i.e., options. The results reveal that MAS, measuring in how far assertiveness, materialism, and heroism are valued by a society, reduces the probability that derivatives with optionalities are used. Other country-specific factors have no consistent and robust influence on hedging strategies.

Robustness tests ensure that the results are not driven by legal restriction on derivative usage, derivative market liquidity, a country's level of economic development, or a sample selection bias. Furthermore, I find that the influence of culture remains strong, even after controlling for a country's legal environment. Thus, my results are in line with the view that culture is not (fully) captured by formalized rules like laws.

Overall, this chapter adds a new perspective on the question why firms hedge, indicating that hedging is at least partly driven by the cultural framework. My results clearly suggest that academics should not only include measures for a country's legal environment when conducting international studies, but also for cultural factors. Furthermore, I provide interesting insights for practitioners. If capital market regulators or policy makers want to foster hedging activities in a country, they should keep in mind that firms' decisions for or against hedging are also influenced by culture as a "soft" factor. Thus, it may well be that monetary benefits have little impact. Instead, programs that convince decision makers that hedging provides several economic advantiges seem more promising for creating a hedging culture.

11 Conclusion

The present thesis considers the topic of hedging determinants. I use a unique, hand-collected sample of approximately 3,800 company years for 651 firms across 57 countries (though the sample is clearly dominated by North America and Western Europe), covering the years 2001 to 2009. The focus lies on derivative based hedging for the three market risk types, exchange rate risks (FX), interest rate risks (IR) and commodity price risks (CO). Relevant data on the hedging strategies has been extracted from the companies' annual reports directly and covers the information if a company hedges (hedging dummy), the hedging volume and the decision to use non-linear hedging instruments. I limit my considerations to one single industry, the energy sector, as most companies in this sector are substantially exposed to all three observed market risk types. In addition this allows me to control for the exposures, companies face with regard to the three different market risks in a more thorough way by building financial estimates for the FX, IR and CO exposures. Both uni- and multivariate methods are used to describe and analyze the hedging patterns. The analysis covers the field of firm- and country-level drivers for hedging. In the multivariate regressions, I consider both well-known hedging determinants (like e.g. costs of distress or underinvestment problems) and introduce new drivers in the form of the production technology and aspects of culture.

Across the countries in my sample, I see large differences between the hedging strategies. The probabilities for companies to hedge at least one of the three market risks range from 13 % in Russia to 87 % in Japan and 85 % in the US. When considering sub risks, I see a relatively low chance for FX hedging in the US. This is potentially driven by the lower FX risk exposure

US companies face. On the other hand the probability for CO hedging is particularly high in that country compared to other regions (more than 75 % of all companies in North America use derivatives to hedge CO risks compared to less than 35 % in Western Europe). I do not find any significant change over time for the horizon under consideration.

Regarding well-established financial theories, I do not find significant and consistent proof for companies hedging to lower costs of distress or underinvestment problems. I do however find economies of scale facilitating the hedging decision for larger compared to smaller companies. The magnitude of this effect is huge, ranging from an approximately 10 % chance for hedging among the smallest to a more than 90 % chance for hedging among the largest companies. As the hedging volume is barely affected once hedging has been established, I conclude that the main obstacles for smaller companies to hedge are still the relatively high costs to build up the knowledge and capacities for portfolio hedging.

As an unstudied driver for hedging, I introduce the production technology as a boundary condition for certain hedging strategies. I find evidence that companies use a delta hedging approach to manage their power plants. The corresponding hedging strategies differ with the characteristics these power plants have. Base load power plants can be considered as options (calls on the spread between the fuel and the power price) that are deep-in-the-money. These options lead to companies hedging overall higher volumes as the Delta for these options and thus the optimal hedging volume is relatively high. However, this hypothesis can only be validated in the liquid European power markets. Peak load power plants are at-the-money and thus confront companies with a high Gamma. Consequently, the companies have to frequently rebalance their hedging position as the delta strongly changes with the price of the underlying (the spread). This makes hedging peak load power plants more complex and cost intense and thus several companies decide to outsource the hedging of their peak load power plants: The probability for option usage increases with the share of peak load power plants. In addition, I find evidence for companies cross-hedging their power exposure using gas derivatives in the US, which has a lower power market liquidity in certain areas but is probably the most liquid gas market in the world. When cross-hedging is involved, the optimal hedging ratio is influenced by the correlation between the gas and the power price and the volatilities of both underlyings. This affects the above mentioned relation between base load capacities and commodity hedging volumes and might be a reason why empirical evidence in this market is rather low.

On the country-level, I find proof that the derivative market liquidity and the dependency on energy imports impact the hedging behavior of companies. As a new explanatory variable, I put forward the culture of a country, which also serves as a proxy for the corporate culture. I find evidence that companies are more likely to hedge and in addition that the hedging volumes are higher in short-term oriented cultures. These cultures are characterized by people highly valuing quick results and achievements. Here companies seem to use derivatives to lock in future gains rather than to wait for the gains to actually materialize. In addition, companies in cultures characterized by a high estimation of masculine values tend to use less non-linear derivatives. These non-linear derivatives (like options) have a favorable risk profile as they do not expose the company to a downside risk while allowing the company to benefit from upside developments. Overall, the impact of culture on the decision to hedge is very strong: The impact is second ranked when it comes to economic importance; only company size is consistently more important.

Certain implications can be drawn from the above presented results: First, I propose a more thorough differentiation between studying the hedging decision and the hedging volumes in the future research. My results suggest that the determinants for these two hedging dimensions differ e.g. when it comes to the company size. Second, due to the very low probabilities of small companies to hedge, regulation could try to ease the access to derivative markets for these companies. As no economic reason exists why smaller companies should benefit less from hedging, it should be in the interest of the regulator to ensure that all companies have the same opportunity to engage in derivative based-hedging activities. Third, my findings allow to consider low market liquidity as another obstacle for companies to follow an optimal hedging strategy. In less liquid power markets companies start to cross-hedge using e.g. gas derivatives. Companies would thus profit from a minimum level of market liquidity. Fourth, I find a relation between the production technology and the hedging strategy companies follow. This has so far not been considered in the discussion about our future energy mix. A potential scenario in which renewable technologies are mixed with gas peakers would lead to very different hedging patterns and thus derivative market requirements than a mix including base load technologies like e.g. nuclear energy. Finally, I find evidence that companies choose their hedging strategy not purely to optimize shareholder value but also as a result of the culture they operate in. From the perspective of financial management, this last aspect must be considered as giving way to a suboptimal hedging strategy and thus presenting an obstacle for companies to act in the best way for the shareholders. Regulation is trying to implement incentives for companies to act in the best way for the shareholders. My findings substantiate the opinion that in this legal process the so far rarely discussed cultural impacts on firms' hedging behavior should be taken into consideration.

12 Appendix

Global patterns in derivative hedging

Appendix A: Distribution hedgers vs. non-hedgers across countries - full sample

Country	Observations	All	FX	IR	CO
United States	1,080	85	15	53	81
Russia	270	13	2	6	6
Brazil	243	56	50	25	1
Canada	207	68	42	41	48
Australia	150	58	34	50	19
India	146	25	24	7	0
United Kindom	129	63	49	53	39
Germany	127	53	39	42	35
Italy	110	78	46	77	37
Chile	96	43	35	32	7
Japan	89	87	84	82	49
Argentina	87	48	23	20	16
Hong Kong	85	52	34	49	11
Switzerland	68	53	32	32	28
New Zealand	67	90	70	87	36
Spain	64	95	75	84	41
France	59	64	51	61	20
Malaysia	53	77	55	43	4
China	47	32	17	23	4
Turkey	45	44	38	31	24

This table shows the distribution of hedgers and non hedgers across countries for the full sample. As usual, the following notation for the secured risks holds: ”ALL” (at least one risk has been hedged), ”CO” (commodity risks hedged), ”FX” (exchange rate risks hedged) and ”IR” (interest rate risks hedged). The corresponding numbers except for ”Observations” are given in percentages. The countries are in order of the number of observations in the sample.

Appendix A: Distribution hedgers vs. non-hedgers across countries - full sample [cont.]

Country	Observations	All	FX	IR	CO
United States	1,080	85	15	53	81
Pakistan	42	17	10	14	0
Philippines	39	72	33	56	15
Czech Republic	32	59	41	56	25
Austria	31	65	61	58	32
Thailand	28	54	46	50	0
Peru	26	50	19	46	0
Sweden	26	69	62	65	54
Singapore	25	36	36	36	36
Norway	24	96	75	96	33
Oman	21	86	19	86	0
Lithuania	19	74	32	47	0
Belgium	17	88	29	88	29
Channel Islands	17	71	71	0	0
Greece	16	50	50	50	25
South Korea	16	56	56	56	0
Hungary	15	0	0	0	0
Kenya	14	21	0	21	0
Poland	13	31	31	23	0
Luxembourg	12	58	0	17	42
Colombia	11	73	73	36	0
Denmark	10	20	0	20	0
Finland	9	100	100	100	100
Portugal	9	100	78	78	22
South Africa	9	11	11	11	0
Qatar	7	71	0	71	0
Romania	7	0	0	0	0
Sri Lanka	7	57	57	57	0
Saudi Arabia	6	50	17	50	0
Bangladesh	5	0	0	0	0
Jordan	5	0	0	0	0
Ukraine	4	0	0	0	0
Vietnam	4	0	0	0	0
Zambia	4	25	25	0	0
Abu Dhabi	3	100	100	100	67
Palestine	3	0	0	0	0
Israel	2	50	50	50	0
Venezuela	2	100	100	100	0
Total ex US	2,682	53	38	40	20
Total	3,762	63	31	44	38

This table shows the distribution of hedgers and non hedgers across countries for the full sample. As usual, the following notation for the secured risks holds: ”ALL” (at least one risk has been hedged), ”CO” (commodity risks hedged), ”FX” (exchange rate risks hedged) and ”IR” (interest rate risks hedged). The corresponding numbers except for ”Observations” are given in percentages. The countries are in order of the number of observations in the sample.

