Doctorate School in
Business Administration

THESIS EXTRACT

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Review of corporate risk management tools and the way they can create shareholder value

Ph.D. dissertation

Adviser:

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Finance and Accounting Institute
Investments and Corporate Finance Department

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I. INTRODUCTION TO TOPIC AND CHOICE OF RESEARCH

I. 1. Links of corporate risk management to shareholder value creation

Finance theory's premise is that the goal of management should be to maximize the market value of the company's shareholder equity through investments in an environment where outcomes are uncertain. Risks facing corporations[1] include market and credit risks, risk to corporate reputation, all manner of operational risks – such as business interruption, third party liability, human capital risk, environmental liability, product liability, risk of fraud, etc. –, legal and regulatory risks, strategic risk, and so on. Corporate risk management – in an optimal case – is the process of trying to optimize – and not simply minimize! – the effect of these exposures on firm value. It shall embrace the firm's determined answer to all these uncertainties by formulating a risk management strategy consistent with the overall corporate objective of shareholder value maximization.

Despite the prevalence of corporate risk management in practice and the effort that has been devoted to developing theoretical rationales for hedging, there are still confusions and misinterpretations around the motivations for risk management as a corporate policy. Finance theory does a good job of instructing firms on the implementation of hedges, but important questions remain regarding the determinants of the extent to which a company hedges[2], the impact of risk management on a firm's value, and the interaction between a firm's hedging policy and its other policy decisions. Both practitioners and academics agree that managing financial (and other corporate) risk more effectively is a way for companies to build shareholder value.[3] But there is a less clear-cut guidance on the whys and hows.

In order to ensure that corporate risk management strategy can add value for shareholders, a sound relationship has to be set up between the two – risk management and shareholder value –, which is grounded on economic, financial and behavioral rationales. The capability to model such mechanism is essential to provide evidence for the existence of an optimal risk management approach in case of any corporation, and to give quantifiable measures to the

[1] Throughout the paper I will refer by 'corporation' or 'company' to any non-financial firm.
[2] Hedging means that a corporation reduces its exposure to a particular risk factor, whilst speculation is used to signify the increase in the corporation's neutral level of exposure to some risk factor. Hedging can be powerfully achieved with the help of financial derivatives, but in practice, corporations have alternative means of effecting risk management strategies (e.g. internal operational hedges (pricing terms of contracts, choice of locations, etc), mergers and acquisitions, or choosing appropriate capital structure (debt currency mix)).
[3] 98% of financial professors at the top 50 business schools worldwide agreed with that, according to a survey conducted by ISDA [2004].

hands of both management and shareholders, along which they can assess the appropriateness of such policy.

The shareholder added value of a company operating in a specific industry with specific activities may be raised in two main areas with ideal shareholders' decisions. First it may be raised in the *original value creation phase*, as I call it, which defines the original corporate added value calculated as the market value of the company before taxation, independent of capital structure decisions, divided by the invested capital required for the operation of the company. The thus defined added market value of the original company[4] may be increased by improving and exploiting the competitive features of the company within the limit specified by the structural growth and risk parameters of the relevant market (existing customers, sales channels, branding, production capacity and efficiency, etc.). Consequently, the most important issue here is how the pre-tax yield of the invested capital, adjusted with systematic risk, may be increased and how the average long-term growth of invested capital may be improved to create additional value

The second area for shareholder value creation is when the *original corporate added value is internally allocated among the stakeholders representing the claim against corporate value*. In this context, stakeholders are the state based on tax payments, the creditors based on the interest payable on loans and principal repayments, any other third party that earns revenues from the company as a result of some transaction costs (e.g., the various legal and lawyer associations in relation to bankruptcy, beneficiaries of transaction fees related to business decisions, such as financial institutions, etc.), the management involved in a share option or other compensation, and the shareholders themselves. The most important issue in this area is how to transform the most of the corporate added value to the shareholders.

Corporate risk management in its wider definition (besides the use of classical financial risk management instruments (derivatives) and analytical tools, also including business policy, strategic, and capital structure decisions) may achieve positive value effects in both areas. These value mechanisms are described directly in this context, or indirectly, in the framework of other corporate financial theory issues by various schools of the technical literature, but they do not provide a comprehensive structured framework of these impact mechanisms.

[4] In other words in this case I define the added value with the price-to-book (PB) ratio, in which the actual added value can be quantified as *(PB-1)*.

