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Essays on corporate risk management and optimal hedging

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Chapter 1

INTRODUCTION, BACKGROUND, AND MOTIVATION

1.1 INTRODUCTION

Over the last decades, risk analysis and corporate risk management activities have become very important elements for both financial as well as non-financial corporations. Firms are exposed to different sources of risk, which can be divided into operational risks and financial risks. Operational risks – or alternatively business risks – relate to the uncertainty regarding the firm’s investments and investment opportunities, and are influenced by the product markets in which a firm operates. In addition to operational risks, unexpected changes in e.g. interest rates, exchange rates, and oil prices create financial risks for individual companies. As opposed to operational risks, which influence a specific firm or industry, financial risks are market-wide risks that can affect the financial performance of companies in the whole economy.¹ Both kinds of risk exposure can have substantial impact on the value of a firm. In this context, we define corporate risk management as the process of trying to control the effect of these risk exposures on firm value.

¹ Commodity price risk is often considered as a financial risk as well, despite the fact that this is a specific risk exposure for the industry in which a corporation operates. That commodity price risk is usually qualified as a financial risk, is induced by the fact that there exist many derivative instruments in the financial markets with commodity prices as underlying assets. This results in possibilities to efficiently transfer commodity price risk to other market participants.

There are several reasons to explain why corporate risk management has gained in popularity over the last decades. The most important reason lies in the increased volatility of exchange rates, interest rates, and commodity prices, causing firms' cash flows to become more uncertain. Secondly, firms tend to focus more on their core business, which makes them less diversified. As a consequence, the volatility of firms' cash flows may increase. A third reason for the growing importance of corporate risk management can be found in the globalization of business activities, in which competition has increased and profit margins have declined. A final explanation we offer is the growing number of opportunities to manage risks. Since the 1970s, there have been numerous financial innovations, including new financial products as mortgage-backed securities and derivative instruments such as options and swaps. In addition to these financial innovations, new exchanges for futures, options, and other (complex) derivatives have been introduced and have become major markets, showing an explosion in trading volume and notional amounts outstanding. As a consequence, risks such as exchange rate risks, interest rate risks as well as commodity price risks can nowadays be transferred quite efficiently among different market participants.

Among others, Mason (1995) argues that firms engage in corporate risk management through insurance, diversification, and hedging activities.² Buying insurance

² In addition to these possibilities, there are other alternatives to manage risks. For example, a firm's choice of real production activities can also be used in managing risk exposures. By moving production to the country in which products are sold, exposure to exchange rate risk can be decreased dramatically. Furthermore, firm-specific risks can be reduced by geographical diversification, issuing hybrid securities like dual-currency and oil-indexed notes, as well as purchasing insurance. Loss prevention and control, engaging in joint ventures, and the choice of technology, for instance, can all be implemented as a risk management tool for reducing production risks.

contracts implies transferring a risk exposure to an insurance company in exchange for the payment of a premium. Insurance policies are usually employed to manage firm-specific risks like e.g. fire hazards. Diversification means engaging in different business activities that are less than perfectly correlated, thereby reducing the volatility of a firm's cash flows. Hedging a risk exposure is usually done through buying or selling financial derivatives to mitigate the effect of a risk exposure.

The standard literature on corporate risk management, which is analyzed in Chapter 2 of this thesis, mainly focuses on the use of financial derivatives within firms' risk management programs. In general, derivatives can be used for hedging and speculation purposes.³

Firms that hedge, use derivatives in order to reduce or eliminate the risks they face from possible adverse changes in certain risk exposures. This is achieved by creating offsetting positions in derivative instruments. Firms that speculate, on the other hand, apply derivatives in order to 1) increase the impact of risk exposures on firm value or 2) incorporate their market view into risk management programs.⁴ If managers of firms incorporate their personal view in the risk management decision, the total derivatives' position may consist of a hedging part and a speculative part.⁵ Stulz (1996) refers to this type of speculation as "selective hedging". In this thesis

³ In addition to hedging and speculation, derivatives can also be used for arbitrage purposes. Arbitrageurs take offsetting positions in different markets or instruments to lock in (risk-free) gains caused by market imperfections. Since arbitrage is usually undertaken by professional financial parties like market makers and hedge funds, in this thesis we abstract from this motivation for the use of derivatives since our focus is on non-financial corporations.

⁴ Several studies have documented that managers believe that they can create value for the shareholders by incorporating speculative elements into their risk management program (see e.g. Bodnar, Hayt, and Marston, 1998).