Company financials and hedging

Appendix B: Firm-level determinants: Definition of variables used

Variable	Definition	Source
Hedging variables		
Hedging dummy	Dummy variable indicating if a company hedged one of the three risk types (exchange rate, interest rate and commodity price risks) in a certain year.	Annual reports
Hedging volume	Notional hedging volume of a company divided by total assets in a certain year, winsorized on a 1% and 99% level.	Annual reports, Worldscope
Option usage	Dummy variable indicating if a company uses derivatives with optionalities for hedging purposes in a certain year.	Annual reports
Variables related to production technologies		
Share of base (mid, peak, stochastic)	Share of installed capacity of base load technologies (see Appendix C) divided by total installed capacity.	Platts WEPP
Run-up time	Capacity weighted average of run-up times of a firm's production portfolio.	see Appendix C
Ramp-up costs	Capacity weighted average of ramp-up costs of a firm's production portfolio.	see Appendix C
Other firm-specific variables		
FX exposure	Cost of goods sold divided by total assets for non-US companies and zero for US companies, winsorized on a 1% and 99% level.	Worldscope
CO exposure	Cost of goods sold plus net sales or revenues divided by total assets, winsorized on a 1% and 99% level.	Worldscope
Size	Company size measured as normal logarithm of total assets in thousand U.S. dollar, winsorized on a 1% and 99% level.	Worldscope
Leverage	Total debt divided by sum of total debt and common equity, winsorized on a 1% and 99% level.	Worldscope
Profitability	EBIT divided by total assets, winsorized on a 1% and 99% level.	Worldscope
Market-to-book	Market capitalization divided by market value of common equity, winsorized on a 1% and 99% level.	Worldscope
Free cash flow	Cash flow from operations minus CAPEX divided by total assets, winsorized on a 1% and 99% level.	Worldscope

The impact of production technology

Appendix C: Classification of production technologies

Category	Technology	Run-up time [hours]	Ramp-up costs [€/ MW]
Base	Nuclear	40.00[A]	132.92[E]
	Coal non-flex (lignite)	6.00[A]	35.75[E]
	Geothermal	-[D]	-[D]
	Biogas	0.25[B]	46.96[D]
	Biomass	2.00[B]	46.96[D]
	Other fossil	3.00[D]	46.96[D]
Mid	Waste	12.00[B]	46.96[D]
	Coal	3.00[A]	46.96[E]
	CCGT	1.50[A]	32.22[E]
	Running river	-[D]	-[D]
Peak	Oil	0.08	25.45[E]
	Gas	0.25[C]	32.22[D]
	Pump storage	0.10[A]	-[D]
Stochastic	Solar	-[D]	-[D]
	Wind	-[D]	-[D]

The table and the following information has been taken with only few adaptations from Reinartz and Schmid (2012). The technologies have been classified based on approximative annual load factors. Run-up times refer to warm-starts for thermal power plants. Sources for the estimates are: Eurelectric (2011) (marked with [A]), Danish Energy Agency (2012) (marked with [B]), Swider (2006) (marked with [C]). The run-up time of oil plants is based on company websites e.g. lifecycle power solution provider Wärtsilä. Figures marked with [D] are based on own assumptions. Other fossile power plants are assumed to have a run-up time that equals the average of gas and lignite power plants. Stochastic power plants, running river and geothermal plants are assumed to have zero run-up time. Ramp-up costs are based on Boldt, Hankel, Laurisch, Lutterbecl, Oei, Sander, Schroeder, Schweter, Sommer, and Sulerz (2012) (marked with [E]) and own assumptions (marked with [D]), e.g. ramp-up costs for gas power plants equal those of CCGTs. Furthermore we assume zero ramp-up costs for geothermal, running river, pump storage, solar and wind. For biomass, biogas, fossil and waste we assume equal ramp-up costs as for coal power plants.

Country-level determinants

Appendix D: Country-level determinants: Hedging volume

	FX	IR	CO
Size	0.0097***	0.0094***	0.062**
	(4.36)	(3.32)	(2.45)
Leverage	-0.053**	0.13***	-0.55**
	(-2.56)	(3.70)	(-2.57)
Market to book	0.0022*	0.0025*	0.0074
	(1.87)	(1.91)	(0.25)
Profitability	0.0023	0.0028	0.24
	(0.24)	(0.20)	(1.16)
Energy import	0.000097	-0.00028*	0.00098
	(1.50)	(-1.90)	(1.20)
Derivative market rank	0.000050	0.0017**	-0.0047
	(0.089)	(2.29)	(-0.50)
CRI	0.0023	0.016**	-0.12*
	(0.46)	(2.04)	(-1.73)
ADRI	0.0091**	-0.011*	-0.068
	(1.97)	(-1.73)	(-1.07)
Closely held	-0.022	-0.00034	-1.35
	(-0.35)	(-0.0037)	(-1.27)
Inflation	-0.0011	-0.0014	-0.017
	(-0.92)	(-1.46)	(-1.12)
Observations	1,615	1,498	1,148
R-squared	0.144	0.200	0.065

The following table presents results from pooled OLS regressions. The output shows the influence of firm- and country-level variables on the hedging volume. All regressions include time dummies and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix E: Country-level determinants: Simultaneous estimation model

	FX	IR	CO
Size	0.46***	0.40***	0.42***
	(10.8)	(11.0)	(9.78)
Leverage	-0.25	0.90***	-0.50
	(-0.97)	(3.40)	(-1.47)
Market to book	0.054	0.027	-0.0052
	(1.58)	(1.36)	(-0.18)
Profitability	-0.77*	-0.25	0.36
	(-1.91)	(-1.15)	(0.78)
Energy import	-0.0026**	-0.0032***	-0.0027**
	(-2.47)	(-3.46)	(-2.18)
Derivative market rank	0.0097	0.028***	0.034***
	(1.59)	(4.12)	(4.14)
CRI	-0.026	0.066	-0.077
	(-0.39)	(0.88)	(-0.78)
ADRI	0.088	-0.16**	-0.19***
	(1.41)	(-2.29)	(-3.00)
Closely held	0.33	0.69	0.66
	(0.66)	(1.25)	(0.97)
Inflation	-0.0050	-0.033**	-0.030
	(-0.38)	(-2.11)	(-1.18)
Observations	2,556	2,556	2,556

The following table presents simultaneous estimation of pooled probit regressions on the impact of firm- and country-level variables on hedging decisions. All regressions include time dummies and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix F: Country-level determinants: Including exposure figures

	FX	IR	CO
Size	0.43***	0.43***	0.45***
	(10.2)	(10.8)	(9.71)
FX exposure	0.096**		
	(2.04)		
CO exposure			0.13***
			(4.34)
Leverage	-0.0051	0.083***	-0.036
	(-0.22)	(3.32)	(-1.10)
Market to book	0.045	0.020	-0.027
	(1.50)	(0.93)	(-1.05)
Profitability	-0.13**	-0.012	0.023
	(-2.14)	(-0.24)	(0.26)
Energy import	-0.064**	-0.094***	-0.078**
	(-2.41)	(-3.61)	(-2.28)
Derivative market rank	0.061*	0.19***	0.23***
	(1.70)	(4.15)	(4.17)
CRI	-0.0097	0.028	-0.028
	(-0.41)	(0.93)	(-0.76)
ADRI	0.037*	-0.067**	-0.073***
	(1.66)	(-2.34)	(-2.86)
Closely held	0.027	0.062	0.073
	(0.64)	(1.27)	(1.12)
Inflation	-0.015	-0.094*	-0.14
	(-0.43)	(-1.87)	(-1.55)
Observations	2,495	2,556	2,494
Pseudo R2	0.31	0.29	0.5

The following table presents marginal effects for pooled probit regressions. Note that all variables except for the dividend dummy have been standardized. All regressions include time dummies and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix G: Country-level determinants: Definition of variables used

Variable	Definition	Source
Hedging decision	Dummy variable, indicating if a company hedged one of the three risk types (exchange rate, interest rate and commodity price risks) in a certain year.	Annual reports, 10-K reports
Hedging volume	Continuous variable, showing the notional hedging volume of a company for one of the three risk types (exchange rate, interest rate and commodity price risks) in a certain year. The values have been normalized by total assets taken from Thomson Reuters (2011) and winsorized on a 1% and 99% level.	Annual reports, 10-K reports
Hedging instruments	Dummy variable, indicating if a company uses derivatives with optionalities for hedging purposes in a certain year.	Annual reports, 10-K reports
Size	Company size measured as normal logarithm of total assets in thousand U.S. dollar, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
FX exposure	Cost of goods sold divided by total assets for non-US companies and "0" for US companies, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
CO exposure	Cost of goods sold plus net sales or revenues divided by total assets, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
Leverage	Total debt divided by sum of total debt and common equity, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
Market-to-book	Market capitalization divided by common equity, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
Profitability	EBIT divided by total assets, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
Trading volume	Normal logarithm of country wide imports plus exports, each standardized by GDP, winsorized on a 1% and 99% level.	World Bank (2012)
Net energy import	Energy import minus export divided by energy consumption, winsorized on a 1% and 99% level.	World Bank (2012)
Derivative market rank	Rank of sum of national daily averages of FX and IR derivative market turnover divided by GDP and adjusted for local inter-dealer double-counting.	Bank for International Settlement (2010a)
Lender protection (CRI)	Creditor rights index.	Djankov et al. (2007)
Shareholder protection (ADRI)	Revised anti director rights index.	Djankov et al. (2008)
Rule of law	Index measuring the effectiveness of laws for contract enforcement and public rights.	Kaufmann et al. (2008)
Political stability	Index measuring the overall political stability of a country.	(Kaufmann et al., 2008)
Regulatory quality	Index measuring the governmental ability to implement sound regulations.	Kaufmann et al. (2008)
Closely held	Percent of market capitalization closely held.	Dahlquist et al. (2003)
Inflation	Annualized inflation, winsorized on a 1% and 99% level.	World Bank (2012)
GDP per capita	Normal logarithm of GDP per capita in thousand U.S. dollars, winsorized on a 1% and 99% level.	World Bank (2012)

This table shows the definitions of all variables used in the analysis on country-level determinants.