I.2. Impact on internal allocation

The so-called positive theory of corporate risk management explains the value creating capability of risk management with the *imperfection of the capital markets*. The estimated direct and indirect bankruptcy costs, the financial (creditors vs. shareholders) and economic (management vs. shareholders) agency costs, the expected extra premium due to the asymmetry of information, the corporate income tax and transaction costs of external financing all lead from shareholders' perspective to the pointless leakage of the original corporate added value. Consequently, these estimated deadweight losses should be reduced even before the 'internal allocation' takes place, for which the tools of the widely interpreted corporate risk management can be used.[5]

It is a characteristic feature of the listed market imperfections that they have different asymmetric impacts in the value bands (on the left and right-hand side of distribution) of the estimated original corporate value process (leading to a higher loss on one side than the added value created on the other side, if such value is created at all). Thus *they make the corporate value after deadweight losses concave alongside the original value process*, which means that by reducing the volatility of the value process, its estimated value may be increased. Consequently, the reduction of the volatility of the original corporate cash flow creates value for the shareholders.

For the corporate analyst, often thinking only of CAPM frameworks, this also means that the shareholder value should not only be quantified with the systematic risk. *The expected value of shareholder cash flows is influenced by the total volatility of the corporate cash flow*.[6]

I.3. Impact on the original value creation

Within the positive theory, several models are dedicated to the so-called economic agent problems, which may lead to deadweight losses due to a conflict of interest between the management and the shareholders. They may result from the management's different risk

[5] In this context, corporate risk management, in compliance with the MM theory, does not expressly aim at forming the risk profile of the share, which can be achieved by the shareholder himself by creating an adequate portfolio. On the other hand, contrary to the MM conclusion, the corporate risk management tools may prevent the destruction of shareholder value, which cannot be achieved by the shareholders.

[6] However, the reality is more complicated. As we shall see later, very often the primary objective is the reduction of the volatility of accounting indicators and the accounting profit instead of the corporate cash flow, which often increases the original volatility in cash flow.

tolerance willingness, the asymmetry of information surrounding the evaluation of management capabilities, or the focus on the selfish interests of the management. In terms of shareholder value, these may lead to sub-optimal investment, business and, as we shall see, risk management decisions, causing primarily a loss in original value creation but, indirectly, they may also affect the volume of deadweight losses in internal allocation.

Also, in a partial overlap with internal allocation deadweight losses, the original corporate value may also be influenced by missed valuable growth opportunities due to the inflexibility of funding or the increasing marginal cost of external financing. In this context, the maintenance of a sufficient debt capacity could be an important value creating factor as, on the one hand, it increases the tax shield effect and, as a result of the clear gearing impact, it also increases the shareholder PB ratio.

During the last few years, increasing emphasis was put in financial literature on the analysis of the ways in which the widely interpreted risk management can increase original value creation. A risk management policy adjusted to the hedging strategy of competitors, and assisting the exploitation of the real option inherent in the flexibility of production (e.g., interruption of production) and helping to achieve relative growth advantages can clearly generate business value. Similarly, the exploitation of flexibility inherent in the production tools and sales contracts (e.g., production capacity that can be operated for dual purposes) and its application for arbitrage purposes can create additional value.

A company which keeps those risks in which it has a comparative advantage (natural owner of the risk) and eliminates all other risks either with financial instruments or with business decisions (e.g. outsourcing) can not only cut its hedge transaction costs, but may also obtain a competitive advantage. Providing value added services of risk management (e.g., incorporation of risk transformation solutions that may be created by the company cheaper into the value proposition to customers), arbitrage profits from active trading and mediation commission revenues may also provide further added value.

I.4. Shareholder value creation with the use of swap-based asset yield hedging and dynamic capital structure policy

Surprisingly the technical literature does not deal with how or to what extent the volatility of the future market value of a company may be influenced with hedging instruments, although numerous theories and empirical studies support, as also seen in the previous chapters, that the corporate value process volatility reduction could be valuable for the shareholders. Ross [1996] is the only one who dealt with this issue for similar reasons and derived a formalised formula, quantifying the maximum ratio (z) to which the volatility of the value process of the initial company can be reduced with the use of hedging instruments closing a given correlation with the value of the assets of a company.

Although this explanation is formalized, it raises several theoretical and practical problems. On the one hand, the original value process of a particular company cannot be observed directly, instead it could be derived from its derivatives, the market values of the outstanding debt and equity. However, in this case we can only derive the corporate value after the impact of market imperfections, which may lead to significant distortion in any optimization task relating to a corporate value before the internal allocation.[7]

Such indirect observation of correlations is also dangerous for a specific company because in its history – for which correlation and volatility data are to be calculated – the company did not pursue a consistent capital structure or risk management policy in most cases, and therefore the market imperfections realized in the past could not be considered permanent either. Therefore, the estimation of future correlations in this way may result in further distortion.