⁵ Among others, Stulz (1996), Graham and Harvey (2001), and Brown, Crabb, and Haushalter (2002) discuss decision making based on market views.

corporate risk management comprises strategies to reduce risk as well as strategies for risk taking.⁶

In this dissertation, we concentrate on risk management behavior by non-financial corporations, since managing financial risk exposures is not their core business. By managing financial risk exposures, non-financial corporations can focus primarily on business risks, which relate to their core business. In contrast, by dealing in financial securities, financial institutions and financial intermediaries are by definition in the risk management business. Merton (1989) even argues that a key feature of financial institutions is to bundle and unbundle different sources of risks. Financial institutions facilitate risk transfers in an increasingly complex area of financial instruments and financial markets; risk management can be seen as a key area of business for financial institutions and intermediaries. As a consequence, their motives for risk management are different from those of non-financial corporations.⁷

1.2 APPROACH AND BACKGROUND

The fact that individual firms are increasingly engaged in risk management practices, does not explain why this behavior can be rationalized. Implicitly, the seminal work by Modigliani and Miller (1958) lays the foundation for the argument whether or not corporate risk management is relevant. Modigliani and Miller (1958) show that,

⁶ Theories of corporate risk management mainly focus on hedging decisions by non-financial corporations. In this thesis, we also provide rationales for why firms may increase risk exposures. Specifically, in Chapter 3 and 4 we show that it may be optimal to overhedge risk exposures. Although a rational decision, this may be qualified as speculation, since the exposure to a specific risk factor is increased – at least for certain states of the world. Note that this does not necessarily mean that the firm's net risk exposure is increased.

⁷ For a discussion on risk management for financial institutions, see e.g. Saunders (1997) and Smithson (1998).

given complete and frictionless capital markets, the value of a firm is independent of the choice of its capital structure. Based on arbitrage arguments, they show that individual investors can replicate the capital structure exposure of a firm through so-called “home-made leveraging or de-leveraging”. This analysis can easily be extended to risk management strategies, using similar straightforward arbitrage arguments. If shareholders can costlessly replicate a firm’s financial risk management policy (“home-made risk management”), there is no use for firms to do it themselves.⁸ As a consequence, from a shareholder’s point of view, both the choice of a firm’s capital structure as well as its corporate risk management decisions can only matter if capital markets exhibit some sort of imperfection. In a pioneering article, Smith and Stulz (1985) provide theoretical rationales for why risk management at the firm level may exist. The demand for risk management by individual firms can be motivated by relaxing some assumptions made by Modigliani and Miller (1958). The reasons to engage in risk management at the firm level range from non-linearity of corporate tax rates, to costs of financial distress and agency problems (see Chapter 2). Their approach has been well-accepted in the research on corporate risk management.

The theory of the optimal choice under uncertainty has been applied to study risk management decisions from a different point of view (i.e., different from the framework provided by Modigliani and Miller). Central in this line of research is the expected utility theory, introduced by Von Neumann and Morgenstern (1947). The expected utility theory is a normative model that has dominated the theory of optimal

⁸ This result holds for all financial decisions. See e.g. Miller and Modigliani (1961) for the irrelevance of a firm’s dividend policy.

decision making under risk and uncertainty. In this model, risk-averse individual agents maximize the expected value of their utility function.⁹ A central and strong element in this line of research is that normative models provide rational procedures for how individual agents should make decisions.¹⁰

Baron (1970) and Sandmo (1971) are the first to study optimal production under uncertainty, given a risk-averse single owner of a firm, who maximizes a Von Neumann-Morgenstern utility function.¹¹ They show that, for higher levels of uncertainty, optimal production decreases. Their models have been extended by e.g., Danthine (1978), Holthausen (1979), and Feder, Just, and Schmitz (1980) to incorporate optimal hedging decisions as well. A famous result is that, when production is non-stochastic, the well-known separation theorem applies. Given the possibility of hedging with unbiased forward contracts,¹² the optimal production decision is independent of the owner's risk preferences and can be separated from the optimal hedging decision. Furthermore, optimal risk management implies full hedging: firms should hedge the price risk of production completely. This model has been extended by numerous research to incorporate e.g. multi-period settings and multiple risk factors, and serves as the basis for our analyses in the Chapters 3 and 4.

⁹ In fact, utility maximization is more broad. Agents can, of course, also maximize their expected utility under the assumption of risk-seeking behavior or risk neutrality. In the economic literature, however, risk aversion is seen as a key element for the behavior of individual agents. See e.g., Pratt (1964) and Arrow (1964).

¹⁰ Descriptive models, as an alternative, intend to describe how agents make decisions, whether they might be rational or not. See e.g., Kahneman and Tversky (1979) and Tversky and Kahneman (1986).

¹¹ In this line of literature, the production decision refers to the joint investment and operating activities of a firm.

¹² Unbiasedness implies that the current price of a financial contract equals its expected payoff. We will discuss properties of unbiasedness in detail in Chapter 3 of this dissertation.