Appendix G

Variable	Definition	Source
Rule of law	Index measuring the effectiveness of laws for contract enforcement and public rights.	Kaufmann et al. (2008)
Political stability	Index measuring the overall political stability of a country.	(Kaufmann et al., 2008)
Regulatory quality	Index measuring the governmental ability to implement sound regulations.	Kaufmann et al. (2008)
Closely held	Percent of market capitalization closely held.	Dahlquist et al. (2003)
Inflation	Annualized inflation, winsorized on a 1% and 99% level.	World Bank (2012)
GDP per capita	Normal logarithm of GDP per capita in thousand U.S. dollars, winsorized on a 1% and 99% level.	World Bank (2012)

This table shows the definitions of all variables used in the analysis on country-level determinants.

The relation of culture and hedging

Appendix H: Culture: Simultaneous estimation model

	FX	IR	CO
UAI	**0.00067**	**0.0093****	**-0.015*****
	(0.17)	**(2.23)**	**(-2.92)**
MAS	**0.0034**	**-0.0051**	**0.012****
	(0.61)	**(-0.92)**	**(2.09)**
LTO	**-0.010****	**-0.019*****	**-0.020*****
	(-2.35)	**(-4.07)**	**(-3.73)**
PDI	**-0.012****	**-0.0068**	**-0.034*****
	(-2.54)	**(-1.36)**	**(-4.94)**
Size	0.50***	0.43***	0.55***
	(10.1)	(10.5)	(11.7)
FX exposure	0.32**		
	(2.41)		
CO exposure			0.39***
			(4.55)
Leverage	-0.15	0.89***	-0.48
	(-0.54)	(3.25)	(-1.28)
Market-to-book	0.058	0.029	-0.037
	(1.54)	(1.34)	(-1.13)
Profitability	-0.98**	-0.15	-0.51
	(-2.14)	(-0.41)	(-1.51)
Energy import	-0.072	-0.045	0.11
	(-0.77)	(-0.54)	(1.23)
Derivative MR	0.0028	0.027***	0.012
	(0.41)	(3.82)	(1.28)
CRI	-0.00097	0.20**	-0.25**
	(-0.013)	(2.38)	(-2.32)
ADRI	0.17**	-0.20***	-0.040
	(2.35)	(-2.69)	(-0.55)
Closely held	0.38	0.60	0.89
	(0.80)	(1.12)	(1.33)
Inflation	-0.015	-0.059***	-0.083**
	(-1.03)	(-3.28)	(-2.00)
Observations	2,478	2,478	2,478

The dependent variables are the decision to hedge. All three models have been estimated simultaneously to account for interaction between hedging decisions concerning the three market risk types. A detailed description of the variables can be found in Appendix S. All regressions include time dummies and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix I: Culture: Hedging decision / volume - countries with hedgers and non-hedgers

	Hedging decision			Hedging volume		
	FX	IR	CO	FX	IR	CO
UAI	**-0.00026**	**0.0073***	**-0.018*****	**0.00029**	**0.0020*****	**-0.0058****
	(-0.061)	**(1.75)**	**(-3.34)**	**(0.52)**	**(2.61)**	**(-2.34)**
MAS	**0.0044**	**-0.0067**	**0.018****	**-0.00059**	**-0.00040**	**-0.0021**
	(0.67)	**(-1.09)**	**(2.57)**	**(-0.73)**	**(-0.38)**	**(-0.52)**
LTO	**-0.011****	**-0.020*****	**-0.021*****	**0.000088**	**-0.0028*****	**-0.0050***
	(-2.37)	**(-4.14)**	**(-3.67)**	**(0.15)**	**(-3.77)**	**(-1.67)**
PDI	**-0.0079**	**-0.0030**	**-0.026*****	**-0.00099**	**0.000028**	**-0.012*****
	(-1.62)	**(-0.57)**	**(-3.65)**	**(-1.62)**	**(0.035)**	**(-2.85)**
Size	0.48***	0.43***	0.52***	0.043***	0.037***	0.16***
	(9.50)	(10.0)	(11.1)	(6.72)	(5.29)	(5.22)
FX exposure	0.32**			0.049**		
	(2.34)			(2.09)		
CO exposure			0.39***			0.16**
			(4.48)			(2.53)
Leverage	0.019	1.09***	-0.39	-0.042	0.29***	-0.26
	(0.069)	(3.89)	(-1.03)	(-0.82)	(4.79)	(-1.36)
Market-to-book	0.053	0.023	-0.036	0.0044	0.0042	-0.0047
	(1.41)	(0.96)	(-1.11)	(1.01)	(1.15)	(-0.23)
Profitability	-0.97**	-0.078	-0.30	0.22	0.24**	0.17
	(-2.05)	(-0.25)	(-0.68)	(1.48)	(2.26)	(0.46)
Energy import	-0.052	-0.027	0.11	-0.0035	-0.020	0.12***
	(-0.49)	(-0.30)	(1.11)	(-0.32)	(-1.16)	(2.70)
Derivative MR	0.012*	0.038***	0.027***	0.0016	0.0064***	0.0038
	(1.70)	(5.10)	(2.60)	(1.54)	(4.46)	(0.65)
CRI	0.0010	0.20**	-0.24**	0.012	0.063***	-0.11*
	(0.013)	(2.29)	(-2.13)	(1.14)	(3.94)	(-1.68)
ADRI	0.14*	-0.26***	-0.13*	0.048***	-0.035**	-0.054
	(1.86)	(-3.38)	(-1.69)	(3.17)	(-2.15)	(-1.04)
Closely held	0.81*	1.09**	1.59**	0.29***	0.33***	0.22
	(1.66)	(2.05)	(2.17)	(5.11)	(3.82)	(0.76)
Inflation	-0.012	-0.053***	-0.063	-0.0020	-0.0093***	-0.031
	(-0.83)	(-2.74)	(-1.48)	(-0.72)	(-2.61)	(-1.45)
Observations	2,310	2,367	2,309	1,435	1,363	986
(Pseudo) R2	0.31	0.33	0.56	0.74	0.82	0.37

The dependent variables are the decision to hedge and the hedged volume. The first three models are pooled probit, the last pooled tobit regressions with censoring at zero and one. The sample is restricted to those countries classified as developed countries under the annual MSCI developed countries index. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a U.S. dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix J: Culture: Hedging instruments - countries with hedgers and non-hedgers

	FX	IR	CO
UAI	**-0.017***	**0.0037**	**-0.00041**
	(-1.91)	**(0.44)**	**(-0.035)**
MAS	**-0.020***	**-0.026****	**-0.032***
	(-1.86)	**(-2.53)**	**(-1.79)**
LTO	**0.019***	**0.0098**	**0.014**
	(1.82)	**(1.26)**	**(0.99)**
PDI	**-0.000027**	**-0.0049**	**-0.048****
	(-0.0026)	**(-0.49)**	**(-2.34)**
Size	0.13	0.28***	0.30***
	(1.33)	(3.38)	(3.48)
FX exposure	-0.89*		
	(-1.92)		
CO exposure			0.53***
			(3.56)
Leverage	-1.14*	0.91	0.55
	(-1.71)	(1.41)	(0.77)
Market-to-book	-0.070	0.063	-0.0074
	(-1.30)	(1.41)	(-0.12)
Profitability	-3.18	1.27	0.30
	(-1.53)	(0.94)	(0.20)
Energy import	0.054	-0.11	-0.16
	(0.37)	(-0.80)	(-0.54)
Derivative MR	-0.0097	-0.0021	0.038
	(-0.61)	(-0.15)	(1.62)
CRI	-0.026	0.26*	0.080
	(-0.16)	(1.67)	(0.44)
ADRI	-0.15	-0.18	-0.75***
	(-0.76)	(-0.99)	(-3.07)
Closely held	-0.33	0.61	-1.38
	(-0.39)	(0.82)	(-1.12)
Inflation	0.028	-0.075	-0.031
	(1.60)	(-0.92)	(-0.45)
Observations	623	963	869
Pseudo R2	0.12	0.17	0.20

The dependent variable is the decision to use asymmetric instruments. The models are pooled probit. The sample is restricted to those countries classified as developed countries under the annual MSCI developed countries index. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix K: Culture: Hedging decision / volume - legal framework

	Hedging decision			Hedging volume		
	FX	IR	CO	FX	IR	CO
UAI	**-0.0018**	**0.0087****	**-0.016*****	**-0.0018*****	**0.00021**	**-0.0077*****
	(-0.42)	**(2.01)**	**(-3.05)**	**(-2.86)**	**(0.30)**	**(-2.71)**
MAS	**0.0032**	**-0.0037**	**0.019*****	**-0.0011**	**-0.0010**	**-0.0036**
	(0.52)	**(-0.62)**	**(2.67)**	**(-1.46)**	**(-1.15)**	**(-0.87)**
LTO	**-0.014*****	**-0.016*****	**-0.020*****	**-0.0026*****	**-0.0046*****	**-0.0072****
	(-2.77)	**(-3.18)**	**(-3.01)**	**(-4.02)**	**(-5.17)**	**(-2.15)**
PDI	**-0.0077**	**-0.0032**	**-0.019*****	**-0.0022*****	**-0.0019****	**-0.010****
	(-1.51)	**(-0.54)**	**(-2.59)**	**(-3.05)**	**(-2.11)**	**(-2.45)**
Size	0.49***	0.43***	0.54***	0.055***	0.045***	0.17***
	(10.0)	(10.5)	(11.6)	(6.59)	(6.15)	(5.82)
FX exposure	0.33**	0.93***		0.035		
	(2.36)	(3.47)		(1.51)		
CO exposure			0.39***			0.17***
			(4.83)			(2.82)
Leverage	-0.12	0.93***	-0.51	-0.076	0.24***	-0.25
	(-0.42)	(3.47)	(-1.38)	(-1.45)	(4.62)	(-1.41)
Market-to-book	0.055	0.020	-0.038	0.0052	0.0037	-0.0090
	(1.49)	(0.84)	(-1.10)	(1.24)	(1.07)	(-0.43)
Profitability	-0.97**	-0.045	-0.38	0.27	0.23**	0.31
	(-2.06)	(-0.14)	(-0.81)	(1.64)	(2.24)	(0.69)
Energy import	0.0098	-0.12	0.10	0.049***	0.0096	0.17***
	(0.097)	(-1.35)	(0.89)	(4.00)	(0.64)	(3.17)
Regulatory quality	-0.18	0.69***	0.59	-0.038	0.13***	0.19
	(-0.75)	(2.82)	(1.38)	(-0.75)	(2.68)	(0.87)
Rule of law	0.34	-0.015	0.53*	0.011	-0.094**	0.12
	(1.34)	(-0.052)	(1.79)	(0.23)	(-2.04)	(0.49)
Political stability	0.22*	-0.29**	-0.18	0.052**	0.0089	0.045
	(1.69)	(-1.97)	(-0.67)	(2.10)	(0.32)	(0.31)
Derivative MR	-0.0098	0.011	-0.020	-0.0016	0.0017	-0.013*
	(-1.00)	(1.08)	(-1.56)	(-1.04)	(1.14)	(-1.82)
CRI	-0.012	0.16*	-0.24**	-0.012	0.031**	-0.14**
	(-0.15)	(1.85)	(-2.24)	(-1.19)	(2.14)	(-2.09)
ADRI	0.16**	-0.24***	-0.11	0.031**	-0.039***	-0.071
	(2.12)	(-3.05)	(-1.45)	(2.39)	(-2.59)	(-1.32)
Closely held	0.25	0.49	0.62	-0.052	-0.011	-0.45
	(0.54)	(0.89)	(0.86)	(-0.69)	(-0.11)	(-1.23)
Inflation	-0.0045	-0.050***	-0.050	-0.0026	-0.0093**	-0.020
	(-0.32)	(-2.72)	(-1.25)	(-0.93)	(-2.55)	(-1.10)
Observations	2,463	2,524	2,462	1,552	1,483	1,085
(Pseudo) R2	0.32	0.33	0.56	0.88	1.03	0.41