For the very same reasons, the methodology proposed by me lead to minor distortions, because – instead of the corporate value reflecting capital structure impacts – it is based on the EBIT-based asset yields, representing the driver of the original value creation process (see later). This process not only reflects the fewest market imperfections[8], but can also be observed more simply than the evolution of the corporate value.[9]

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[7] E.g., if we need to know how to reduce the deadweight losses arising from market imperfection by reducing the volatility of the corporate value process, then we come across a contradiction, because the observed volatility of corporate assets and their correlation factors closed with hedging instruments depend on the size of market imperfection.

[8] As I have indicated earlier, the suboptimal management business and investment decisions resulting from economic agent problems also have an impact on the yield of assets. However, if we can assume that this impact

Similarly, Ross' [1996] theory does not give any answer to practical questions as to how often and in what form an instrument reducing the volatility of the corporate value process should be selected into the hedging portfolio in order to achieve the largest reduction of the volatility of corporate value. Consequently, I analyze how the original corporate market value may be influenced with swap contracts[10] written on industrial risks - or with business policy decisions[11] of equivalent impact -, the volume and/or direction of which being different from the average hedging strategy used by the industrial actors.

I.5. Empirical modeling of the achievable shareholder added value in the oil refining industry

Building on the results of chapter VI., i investigate in an empirical research the size of shareholder added value achievable in case of an average oil refinery by committed corporate value hedging and the parallel increase of debt capacity at unchanged credit rating.

In this analysis, my aim is to arrive at results that are concrete, and can also be interpreted from a practical point of view. For this reason, I am looking beyond the assumption presented so far, i.e. that swap contracts are available to hedge the entire industrial risk, and I narrow my scope to an actually traded swap type, the diesel crack spread swap. I have made this choice because taking the example of MOL Group the hypothesis can be supported that in the case of refineries holding refinery technologies and business portfolios like MOL, the market (industrial) risks of earnings can be divided into two, nearly orthogonal components, namely the diesel crack spread and the linear combination of other market risk factors. Owing to this orthogonality, for such a company we can measure – without the distorting effects of multi-collinearity – the extent of the increase in debt capacity that can be achieved with the hedging

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is very low in the case of the company, or if it may be assumed while drawing conclusions from the analysis that these agent costs will remain unchanged, then this phenomenon will not distort the result.

[9] It is especially problematic for companies not listed on the stock exchange.

[10] In contrast with options, I chose swap contracts for my analysis because, on the one hand, in those industries where there is a financial market to hedge against the industrial risk (typically these are the "commodity' markets), the swap contracts are the most liquid hedging instruments available for the longest term and, on the other hand, for swaps the pricing is also more transparent, the transaction costs are lower and they do not generate any cash demand from the companies when they are established – these factors all add to their popularity in practice.

[11] Naturally, not each industry has a liquid derivative market fully or partially reflecting the industrial risk. However, non-financial tools such as business policy (e.g., so-called pass-through sales price agreements, purchase and sales price agreements based on moving average or long-term fixed prices), or strategic (e.g., vertical or geographic integration) instruments may also be considered swaps, as using them the company may also reduce the volatility of the original industrial risk.

of the diesel crack spread with any balanced swap basket of a given swap-term, as well as the resulting shareholder added value.

II. METHODS APPLIED

The dissertation consists of three major parts. Relying on the technical financial literature of the recent years, the first section – including Chapter II, III, IV and V – summarizes the impact mechanisms and the extent to which the risks of a company may be managed with various instruments and various directions to create value for the shareholders in the two areas of shareholder value creation: original corporate value creation and the internal allocation process. On this purpose, I put the conclusions of relevant schools and model-families of financial literature into a structured framework, highlighting the various, often conflicting ways of value-creation impact mechanisms and associated palette of available tools.

In the sixth chapter of the dissertation, I analyzed how swap contracts can influence the volatility of the future market values of the original corporate value. The above issues are not at all analyzed in the technical literature.[12] Consequently, I use analytical closed formula to define the impact of the ideal swap basket on corporate value and shareholder added value. A key assumption used is that the industrial asset yield follows an Ornstein-Uhlenbeck arithmetic mean-reversion process, where the long-term mean is determined by the industrial technology and the balanced level of market demand. I use the Mathematica software for the illustration of relations and quantification of results.

In chapter VII., I applied a combination of different methods to arrive at the empirical analysis of the achievable shareholder added value for oil refineries via the steady hedging of diesel crack spread. On the one hand, I have used the CF@Risk model and 2003 business data of MOL Group to quantify the contribution of the diesel crack spread to the volatility of corporate asset yields. The CF@Risk model has been developed for the continuous modeling of the Group's operating results for 12 months in advance using Monte Carlo simulation

[12] As I describe it in the fourth chapter, Ross [1996] uses a structural model analysing the additional shareholder value increase with the optimisation of the capital structure by reducing the volatility of the corporate value process to a specific extent. The model quantifies approximately 10-15% shareholder value increase for an average company. However, Ross does not analyse the reasonability of the assumption of the reduction of the corporate value process volatility or its relationship with the nature of the risk process of the industrial asset value.

technique. Building on the relations embedded in the model, I have conducted a multivariate statistical analysis, the so-called principal components analysis using software SPSS.