The theories presented above are designed to explain why risk management at the firm level may be undertaken. Within the theory of corporate finance, firms are assumed to maximize shareholder value, in which managerial risk aversion is unimportant. By imposing market imperfections, such as convex corporate taxes and costs of financial distress, specific costs are introduced for certain states of the world (see Chapter 2). If a firm wishes to avoid these costs, it will behave as if it faces a concave objective function. From this, it follows that the optimization problem for both the framework provided by Modigliani and Miller and the theory of optimal choice under uncertainty can be treated in a similar way. In both cases, the decision-maker faces a non-linear optimization problem, leading to a rational incentive to decrease the volatility of the firm's cash flows. In the case of utility maximization by a risk-averse manager, the objective function itself is concave, whereas in the case of the approach by Smith and Stulz (1985), market imperfections will cause the managers or owners of a firm to behave in a risk-averse manner.

The existing literature on optimal risk management policies provides rationales for *why* individual firms should engage in corporate risk management strategies (see e.g., Smith and Stulz (1985) and Chapter 2 of this thesis). That does not answer the question, however, *how* hedging should take place. Should it be done by selling linear hedging instruments, such as forward contracts or, alternatively, by buying non-linear hedging instruments such as put options? Furthermore, *how much* should firms hedge? Is it rational to completely hedge certain risk exposures or should firms under- or overhedge? Finally, do operational and hedging decisions interact, and if so, how do they interact?

In this dissertation we mainly build upon the theory of optimal choice in which both optimal production and hedging decisions are analyzed. We have selected this approach because of the strong normative conclusions that can be drawn, in which optimal behavior can be specified. From a theoretical point of view, we provide rational recommendations on the optimal choice of derivative instruments within corporate risk management policies at the firm level. In our analysis, a key issue to explain a rational motive for risk management is the existence of market incompleteness. In this context, capital markets are defined as incomplete if the implicit private pricing systems, which are used by individual economic agents to value financial assets, differ from the equilibrium market pricing systems (i.e., the consensus in the market). In this case, economic agents will, in general, disagree with the market about the pricing of financial instruments.

The previous arguments and assumptions are reflected in the main goal of this study:

The main goal of this thesis is to extend the existing literature of corporate risk management to provide a better understanding of the interaction between optimal production and risk management decisions through the use of financial derivatives.

In order to realize the goal, we define four *research questions*:

1. Are optimal production and risk management decisions dependent on the type of derivative contract that can be used for risk management purposes?

2. Is it rational for firms to engage in full hedging, or should they over- or underhedge total price risk of production?
3. Given the specific type of derivative contract and the optimal amount of production and risk management, is there separation between the optimal production and risk management decision?
4. Do optimal production and risk management decisions change for different kinds of managerial compensation?

1.3 OUTLINE OF THE THESIS

The remainder of this thesis consists of four chapters.¹³ The purpose of *Chapter 2* is twofold. First of all, it provides a review of the literature regarding the possible rational motives for corporate risk management, which have been briefly introduced in Section 1.2. Secondly, it serves as a background for the analytical studies in Chapter 3 and 4. It is shown that market imperfections give rise to motives that may induce firms to engage in risk management policies. The impact of market imperfections like exponentially increasing tax rates, costs of financial distress, and agency costs of debt will incur costs for the shareholders that can be eliminated or – at least – decreased by risk management strategies undertaken at the firm level. Furthermore, since the wealth of managers, which are hired to implement the optimal risk management policy, is often tied to the value and risk of the firm, managerial risk aversion may explain the corporate use of derivative instruments.

¹³ Note that the structure of this dissertation is essay-based, implying that the individual chapters can be read separately instead of subsequently. Given this structure, relevant definitions and symbols are (re-)defined in each individual chapter.

In *Chapter 3*, we develop a normative model of optimal corporate hedging and production decisions. In this chapter, we first deal with the market conditions for the unbiasedness of derivative contracts, which is an ever recurring restrictive assumption in the optimal hedging literature. We will show that restricting the probability distribution suffices for unbiasedness to hold and that, therefore, the standard assumption of risk neutrality is too restrictive.¹⁴ Furthermore, we will present the optimal production and hedging decisions of a competitive firm and show that, contrary to previous research, there is a hedging role for put options.

Chapter 4 studies the effect of the structure of managerial compensation on optimal production and hedging policies, employed at the firm level. In the financial literature it is widely assumed that managerial compensation through call options gives rise to excessive risk taking since an increase in the volatility of the firm increases the value of managerial stock option holdings. We will show that this is not necessarily true. If the manager is compensated with at-the-money call options, hedging with unbiased forward contracts leads to the same optimal production and hedging decisions as if he were compensated with shares of stock. However, if the manager of the firm can hedge with unbiased put options, optimal production and hedging decisions are not the same if he is compensated with either shares of stock or at-the-money call options. It is optimal to hedge more of the risk exposure and to produce less than in the case of hedging with linear instruments.

Chapter 5, finally, concludes and summarizes this dissertation. In this chapter, we review the results from the preceding chapters, discuss the relationships,

¹⁴ In the financial literature, unbiasedness is assumed to be possible only in risk-neutral and efficient markets. In Chapter 3 we will show that these conditions are too restrictive.

and describe the contributions of this study to the literature on corporate risk management. Furthermore, we discuss extensions for future research.