The dependent variables are the decision to hedge and the hedging volume. The first three models are pooled probit, the last three pooled tobit regressions with censoring at zero and one. Additional variables capturing the legal framework have been included. A detailed description of variables is given in Appendix S. All regressions include time dummies and a US dummy. T-statistics are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix L: Culture: Hedging instruments - legal framework

	FX	IR	CO
UAI	**-0.022*** **	**0.0062**	**0.0072**
	(-3.23)	**(0.81)**	**(0.62)**
MAS	**-0.024** **	**-0.031*** **	**-0.047** **
	(-2.26)	**(-3.02)**	**(-2.02)**
LTO	**0.012**	**0.010**	**0.024**
	(1.19)	**(1.19)**	**(1.30)**
PDI	**-0.0087**	**-0.026***	**-0.070*** **
	(-0.76)	**(-1.73)**	**(-3.69)**
Size	0.19**	0.32***	0.30***
	(2.07)	(3.53)	(3.46)
FX exposure	-0.92**		
	(-2.26)		
CO exposure			0.55***
			(3.63)
Leverage	-0.81	0.93	0.60
	(-1.45)	(1.51)	(0.84)
Market-to-book	-0.056	0.057	-0.013
	(-1.07)	(1.36)	(-0.20)
Profitability	-3.65*	0.14	0.41
	(-1.84)	(0.10)	(0.28)
Energy import	0.24*	-0.10	-0.25
	(1.81)	(-0.76)	(-0.70)
Regulatory quality	-0.65	-0.20	0.26
	(-1.62)	(-0.45)	(0.49)
Rule of law	0.68	-0.72	-0.63
	(1.60)	(-1.27)	(-0.71)
Political stability	-0.027*	0.028	0.045*
	(-1.72)	(1.55)	(1.89)
Derivative MR	-0.16	0.19	0.017
	(-1.13)	(1.22)	(0.078)
CRI	-0.13	0.016	-0.55*
	(-0.98)	(0.10)	(-1.85)
ADRI	-2.77***	0.36	-1.31
	(-3.20)	(0.45)	(-0.96)
Closely held	0.033**	-0.094*	-0.049
	(2.36)	(-1.86)	(-0.66)
Inflation	-1.68***	0.077	0.50
	(-2.86)	(0.13)	(0.52)
Observations	809	1,131	900
Pseudo R2	0.19	0.17	0.22

The dependent variable is the decision ot use asymmetric hedging instruments. All models are pooled probit regressions. The sample is restricted to hedgers and includes additional legal variables. A detailed description of variables is given in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels.

Appendix M: Culture: Hedging decision / volume - derivative market volume

	Hedging decision			Hedging volume		
	FX	IR	CO	FX	IR	CO
UAI	**-0.0021**	**0.0058**	**-0.019*****	**-0.0016****	**0.00011**	**-0.0089*****
	(-0.49)	**(1.37)**	**(-3.31)**	**(-2.40)**	**(0.15)**	**(-3.01)**
MAS	**0.0028**	**-0.0091**	**0.012****	**-0.0011**	**-0.0014***	**-0.0057**
	(0.50)	**(-1.64)**	**(2.05)**	**(-1.50)**	**(-1.74)**	**(-1.54)**
LTO	**-0.011****	**-0.016*****	**-0.020*****	**-0.0022*****	**-0.0049*****	**-0.0078****
	(-2.38)	**(-3.39)**	**(-3.57)**	**(-3.73)**	**(-6.29)**	**(-2.42)**
PDI	**-0.014*****	**-0.015*****	**-0.038*****	**-0.0024*****	**-0.0027*****	**-0.016*****
	(-3.44)	**(-3.10)**	**(-6.01)**	**(-4.05)**	**(-3.88)**	**(-4.11)**
Size	0.50***	0.43***	0.55***	0.055***	0.045***	0.17***
	(10.1)	(10.5)	(11.6)	(6.74)	(6.26)	(5.86)
FX exposure	0.29**			0.032		
	(2.09)			(1.37)		
CO exposure			0.38***			0.17**
			(4.23)			(2.51)
Leverage	-0.17	0.91***	-0.55	-0.080	0.24***	-0.25
	(-0.60)	(3.40)	(-1.48)	(-1.60)	(4.46)	(-1.37)
Market-to-book	0.052	0.019	-0.036	0.0040	0.0027	-0.0084
	(1.38)	(0.86)	(-1.11)	(0.97)	(0.79)	(-0.40)
Profitability	-1.04**	-0.19	-0.54	0.29*	0.19**	0.24
	(-2.30)	(-0.75)	(-1.54)	(1.90)	(2.08)	(0.55)
Energy import	-0.052	-0.018	0.14	0.039***	0.026**	0.19***
	(-0.55)	(-0.21)	(1.52)	(3.19)	(1.99)	(3.64)
Derivative MR	-1.28	1.47	-0.96	-0.23	0.27	-0.83
	(-1.00)	(1.14)	(-0.54)	(-1.06)	(1.32)	(-0.83)
CRI	0.011	0.23***	-0.22**	-0.011	0.037***	-0.14**
	(0.14)	(2.63)	(-2.06)	(-1.12)	(2.67)	(-1.97)
ADRI	0.17**	-0.15**	-0.012	0.030**	-0.035**	-0.048
	(2.52)	(-2.11)	(-0.17)	(2.50)	(-2.49)	(-0.97)
Closely held	0.027	-0.044	0.33	-0.036	-0.043	-0.47
	(0.053)	(-0.083)	(0.48)	(-0.40)	(-0.44)	(-1.29)
Inflation	-0.020	-0.079***	-0.11**	-0.0040	-0.013***	-0.043**
	(-1.25)	(-3.25)	(-2.34)	(-1.39)	(-3.12)	(-2.31)
Observations	2,479	2,540	2,478	1,561	1,492	1,094
(Pseudo) R2	0.32	0.31	0.55	0.89	1.01	0.40

The dependent variables are the decision to hedge and the hedged volume. The first three models are pooled probit, the last three pooled tobit regressions with censoring at zero and one. The sample is restricted to those countries classified as developed countries under the annual MSCI developed countries index. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix N: Culture: Hedging instruments - derivative market volume

	FX	IR	CO
UAI	**-0.026*** **	**0.0048**	**0.0054**
	(-3.71)	**(0.65)**	**(0.48)**
MAS	**-0.016** **	**-0.024*** **	**-0.041** **
	(-1.97)	**(-2.69)**	**(-2.22)**
LTO	**0.0063**	**0.0080**	**0.021**
	(0.75)	**(1.06)**	**(1.35)**
PDI	**-0.0086**	**-0.011**	**-0.064*** **
	(-0.97)	**(-1.23)**	**(-3.56)**
Size	0.20**	0.27***	0.30***
	(2.07)	(3.34)	(3.49)
FX exposure	-0.78**		
	(-1.96)		
CO exposure			0.54***
			(3.61)
Leverage	-1.12*	0.93	0.58
	(-1.87)	(1.59)	(0.83)
Market-to-book	-0.050	0.064	-0.0077
	(-0.92)	(1.47)	(-0.12)
Profitability	-3.74*	0.69	0.35
	(-1.84)	(0.55)	(0.24)
Energy import	0.19	-0.070	-0.18
	(1.38)	(-0.50)	(-0.55)
Derivative MR	-5.20***	0.042	5.38*
	(-2.80)	(0.017)	(1.72)
CRI	-0.23	0.21	0.0087
	(-1.63)	(1.40)	(0.041)
ADRI	-0.11	-0.081	-0.59***
	(-0.88)	(-0.53)	(-2.85)
Closely held	-3.16***	0.027	-0.96
	(-3.61)	(0.030)	(-0.65)
Inflation	0.040**	-0.054	-0.075
	(2.45)	(-0.95)	(-1.15)
Observations	818	1,140	900
Pseudo R2	0.18	0.16	0.22

The dependent variable is the decision to use asymmetric hedging instruments. The first three models are pooled probit, the last three pooled tobit regressions. The sample is restricted to those countries classified as developed countries under the annual MSCI developed countries index. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix O: Culture: Hedging decision / volume - developed countries only