For the calibration of the mean reversion parameters of the diesel crack spread, the market data for US diesel (USGC) and crude oil (WTI) have been used for the period from January 1990 to February 2005 in a monthly breakdown.[13] In the period after February 2005, there has been a major disruption in the course of the diesel crack spread, reflecting the fundamental changes occurring on the oil market. Since one of the key assumptions has been taken from the correlations embedded in MOL Group's business performance in 2003, and because the mean reversion process is worth being calibrated only for periods featuring homogeneous market fundaments, the details of my analysis show the relations of the equilibrium on the oil markets until February 2005.[14] The parameters of the Ornstein-Uhlenbeck mean reversion process can be estimated from the monthly crack spread data and the regression analysis of the associated price changes (see Dixit & Pindyck [1994] pp. 76.).

In order to quantify the size of the shareholder added value that can be achieved with the hedging of the diesel crack spread, the mean reversion parameters of the refinery asset yield process and other necessary business parameters of the sectoral actors (e.g. gearing, growth rate, expected rate of return) are to be estimated on the basis of the historic performance of the market in relation to sectoral actors that are similar in size and structure to MOL Group, and – in view to the assumed endogenous bankruptcy – are run with bond financing.

Bond financing is primarily characteristic of US capital markets, and therefore I have performed the empirical analysis in relation to this market, in two distinct ways. On the one hand, I have succeeded in obtaining annual information starting from the year 1977 in connection with the aggregated net tangible asset and EBIT figures of US market actors involved in oil refining and trading from the database collected and published by the Energy Information Administration. In the other technique, I have identified four small and medium-sized companies operating in the US market for at least 20 years and involved specifically in oil refining and trading (Valero Energy Co., Tesoro Co., Sunoco Inc., Holly Co.). For these

[13] The series of monthly data have been borrowed from the Platt's database with the earliest available figures going back to January 1990.
[14] After the establishment of a new equilibrium on the oil markets, with a sufficiently long series of data the process of mean reversion can be re-calibrated.

companies, quarterly asset[15] and EBIT figures have been collected from the Reuters database, from the year of 1990. Both techniques have resulted in nearly identical mean reversion parameters for the process of the US refinery asset yields in recent decades (up to 2004).

Furthermore, on the basis of the Reuters database, my model relies on the following parameters in relation to the US market and the sectoral actors: refinery asset beta: 0.84; risk-free yield: 4%; risk premium: 5%; average refinery gearing[16]: 20%; average refinery credit risk premium (BBB rating): 200 bp; average annual increase in assets: 4%; marginal corporate tax rate: 40%. The literature on structural models[17] typically recognizes a 20–25% bankruptcy costs in relation to the value of the company. Following Ross' [1996] assumption, this value is set to be 22%. For transactions of normal volume, the transaction costs of diesel crack spread swaps are around 0.2% (see Dunis et. al. [2005] pp. 7).

The above analysis can be performed so that the parameters of the hedged company used in my model ($H_m^{n,i}$) are made equal to the corresponding parameters of the company ($\hat{F}_m$) which hedges its diesel crack spread exposure with described swap baskets and have assumed parameters as described above.

III. KEY RESULTS OF THE DISSERTATION

The dissertation contributes to the financial literature with below major results and conclusions:

III. 1. Value-creation impact mechanisms and available tools of corporate risk management

A key result of the dissertation is the comprehensive and structured summary of the potential impact mechanisms taken from the technical literature or real-life practice, which may be applied to corporate risks to increase shareholder value in one or the other form of shareholder value creation. On the right hand side of Figure 1, I have also indicated those potential instruments with which a particular impact mechanism may be most effective. This diversity illustrates well that corporate risk management can function really well only if it is implicit in

[15] The volume of invested capital has been estimated as the sum of net tangible assets and net current assets (current assets – current liabilities).
[16] Interest-bearing liabilities/Total assets
[17] See e.g. Leland [1998] pp. 19, Ross [1996] pp. 22

all the strategic and operational decisions of the company as a result of continuous co-operation of the various functional units. The most important conclusions made throughout the overview are the following:

- Minimization of dead weight loss is a very complex task because *it simultaneously requires influencing various corporate target parameters on different time horizon*, and these impact mechanisms may also be contradictory to each other – especially if we think of the application of financial hedging instruments only.