	Hedging decision			Hedging volume		
	FX	IR	CO	FX	IR	CO
UAI	**-0.017***	**0.0032**	**-0.037*****	**-0.0024*****	**-0.00050**	**-0.011*****
	(-1.87)	**(0.34)**	**(-3.30)**	**(-3.13)**	**(-0.48)**	**(-2.68)**
MAS	**0.00042**	**-0.023****	**0.0011**	**-0.0012**	**-0.00084**	**-0.0065**
	(0.041)	**(-2.35)**	**(0.12)**	**(-1.31)**	**(-0.76)**	**(-1.54)**
LTO	**-0.028*****	**-0.031*****	**-0.016***	**-0.0023****	**-0.0056*****	**-0.0028**
	(-3.17)	**(-3.29)**	**(-1.80)**	**(-2.36)**	**(-5.21)**	**(-0.90)**
PDI	**-0.033*****	**-0.0058**	**-0.036*****	**-0.0022****	**-0.00086**	**-0.016*****
	(-3.21)	**(-0.57)**	**(-2.96)**	**(-2.01)**	**(-0.80)**	**(-3.17)**
Size	0.80***	0.51***	0.78***	0.057***	0.042***	0.18***
	(7.79)	(6.19)	(8.90)	(5.76)	(5.44)	(5.85)
FX exposure	0.84***			0.069***		
	(3.54)			(3.23)		
CO exposure			0.89***			0.31***
			(5.25)			(4.36)
Leverage	-0.99**	0.92**	-1.75***	-0.089	0.28***	-0.48**
	(-2.12)	(2.15)	(-2.79)	(-1.58)	(4.42)	(-2.30)
Market-to-book	-0.084**	0.000032	-0.14*	-0.0039	0.00080	-0.035
	(-1.96)	(0.00084)	(-1.76)	(-0.92)	(0.20)	(-1.46)
Profitability	0.87	1.96**	-0.76	0.11	0.29**	0.11
	(0.88)	(2.22)	(-0.65)	(1.12)	(2.46)	(0.28)
Energy import	0.33***	0.22	0.14	0.034***	0.021	0.14**
	(2.59)	(1.51)	(1.10)	(2.81)	(1.44)	(2.32)
Derivative MR	-0.033**	-0.024	-0.044**	-0.0018	0.00041	-0.012
	(-2.15)	(-1.52)	(-2.19)	(-1.46)	(0.24)	(-1.41)
CRI	-0.31***	0.26**	-0.22	-0.0095	0.039**	-0.15**
	(-2.66)	(2.05)	(-1.39)	(-0.77)	(2.34)	(-2.33)
ADRI	0.32*	-0.27	0.14	0.011	-0.043**	0.019
	(1.68)	(-1.44)	(0.88)	(0.93)	(-2.33)	(0.27)
Closely held	-0.57	-0.27	1.05	0.0043	-0.037	-0.29
	(-0.66)	(-0.30)	(0.91)	(0.054)	(-0.35)	(-0.75)
Inflation	-0.066	-0.0093	-0.058	-0.016	-0.0092	-0.044*
	(-0.84)	(-0.16)	(-0.78)	(-1.14)	(-1.12)	(-1.75)
Observations	1,185	1,171	842	1,185	1,171	842
(Pseudo) R2	0.58	0.44	0.56	1.68	1.12	0.41

The dependent variables are the decision to hedge and the hedged volume. The first three models are pooled probit, the last three pooled tobit regressions with censoring at zero and one. The sample is restricted to those countries classified as developed countries under the annual MSCI developed countries index. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix P: Culture: Hedging instruments - developed countries only

	FX	IR	CO
UAI	**-0.013**	**0.010**	**0.0023**
	(-1.30)	**(1.11)**	**(0.19)**
MAS	**-0.038*** **	**-0.031*** **	**-0.039** **
	(-2.82)	**(-2.68)**	**(-2.44)**
LTO	**0.022***	**0.0098**	**0.016**
	(1.81)	**(0.99)**	**(1.17)**
PDI	**-0.025** **	**-0.014**	**-0.057*** **
	(-2.20)	**(-1.10)**	**(-2.91)**
Size	0.17*	0.28***	0.30***
	(1.68)	(3.12)	(3.49)
FX exposure	-1.06**		
	(-2.11)		
CO exposure			0.55***
			(3.45)
Leverage	-0.46	1.34**	0.57
	(-0.65)	(2.00)	(0.79)
Market-to-book	-0.24**	0.039	-0.012
	(-1.98)	(0.81)	(-0.18)
Profitability	-0.95	1.95	0.44
	(-0.35)	(1.50)	(0.30)
Energy import	0.25	-0.032	-0.14
	(1.49)	(-0.19)	(-0.49)
Derivative MR	-0.0094	0.015	0.036
	(-0.51)	(0.89)	(1.56)
CRI	-0.18	0.28	0.052
	(-1.05)	(1.64)	(0.30)
ADRI	-0.18	-0.23	-0.70***
	(-0.96)	(-1.20)	(-2.92)
Closely held	-2.50**	0.043	-1.69
	(-2.52)	(0.048)	(-1.42)
Inflation	0.11	-0.058	-0.047
	(1.13)	(-0.51)	(-0.63)
Observations	582	981	878
Pseudo R2	0.22	0.17	0.21

The dependent variable is the decision to use asymmetric hedging instruments. All models are pooled probit regressions. The sample is restricted to hedgers and those countries classified as developed countries under the annual MSCI developed countries index. A detailed description of the variables can be found in Appendix S. All regressions include a constant, time dummies, and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix Q: Culture: Hedging decision - excluding closely held

	FX	IR	CO
UAI	**-0.0030**	**0.0089****	**-0.0095****
	(-0.82)	**(2.37)**	**(-1.97)**
MAS	**0.0055**	**-0.012****	**0.0053**
	(1.05)	**(-2.20)**	**(0.97)**
LTO	**-0.015*****	**-0.015*****	**-0.0083**
	(-4.06)	**(-3.74)**	**(-1.53)**
PDI	**-0.014*****	**-0.0078**	**-0.027*****
	(-3.21)	**(-1.63)**	**(-4.31)**
Size	0.51***	0.42***	0.51***
	(10.4)	(10.6)	(12.0)
FX exposure	0.24**		
	(2.29)		
CO exposure			0.31***
			(6.56)
Leverage	-0.075	0.96***	-0.64*
	(-0.29)	(3.80)	(-1.83)
Market-to-book	0.058	0.030	-0.046
	(1.61)	(1.35)	(-1.59)
Profitability	-0.98**	0.0078	-0.37
	(-2.03)	(0.026)	(-0.99)
Energy import	-0.00088	-0.062	-0.026
	(-0.012)	(-0.93)	(-0.29)
Derivative MR	0.00077	0.022***	0.0086
	(0.13)	(3.80)	(1.16)
CRI	-0.070	0.20***	-0.15
	(-0.98)	(2.59)	(-1.46)
ADRI	0.17**	-0.20***	-0.052
	(2.36)	(-2.83)	(-0.76)
Inflation	-0.024	-0.057***	-0.029
	(-1.42)	(-3.08)	(-1.23)
Observations	2,660	2,723	2,659
Pseudo R2	0.34	0.33	0.53

The dependent variable is the decision to hedge. The models are pooled probit. All regression exclude the variable CLOSELY HELD. By this, additional countries, e.g. "Russian Federation", can be included in the sample. A detailed description of the variables can be found in Appendix S. All regressions include time dummies and a US dummy. T-statistics (presented in parentheses) are based on Huber-White robust standard errors and clustered by firms. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix R: Culture: Hedging decision - alternative models

	Population averaged probit			Panel probit		
	FX	IR	CO	FX	IR	CO
UAI	**-0.0011**	**0.0064**	**-0.013*** **	**0.00094**	**0.018***	**-0.044*** **
	(-0.28)	**(1.52)**	**(-2.72)**	**(0.11)**	**(1.79)**	**(-2.87)**
MAS	**0.0012**	**-0.0087**	**0.0069**	**0.0052**	**-0.022**	**0.012**
	(0.24)	**(-1.49)**	**(1.20)**	**(0.44)**	**(-1.62)**	**(0.62)**
LTO	**-0.0075***	**-0.011** **	**-0.014*** **	**-0.017***	**-0.027** **	**-0.040** **
	(-1.77)	**(-2.29)**	**(-2.64)**	**(-1.73)**	**(-2.39)**	**(-2.33)**
PDI	**-0.016*** **	**-0.016*** **	**-0.032*** **	**-0.033*** **	**-0.040*** **	**-0.11*** **
	(-3.76)	**(-3.54)**	**(-5.68)**	**(-3.43)**	**(-3.57)**	**(-5.92)**
Size	0.46***	0.41***	0.49***	0.94***	1.02***	1.53***
	(13.5)	(12.8)	(12.6)	(12.1)	(12.3)	(10.3)
FX exposure	0.34***			0.73***		
	(3.17)			(3.12)		
CO exposure			0.25***			0.86***
			(5.23)			(5.41)
Leverage	0.086	0.45***	-0.32	0.19	1.08***	-0.27
	(0.44)	(2.74)	(-1.38)	(0.50)	(2.66)	(-0.41)
Market-to-book	0.034**	0.0066	-0.028	0.052	0.024	-0.059
	(2.02)	(0.45)	(-1.47)	(1.63)	(0.64)	(-1.01)
Profitability	-0.91***	-0.21	-0.14	-1.67***	-0.53	0.90
	(-3.52)	(-1.10)	(-0.37)	(-3.57)	(-0.90)	(0.71)
Energy import	-0.037	-0.058	0.067	-0.051	-0.15	0.19
	(-0.48)	(-0.65)	(0.72)	(-0.29)	(-0.70)	(0.62)
Derivative MR	-0.0057	0.012**	0.0055	-0.018	0.032**	0.040**
	(-1.03)	(2.26)	(0.82)	(-1.53)	(2.48)	(2.05)
CRI	-0.043	0.13*	-0.23***	-0.051	0.41**	-0.96***
	(-0.61)	(1.71)	(-2.64)	(-0.31)	(2.14)	(-3.19)
ADRI	0.22***	-0.080	-0.051	0.45***	-0.17	-0.17
	(3.35)	(-1.05)	(-0.63)	(2.97)	(-0.97)	(-0.66)
Closely held	-0.067	0.15	-0.034	-0.51	0.71	0.60
	(-0.15)	(0.31)	(-0.060)	(-0.49)	(0.60)	(0.33)
Inflation	-0.0060	-0.027***	-0.053**	-0.0077	-0.067***	-0.087*
	(-0.66)	(-3.06)	(-2.45)	(-0.46)	(-2.86)	(-1.74)
Observations	2,479	2,540	2,478	2,479	2,540	2,478

This table shows results from population averaged and panel probit regressions for impact factors on the decision to hedge, separately considered for the three risk types. A detailed description of the variables can be found in Appendix S. All regressions include time dummies and a US dummy. T-statistics are presented in parentheses. ***, ** and * indicate significance on the 1%-, 5%- and 10%-levels, respectively.

Appendix S: Culture: Definition of variables used

Variable	Definition	Source
Hedging decision	Dummy variable, indicating if a company hedged one of the three risk types (exchange rate, interest rate and commodity price risks) in a certain year.	Annual reports, 10-K reports
Hedging volume	Continuous variable, showing the notional hedging volume of a company for one of the three risk types (exchange rate, interest rate and commodity price risks) in a certain year. The values have been normalized by total assets taken from Thomson Reuters (2011) and winsorized on a 1% and 99% level.	Annual reports, 10-K reports
Hedging instruments	Dummy variable, indicating if a company uses derivatives with optionalities for hedging purposes in a certain year.	Annual reports, 10-K reports
UAI	Uncertainty avoidance index.	Hofstede (2001)
MAS	Masculinity vs. femininity index.	Hofstede (2001)
LTO	Long-term orientation vs. short-term orientation index.	Hofstede (2001)
PDI	Power distance indicator.	Hofstede (2001)
Size	Company size measured as normal logarithm of total assets in thousand U.S. dollar, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
FX exposure	Cost of goods sold divided by total assets for non-US companies and "0" for US companies, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
CO exposure	Cost of goods sold plus net sales or revenues divided by total assets, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
Leverage	Total debt divided by sum of total debt and common equity, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
Market-to-book	Market capitalization divided by common equity, winsorized on a 1% and 99% level.	Thomson Reuters (2011)
Profitability	EBIT divided by total assets, winsorized on a 1% and 99% level.	Thomson Reuters (2011)

This table shows the definitions of all variables used in the analysis on cultural determinants.

Appendix S

Variable	Definition	Source
Energy import	Energy import minus export divided by energy consumption, winsorized on a 1% and 99% level.	World Bank (2012)
Regulatory quality	Index measuring the governmental ability to implement sound regulations.	Kaufmann et al. (2008)
Rule of law	Index measuring the effectiveness of laws for contract enforcement and public rights.	Kaufmann et al. (2008)
Political stability	Index measuring the overall political stability of a country.	(Kaufmann et al., 2008)
Derivative market rank	Rank of sum of national daily averages of FX and IR derivative market turnover divided by GDP and adjusted for local inter-dealer double-counting.	Bank for International Settlement (2010a)
Derivative market volume	Log sum of national daily averages of FX and IR derivative market turnover divided by GDP and adjusted for local inter-dealer double-counting.	Bank for International Settlement (2010a)
Creditor rights	Creditor rights index.	Djankov et al. (2007)
Shareholder rights	Revised anti director rights index.	Djankov et al. (2008)
Closely held	Percent of market capitalization closely held.	Dahlquist et al. (2003)
Inflation	Annualized inflation, winsorized on a 1% and 99% level.	World Bank (2012)
Accounting standard	Dummy that equals ”1” in case the company reports under US GAAP or IFRS and ”0” otherwise.	Worldscope
Analyst following	Number of analyst followings.	I/B/E/S

This table shows the definitions of all variables used in the analysis on cultural determinants.

Bibliography

Adam, T. R., 2002. Do firms use derivatives to reduce their dependence on external capital markets? European Finance Review 6, 163 – 187.

Adam, T. R., Dasgupta, S., Titman, S., 2007. Financial constraints, competition, and hedging in industry equilibrium. Journal of Finance 62, 2445 – 2473.

Adam, T. R., Fernando, C. S., 2006. Hedging, speculation, and shareholder value. Journal of Financial Economics 81, 283 – 309.

Adam, T. R., Fernando, C. S., Golubeva, E., 2011. Managerial overconfidence and corporate risk management. SSRN.

Adam, T. R., Fernando, C. S., Salas, J. M., 2008. Why do firms hedge selectively? Evidence from the gold mining industry. Working Paper.

Adkins, L. C., Carter, D. A., Simpson, W. G., 2007. Managerial incentives and the use of foreign-exchange derivatives by banks. Journal of Financial Research 30, 399 – 413.

Adler, M., Dumas, B., 1984. Exposure to currency risk: Definition and measurement. Financial Management 13, 41 – 50.

Aggarwal, R., Goodell, J. W., 2009. Markets and institutions in financial intermediation: National characteristics as determinants. Journal of Banking and Finance 33, 1770 – 1780.

Ahern, K. R., Daminelli, D., Fracassi, C., 2013. Lost in translation? The effect of cultural values on mergers around the world. Journal of Financial Economics, forthcoming.

Alkeback, P., Hagelin, N., 1999. Derivative usage by nonfinancial firms in Sweden with an international comparison. Journal of International Financial Management and Accounting 10, 105 – 120.

Allayannis, G., Lel, U., Miller, D. P., 2012. The use of foreign currency derivatives, corporate governance, and firm value around the world. Journal of International Economics 87, 65 – 79.

Allayannis, G., Ofek, E., 2001. Exchange rate exposure, hedging, and the use of foreign currency derivatives. Journal of International Money and Finance 20, 273 – 296.

Allayannis, G., Weston, J. P., 2001. The use of foreign currency derivatives and firm market value. Review of Financial Studies 14, 243 – 276.

Altman, E. I., 1984. A further empirical investigation of the bankruptcy cost question. Journal of Finance 39, 1067 – 1089.

Amit, R., 1990. Why do firms reduce business risk? Academy of Management Journal 33, 520 – 533.

Ankirchner, S., Heyne, G., 2012. Cross hedging with stochastic correlation. Finance and Stochastics 16, 17 – 43.

Aretz, K., Bartram, S. M., 2010. Corporate hedging and shareholder value. Journal of Financial Research 33, 317 – 371.

Aretz, K., Bartram, S. M., Dufey, G., 2007. Why hedge? Rationales for corporate hedging and value implications. Journal of Risk Finance 8, 434 – 449.

Bank for International Settlement, 2008. Financial globalisation and emerging market capital flows. Hedging instruments in emerging market economies, 71 – 87.

Bank for International Settlement, 2010a. Foreign exchange and derivatives market activity in april 2010. Triennial Central Bank Survey.

Bank for International Settlement, 2010b. Report on global foreign exchange market activity in 2010. Triennial Central Bank Survey.

Bartram, S. M., 2002. The interest rate exposure of nonfinancial corporations. European Finance Review 6, 101 – 125.

Bartram, S. M., Brown, G. W., Conrad, J., 2011. The effect of derivatives on firm risk and value. Journal of Financial and Quantitative Analysis 46, 967 – 999.

Bartram, S. M., Brown, G. W., Fehle, F. R., 2009. International evidence on financial derivative usage. Financial Management 38, 185 – 206.

Baum, C. F., 2006. An introduction to modern econometrics using Stata. College Station, Tex.

Benito, G., Gripsrud, G., 1992. The expansion of foreign direct investments: Discrete rational location choice or a cultural learning process. Journal of International Business Studies 23, 461 – 476.

Berger, P. G., Ofek, E., 1995. Diversification's effect on firm value. Journal of Financial Economics 37, 39 – 65.

Berkman, H., Bradbury, M. E., 1996. Empirical evidence on the corporate use of derivatives. Financial Management 25, 5 – 13.

Berkman, H., Bradley, M. E., Magan, S., 1997. An international comparison of derivative use. Financial Management 26, 69 – 73.

Bessembinder, H., 1991. Forward contracts and firm value: Investment incentive and contracting effects. Journal of Financial and Quantitative Analysis 26, 519 – 532.

Bhattacharyya, S. C., 2011. Energy economics: Concepts, issues, markets and governance. London.

Block, S. B., Gallagher, T. J., 1986. The use of interest rate futures and options by corporate financial managers. Financial Management 15, 71 – 78.

Bodnar, G. M., Hayt, G. S., Marston, R. C., 1996. 1995 Wharton survey of derivatives usage by US non-financial firms. Financial Management 25, 113 – 133.

Bodnar, G. M., Hayt, G. S., Marston, R. C., Smithson, N., 1995. Wharton survey of derivatives usage by U.S. non-financial firms. Financial Management 24, 104 – 114.

Boldt, J., Hankel, L., Laurisch, L. C., Lutterbecl, F., Oei, P.-Y., Sander, A., Schroeder, A., Schweter, H., Sommer, P., Sulerz, J., 2012. Renewables in the grid - modeling the German power market of the year 2030. Working Paper.

Booth, L., Aivazian, V., Demirguc-Kunt, A., Maksimovic, V., 2001. Capital structure in developing countries. Journal of Finance 56, 87 – 130.

Borenstein, S., Shepard, A., 2002. Sticky prices, inventories, and market power in wholesale gasoline markets. RAND Journal of Economics 33, 116 – 139.

Borokhovich, K. A., Brunarski, K. R., Crutchley, C. E., Simkins, B. J., 2004. Board composition and corporate use of interest rate derivatives. Journal of Financial Research 2, 199 – 216.

BP, 2012. BP statistical review of world energy. http://www.bp.com/sectionbodycopy.do?categoryId=7500&contentId=7068481.

Bradley, M., Jarrel, G., Kim, E., 1984. On the existence of an optimal capital structure: Theory and evidence. Journal of Finance 39, 857 – 878.

Breeden, D., Viswanathan, S., 1998. Why do firms hedge? An asymmetric information. Working paper.

Brouthers, K. D., Brouthers, L. E., Werner, S., 2002. Industrial sector, perceived environmental uncertainty and entry mode strategy. Journal of Business Research 55, 495 – 507.

Brown, G., 2001. Managing foreign exchange risk with derivatives. Journal of Financial Economics 60, 401 – 448.