- Typically in bond financing, when the creditor cannot monitor the borrower regularly based on financial covenants, the primary objective is *to reduce the downside risk of the original corporate market value*.

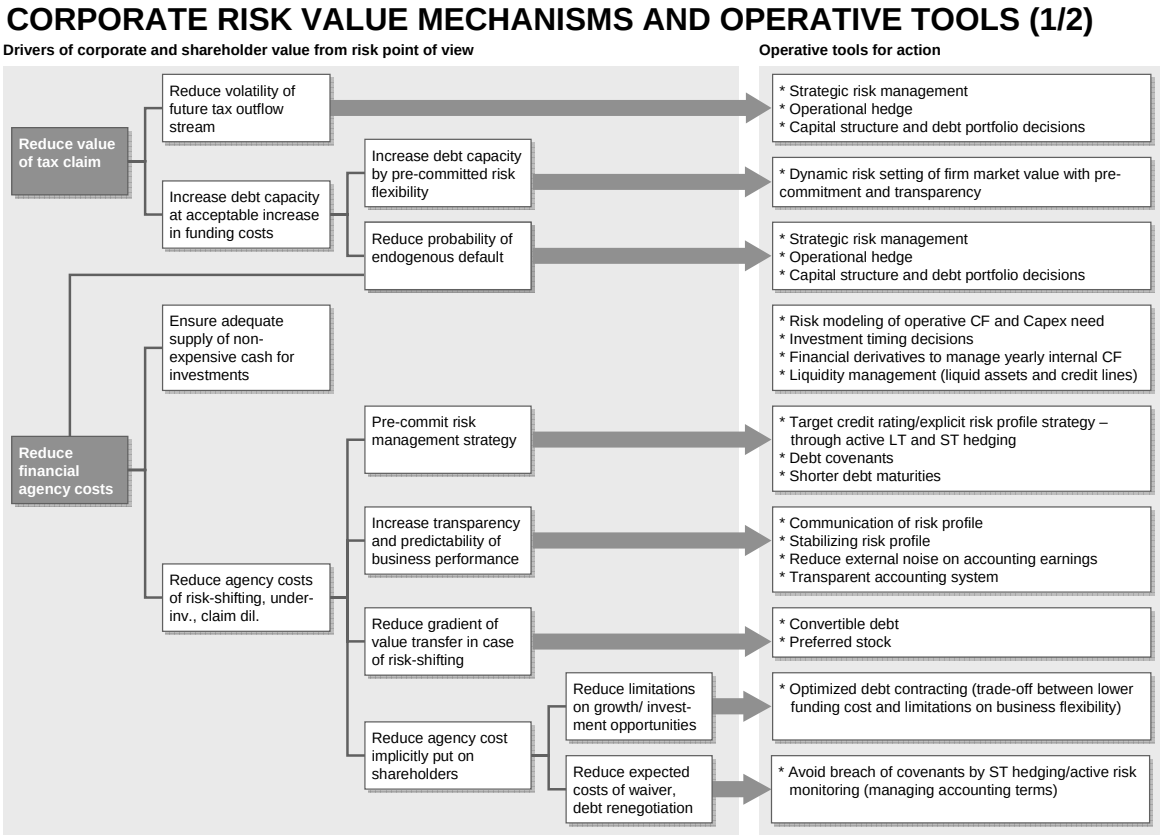
- *Co-ordination of short-term corporate (before investment) cash flow* and the estimated demand for investment is an especially important objective for those companies, which (due to their size, the information asymmetry surrounding the company or unfavorable credit rating) find it more difficult to raise funding at acceptable costs on a short-term, yet they have considerable growth demand.

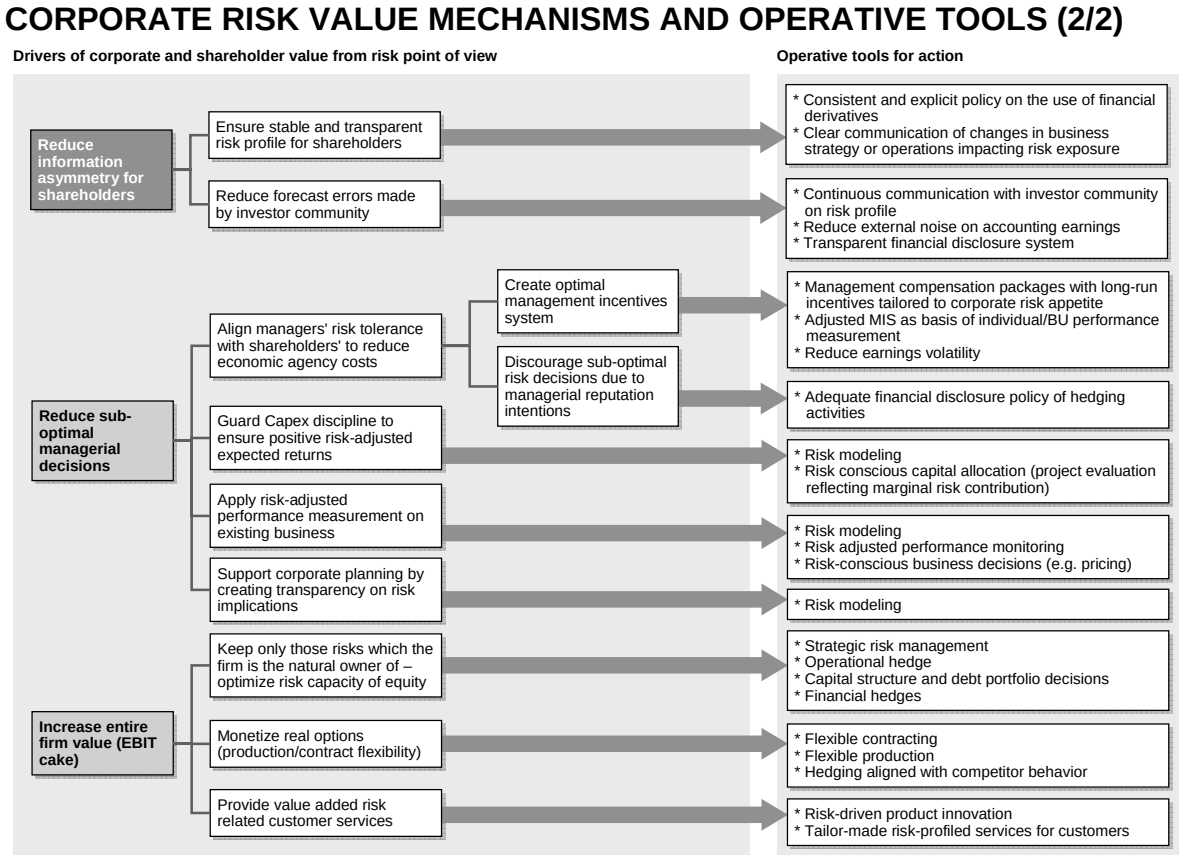
- *The future distribution of the original corporate value* process and its downside risks thereof *cannot be influenced considerably with financial derivative instruments.* Strategic and business policy instruments offer more effective solutions for managing the risks of the original corporate value process.

- Although it does not have any impact on the risk of the original corporate value process, *the financing policy also offers an instrument* of equivalent impact in terms of the correlation between the bankruptcy limit and corporate value.

- Any instrument can only effectively reduce the applicable additional costs of financing if the *creditors consider credible the management's efforts* to ensure that the corporate risk profile will not change negatively from the agreed profile during the term. Possible tools are financial covenants of loan agreements, maintenance of a

Figure 1
Value creation impact mechanisms and available tools of corporate risk management





specific credit rating category for a long-term and its active communication, use of shorter-term loans, convertible or recallable bonds.

- Whenever the risk management policy is chosen, a company cannot be examined in isolation for the sole purpose of minimizing the dead weight of the internal allocation process. Instead, the company must also be *evaluated in the context of sectoral competition*.