Brown, G. W., Toft, K. B., 2002. How firms should hedge. Review of Financial Studies 15, 1283 – 1324.

Brunzell, T., Hansson, M., Liljeblom, E., 2011. The use of derivatives in Nordic firms. European Journal of Finance 17, 355 – 376.

Burger, M., Graber, B., Schindlmayr, G., 2007. Managing energy risk: An integrated view on power and other energy markets. Chichester.

Cameron, A. C., Trivedi, P. K., 2010. Microeconometrics using stata. College Station.

Campbell, J. Y., Medeiros, K. S., Viceira, L. M., 2010. Global currency hedging. Journal of Finance 65, 87 – 121.

Campello, M., Lin, C., Ma, Y., Zou, H., 2011. The real and financial implications of corporate hedging. Journal of Finance 66, 1615 – 1647.

Cappellari, L., Jenkins, S. P., 2006. MVPROBIT: Stata module to calculate multivariate probit regression using simulated maximum likelihood. Statistical Software Components, Boston College Department of Economics.

Carter, D. A., Rogers, D. A., Simkins, B. J., 2006. Does hedging affect firm value? Evidence from the US airline industry. Financial Management 35, 53 – 86.

Chui, A. C., Titman, S., Wei, K. J., 2010. Individualism and momentum around the world. Journal of Finance 65, 361 – 392.

Chui, A. C. W., Kwok, C. C. Y., 2007. National culture and life insurance consumption. Journal of International Business Studies 39, 88 – 101.

Chui, A. C. W., Lloyd, A. E., Kwok, C. C. Y., 2002. The determination of capital structure: Is national culture a missing piece to the puzzle? Journal of International Business Studies 33, 99 – 127.

Clark, E., Judge, A., 2009. Foreign currency derivatives versus foreign currency debt and the hedging premium. European Financial Management 15, 606 – 642.

CME group, 2012. www.cmegroup.com/.

Cornaggia, J., 2013. Does risk management matter? Evidence from the U.S.

agricultural industry. Journal of Financial Economics, forthcoming.

Dadalt, P., Gay, G. D., Nam, J., 2002. Asymmetric information and corporate derivative use. Journal of Futures Markets 22, 241 – 267.

Dahlgren, R., Liu, C.-C., Lawarree, J., 2003. Risk assessment in energy trading. IEEE Transactions on power systems 18, 503 – 511.

Dahlquist, M., Pinkowitz, L., Stulz, R. M., Williamson, R., 2003. Corporate governance and the home bias. Journal of Financial and Quantitative Analysis 38, 87 – 110.

Danish Energy Agency, 2012. Technology data for energy plants, June 2012. www.ens.dk/en-us/Sider/forside.aspx.

Davies, D., Eckberg, C., Marshall, A., 2011. The determinants of Norwegian exporters' foreign exchange risk management. European Journal of Finance 12, 217 – 240.

DeMarzo, P. M., Duffie, D., 1995. Corporate incentives for hedge and hedge accounting. Review of Financial Studies 8, 743 – 771.

Demidenko, E., 2004. Mixed models - Theory and applications. Hoboken.

Deng, S. J., Oren, S. S., 2006. Electricity derivatives and risk management. Energy 31, 940 – 953.

Denton, M., Palmer, A., Masiello, R., Skantze, P., 2003. Managing market risk in energy. IEEE Transactions on power systems 18, 494 – 502.

Dionne, G., Garand, M., 2003. Risk management determinants affecting firms' values in the gold mining industry: New empirical results. Economics Letters 79, 43 – 52.

Dionne, G., Triki, T., 2004. On risk management determinants: What really matters? Working Paper.

Dionne, G., Triki, T., 2005. Risk management and corporate governance: The importance of independence and financial knowledge for the board and the audit committee. HEC Montreal Working Paper.

Djankov, S., McLiesh, C., Shleifer, A., 2007. Private credit in 129 countries. Journal of Financial Economics 84, 299 – 329.

Djankov, S., Porta, R. L., de Silanes, F. L., Shleifer, A., 2008. The law and economics of self-dealing. Journal of Financial Economics 88, 430 – 465.

Early, P., 1986. Trust, perceived importance of praise and criticism, and work performance; An examination of feedback in the United States and England. Journal of Management 12, 457 – 473.

Eby, L., Adams, D. M., Russel, J., Gaby, S., 2000. Perceptions of organizational readiness for change. factors related to employees' reactions to the implementation of team-based selling. Human relations 53, 419 – 442.

El-Masry, A. A., 2003. A survey of derivatives use by UK nonfinancial companies. SSRN.

Energy Information Administration, 2011. International energy outlook.

Energy Information Administration, 2013. International energy statistics. http://www.eia.gov/countries/data.cfm.

Eni, 2011. World oil and gas review. www.eni.com/world-oil-gas-review/allegati/wogr-2011.pdf.

Eurelectric, 2011. Flexible generation: Backing up renewables, Report of the Union of Electricity Industry - Eurelectric. www.eurelectric.org/download/download.aspx?DocumentFileID=71337.

Faulkender, M., 2005. Hedging or market timing? Selecting the interest rate exposure of corporate debt. Journal of Finance 60, 931 – 962.

Federal Energy Regulation Commission (FERC), 2013. Electric power markets: National overview. www.ferc.gov/market-oversight/mkt-electric/overview.asp.

Fok, R. C. W., Carroll, C., Chiou, M. C., 1997. Determinants of corporate hedging and derivatives: A revisit. Journal of Economics and Business

49, 569 – 570.

Frank, M. Z., Goyal, V. K., 2003. Testing the pecking order theory of capital structure. Journal of Financial Economics 67, 217 – 248.

Froot, K. A., Scharfstein, D. S., Stein, J. C., 1993. Risk management: Coordinating corporate investment and financing policies. Journal of Finance 48, 1629 – 1658.

Gay, G. D., Lin, C.-M., Smith, S. D., 2011. Corporate derivatives use and the cost of equity. Journal of Banking and Finance 35, 1491 – 1506.

Gay, G. D., Nam, J., 1998. The underinvestment problem and corporate derivatives use. Financial Management 27, 53 – 69.

Geczy, C., Minton, B. A., Schrand, C., 1997. Why firms use currency derivatives. Journal of Finance 52, 1323 – 1354.

Geman, H., 2005. Commodities and commodity derivatives. Chichester.

Geman, H., Roncoroni, A., 2006. Understanding the fine structure of electricity prices. Journal of Business 79, 1225 – 1261.

Giannetti, M., Yafeh, Y., 2012. Do cultural differences between contracting parties matter? Evidence from syndicated bank loans. Management Science 58, 365 – 383.

Gibson, R., Schwartz, E. S., 1990. Stochastic convenience yield and the pricing of oil contingent claims. Journal of Finance 45, 959 – 976.

Giuli, A. D., Caselli, S., Gatti, S., 2011. Are small family firms financially sophisticated? Journal of Banking and Finance 35, 2931–2944.

Graham, J. R., Rogers, D. A., 1999. Is corporate hedging consistent with value maximization? SSRN.

Graham, J. R., Rogers, D. A., 2002. Do firms hedge in response to tax incentives? Journal of Finance 57, 815 – 839.

Graham, J. R., Smith, C. W., 1999. Tax incentives to hedge. Journal of Finance 54, 2241 – 2262.

Greene, W. H., 2012. Econometric analysis. Boston.

Guay, W., Kothari, S. P., 2003. How much do firms hedge with derivatives? Journal of Financial Economics 70, 423 – 461.

Habib, M., Zurawicki, L., 2002. Corruption and foreign direct investment. Journal of International Business Studies 33, 291 – 307.

Hagelin, N., Pramborg, B., 2002. Hedging foreign exchange exposure: Risk reduction from transaction and translation hedging. Working Paper.

Hagelin, N., Pramborg, B., 2006. Empirical evidence concerning incentives to hedge transaction and translation exposures. Journal of Multinational Financial Management 16, 142 – 159.

Hakkarainen, A., Kasanen, E., Puttonen, V., 1997. Interest rate risk management in major Finnish firms. European Financial Management 3, 255 – 268.

Han, S., Kang, T., Salter, S., Yoo, Y. K., 2010. A cross-country study on the effects of national culture on earnings management. Journal of International Business Studies 41, 123 – 141.

Haushalter, D., Klasa, S., Maxwell, W. F., 2007. The influence of product market dynamics on a firm's cash holdings and hedging behavior. Journal of Financial Economics 84, 797 – 825.

Haushalter, D. G., Heron, R. A., Lie, E., 2002. Price uncertainty and corporate value. Journal of Corporate Finance 8, 271 – 286.

Haushalter, G. D., 2000. Financing policy, basis risk, and corporate hedging: Evidence from oil and gas producers. Journal of Finance 55, 107–152.

Hayashi, F., 2000. Econometrics. Princeton.

Hayn, S., Waldersee, G. G., 2008. IFRS/HGB/HGB-BilMoG im Vergleich - Synoptische Darstellung mit Bilanzrechtsmodernisierungsgesetz. Stuttgart.

Hofstede, G., 2001. Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations. Thousand Oaks.

Hofstede, G. H., Bond, M. H., 1988. The Confucius connection: From cultural roots to economic growth. Organizational Dynamics 16, 5 – 21.

Howton, S. D., Perfect, S. B., 1998. Currency and interest-rate derivative use in US firms. Financial Management 27, 111 – 121.

Huang, P., Ryan Jr., H. E., Wiggins III, R. A., 2007. The influence of firm- and CEO-specific characteristics on the use of nonlinear instruments. Journal of Financial Research 30, 415 – 436.

Hulley, H., McWalter, T. A., 2008. Quadratic hedging of basis risk. Research Paper 225, Quantitative Finance Research Centre, University of Technology, Sydney.

Hwang, B.-H., 2011. Country-specific sentiment and security prices? Journal of Financial Economics 100, 382 – 401.

International Energy Agency, 2010. Projected costs of generating electricity. www.iea.org/publications/.

International Energy Agency, 2011. World Energy Outlook. www.worldenergyoutlook.org/.

International Energy Agency, 2012. Key world energy statistics. http://www.iea.org/publications/.