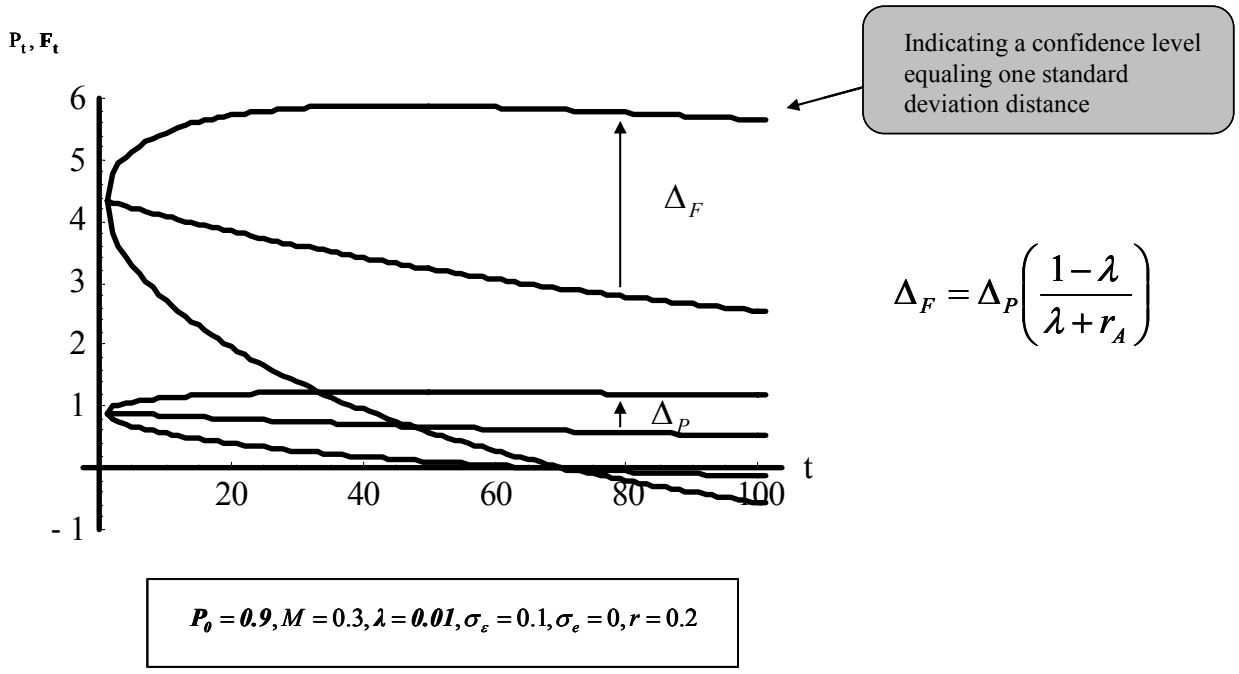
- There is also considerable value creation potential in the *prevention of sub-optimal management decisions*. Risk management can create value in this respect by reducing the economic agent costs, creating transparency on the risk consequences of corporate decisions and providing regular feedback thereon, or even by reflecting the risks more clearly in the corporate business planning process.

- Offering *value added services* related to risk management (e.g., integration of risk transformation solutions to its value proposition for customers) and generation of arbitrage income and mediation commission revenues through active *trading* may create further additional value.

III.2. Shareholder value creation with swap-based asset yield hedging and dynamic capital structure policy

Modeling the asset yields with a mean-reversion process indicates a very interesting relationship, according to which 1 percentage point deviation of the asset yield due to industrial factors will move the corporate PB value by $\left(\frac{1-\lambda}{\lambda+r_A}\right)$ percentage point from its previous expected value. If there is perfect reversion, then the fluctuation of the asset yield process does not influence the PB ratio (the corporate value process is free of risks). In a diffuse asset yield process, $\frac{1}{r_A}$ of the yield change is integrated into the PB ratio, indicating that the mean value of the process has been shifted, and therefore the change will be integrated into the current market value of the company as a permanent annuity. Consequently, the strength of mean reversion is critical in the correlation between the periodic yield changes and the market value of the company. (See Figure 2)

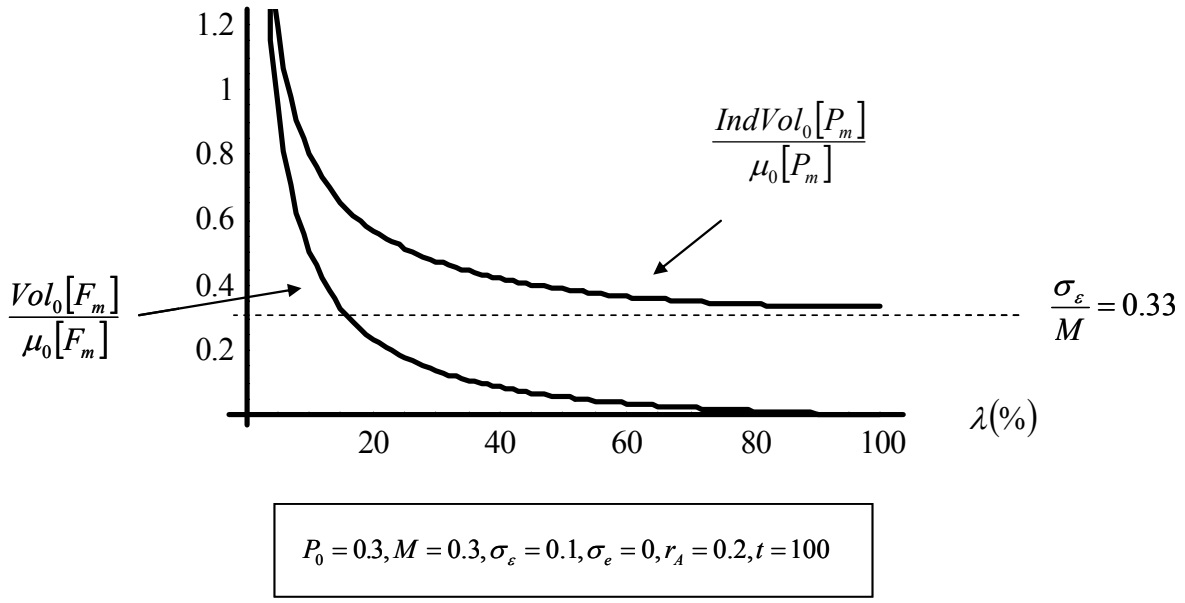
Figure 2
Relation of the asset return process and the corporate PB process



The starting asset yield in the illustrated case is above its long-term mean, hence the expected values of both processes converge to their long-term mean (F→ 0.3/0.2 = 1.5, P → M=0.3), however, the convergence goes slowly due to the low level of reversion factor.