International Gas Union, 2010. World LNG report. www.igu.org/gas-knowhow/publications/igu-publications/LNG

James, K., 1993. Enhancing the perceived self-relevance of technology to influence attitudes and information retention. Journal of Applied Behavioral Finance 29, 56 – 75.

Jensen, M. C., Meckling, W. H., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics 3, 305 – 360.

Jin, Y., Jorion, P., 2006. Firm value and hedging: Evidence from U.S. oil and gas producers. Journal of Finance 61, 893 – 919.

Jorion, P., 1990. The exchange-rate exposure of U.S. multinationals. Journal of Business 63, 331 – 345.

Joseph, N. L., Hewins, R. D., 1997. The motives for corporate hedging among UK multinationals. International Journal of Finance and Economics 2, 151 – 171.

Judge, A., 2002. Hedging and the use of derivatives: Evidence from UK non-financial firms. SSRN.

Kaufmann, D., Kraay, A., Mastruzzi, A., 2008. Governance matters VII: Aggregate and individual governance indicators, 1996-2007. World Bank Policy Research Working Paper 4654.

Kedia, S., Mozumdar, A., 2003. Foreign currency-denominated debt: An empirical examination. Journal of Business 76, 521 – 546.

Kennedy, P., 2008. A guide to econometrics. Malden, Mass.

Kirkman, B. L., Lowe, K. B., Gibson, C. B., 2006. A quarter century of culture's consequences: A review of empirical research incorporating Hofstedes cultural values framework. Journal of International Business Studies 37, 285 – 320.

Kumar, P., Rabinovitch, R., 2011. CEO entrenchment and corporate risk management. SSRN.

Kwok, C. C. Y., Tadesse, S., 2006. National culture and financial systems. Journal of International Business Studies 37, 227 – 247.

Lang, L. H. P., Stulz, R. M., 1994. Tobin's q, corporate diversification, and firm performance. Journal of Political Economy 102, 1248 – 1280.

Lel, U., 2012. Currency hedging and corporate governance: A cross-country analysis. Journal of Corporate Finance 18, 221 – 237.

Leland, H. E., 1998. Agency costs, risk management and capital structure. Journal of Finance 53, 1213 – 1243.

Li, J., Guisinger, S., 1991. Comparative business failure of foreign-controlled firms in the United States. Journal of International Business Studies 22, 209 – 224.

Li, K., Griffin, D., Yue, H., Zhao, L., 2011. National culture and capital structure decisions: Evidence from foreign ventures in China. Journal of International Business Studies 42, 477 – 503.

Licht, A. N., Goldschmidt, C., Schwartz, S. H., 2005. Culture, law, and corporate governance. International Review of Law and Economics 25, 229 – 255.

Lievenbrueck, M., Schmid, T., 2013. Hedging patterns in the global energy market. Working Paper.

Lievenbrueck, M., Schmid, T., 2014. Why do firms (not) hedge? - Noval evidence on cultural influence. Journal of Corporate Finance 25, 92 – 106.

Lins, K., Servaes, H., 1999. International evidence on the value of corporate diversification. Journal of Finance 54, 2215 – 2239.

Litzenberger, R. L., Rabinowitz, N., 1995. Backwardation in oil futures markets: Theory and empirical evidence. Journal of Finance 50, 1517 – 1545.

Luo, Y., Park, S., 2001. Strategic alignment and performance of market-seeking MNCs in China. Strategic Management Journal 22, 141 – 155.

Mackay, P., Moeller, S. B., 2007. The value of corporate risk management. Journal of Finance 62, 1379 – 1419.

MacMinn, R. D., 1987. Insurance and corporate risk management. Journal of Risk and Insurance 54, 658 – 677.

Marsden, A., Prevost, A. K., 2005. Derivatives use, corporate governance, and legislative change: An empirical analysis of new zealand listed companies. Journal of Business Finance and Accounting 32, 255 – 295.

Mayers, D., Smith, C. W., 1982. On the corporate demand for insurance. Journal of Business 55, 281 – 296.

Mello, A. S., Pearson, J. E., 2000. Hedging and liquidity. Review of Financial Studies 13, 127 – 153.

Mian, S. L., 1996. Evidence on corporate hedging policy. Journal of Financial and Quantitative Analysis 31, 419 – 439.

Miller, K. D., 1992. A framework for integrated risk management in international business. Journal of International Business Studies 23, 311 – 331.

Modigliani, F., Miller, M. H., 1958. The cost of capital, corporation finance and the theory of investment. American Economic Review 48, 261 – 297.

Morris, M., Avila, R., Allen, J., 1993. Individualism and the modern corporation: Implications for innovation and entrepreneurship. Journal of Management 19, 595 – 612.

Myers, S. C., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147 – 175.

Myers, S. C., 1984. The capital structure puzzle. Journal of Finance 39, 575 – 592.

Myers, S. C., Majluf, N. S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics 13, 187 – 221.

Nance, D. R., Smith, C. W., Smithson, C. W., 1993. On the determinants of corporate hedging. Journal of Finance 48, 267 – 284.

Nelson, J. M., Moffit, J. S., Affleck-Graves, J., 2005. The impact of hedging on the market value of equity. Journal of Corporate Finance 11, 851 – 881.

Nguyen, H. V., Mensah, M. O., Fan, Y., 2007. Derivative instruments and their use for hedging by U.S. non-financial firms: A review of theories and empirical evidence. SSRN.

North, D. C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge.

Platts, 2012. World electric power plants data base.

www.platts.com/products/worldelectricpowerplantsdatabase.

Pothukuchi, V., Damanpour, F., Choi, J., Chen, C., Park, S., 2002. National and organizational culture differences and international joint venture performance. Journal of International Business Studies 33, 243 – 265.

Raposo, C. C., 1997. Corporate risk management and optimal hedging disclosure. SSRN.

Reinartz, S. J., Schmid, T., 2012. Production characteristics, financial flexibility, and capital structure decisions. SSRN.

Rodt, M., Schaefer, K., 2005. Absicherung von Strompreisrisiken mit Futures: Theorie und Empirie. Working Paper.

Rogers, D. A., 2002. Does executive portfolio structure affect risk management? CEO risk-taking incentives and corporate derivatives usage. Journal of Banking and Finance 26, 271 – 295.

Schuler, R. S., Rogovsky, N., 1998. Understanding compensation practice variations across firms: The impact of national culture. Journal of International Business Studies 29, 159 – 177.

Schwartz, E. S., 1997. The stochastic behavior of commodity prices: Implications for valuation and hedging. Journal of Finance 52, 923 – 973.

Shao, L., Kwok, C. C., Guedhami, O., 2010. National culture and dividend policy. Journal of International Business Studies 41, 1391 – 1414.

Siegel, J. I., Licht, A. N., Schwartz, S. H., 2011. Egalitarianism and international investment. Journal of Financial Economics 102, 621 – 642.

Sinkey, J. F., Carter, D. A., 2000. Evidence on the financial characteristics of banks that do and do not use derivatives. Quarterly Review of Economics and Finance 40, 431 – 449.

Slitor, R. E., 1948. The measurement of progressivity and built-in flexibility. Quarterly Journal of Economics 62, 309 – 313.

Smith, C. W., 1995. Corporate risk management: Theory and practice. Journal of Derivatives 2, 21 – 30.

Smith, C. W., Stulz, R. M., 1985. The determinants of firm hedging policies. Journal of Financial and Quantitative Analysis 20, 391 – 405.

Smithson, C. W., Smith, C. W., Wilford, D. S., 1998. Managing financial risk: A guide to derivative products, financial engeneering, and value maximization. New York.

Spanos, A., 1998. Statistical foundations of econometric modelling. Cambridge.

Stock, J. H., Watson, M. W., 2012. Introduction to econometrics. Boston.

Stulz, R. M., 1984. Optimal hedging policies. Journal of Financial and Quantitative Analysis 19, 127 – 140.

Stulz, R. M., 1996. Rethinking risk management. Journal of Applied Corporate Finance 9, 8 – 24.

Swider, D. J., 2006. Handel an Regelenergie- und Spotmaerkten - Methoden zur Entscheidungsunterstuetzung fuer Netz- und Kraftwerksbetreiber. Wiesbaden.

Thomas, A., Mueller, S., 2000. A case for comparative entrepreneurship: Assessing the relevance of culture. Journal of International Business Studies 31, 287 – 301.

Thomas, D., Grosse, R., 2001. Country-of-origin determinants of foreign direct investment in an emerging market: The case of Mexico. Journal of International Management 7, 59 – 79.

Thomson Reuters, 2011. Data retrieved March 20, 2011. From Worldscope Fundamentals database.

Tufano, P., 1996. Who manages risk? An empirical examination of risk management practices in the gold mining industry. Journal of Finance 51, 1097 – 1137.

Vickery, J., 2008. How and why do small firms manage interest rate risk? Journal of Financial Economics 97, 263 – 278.

Visvanathan, G., 1998. Who uses interest rate swaps? A cross-sectional analysis. Journal of Accounting, Auditing and Finance 13, 173 – 200.

Wade-Benzoni, K., Okumura, T., Brett, J., Moore, D., Tenbrunsel, A., Bazerman, M., 2002. Cognitions and behavior in asymmetric social dillemmas: A comparison of two cultures. Journal of Applied Psychology 87, 87 – 95.

Warner, J. B., 1977. Bankruptcy costs: Some evidence. Journal of Finance 32, 337 – 347.

Williamson, O. E., 2000. The new institutional economics: Taking stock, looking ahead. Journal of Economic Literature 38, 595 – 613.

Wooldridge, J. M., 2010. Econometric analysis of cross section and panel data. Cambridge, Mass.

Working, H., 1953. Futures trading and hedging. American Economic Review 43, 314 – 343.

World Bank, 2012. Data retrieved January 20, 2012 from World Development Indicators Online (WDI) database. http://data.worldbank.org/data-catalog/world-development-indicators.

World Coal Institute, 2009. The coal resource - a comprehensive overview of coal. www.worldcoal.org/resources/.

Zheng, X., Ghoul, S. E., Guedhami, O., Kwok, C. C., 2012. National culture and corporate debt maturity. Journal of Banking and Finance 36, 468 – 488.