By quantifying the relative volatility, we can also see that the relative volatility of the PB process remains below the relative volatility of the asset yield process under all circumstances, and the two values become equal only in a diffuse state. As mean reversion increases, the volatility of the PB process moves towards zero, while that of the asset yield moves closer to its single-period volatility. Consequently, if there is strong enough mean reversion, the PB process is highly insensitive to the volatility of the asset yield. (See Figure 3)

Figure 3
Comparison of the relative volatilities of the industry asset return and the corporate PB processes with different reversion factors



$P_0 = 0.3, M = 0.3, \sigma_\varepsilon = 0.1, \sigma_e = 0, r_A = 0.2, t = 100$

With the help of my model, i was able to prove the following hypotheses:

Hypothesis 1

If the swap contracts available on the market have a term of n=2k period only, then for the purpose of long-term reduction of the volatility of the asset yields at a given point of time far in the future, the structure of the chosen swap basket is absolutely irrelevant.

Hypothesis 2

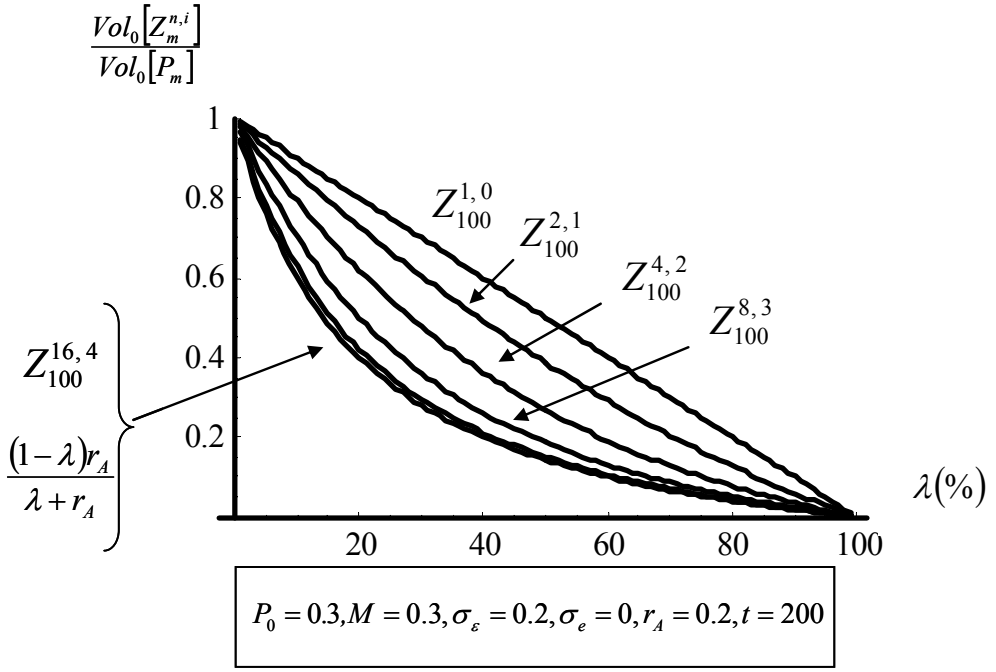
The longer the term of the available swap contract is, the more effectively the resulting balanced swap basket can reduce the long-term volatility of the original asset yield process. However, the marginal efficiency improvement that can be achieved with the longer term is decreasing, maximizing the potentially available hedging impact.

(See Figure 4)

Hypothesis 3

If the swap contracts available on the market have a term of $n=2^k$ period only, then there is an ideal swap basket structure which, with 100% relative hedge, can most efficiently reduce the uncertainty of the asset yield process on a short term.

Figure 4
Ratio of the volatility of hedged asset return process using most frequently refreshed balanced swap baskets of different swap-terms and the volatility of original asset return process with different reversion factors



Hypothesis 4

If swaps with various terms are available at the same time, mixing ideal balanced swap baskets of various terms will not result in better hedging impact than what is achievable with the use of the ideal balanced basket of the longest term.

Hypothesis 5

The use of single-period-term swaps will not have any impact on the expected future volatility of the PB process.

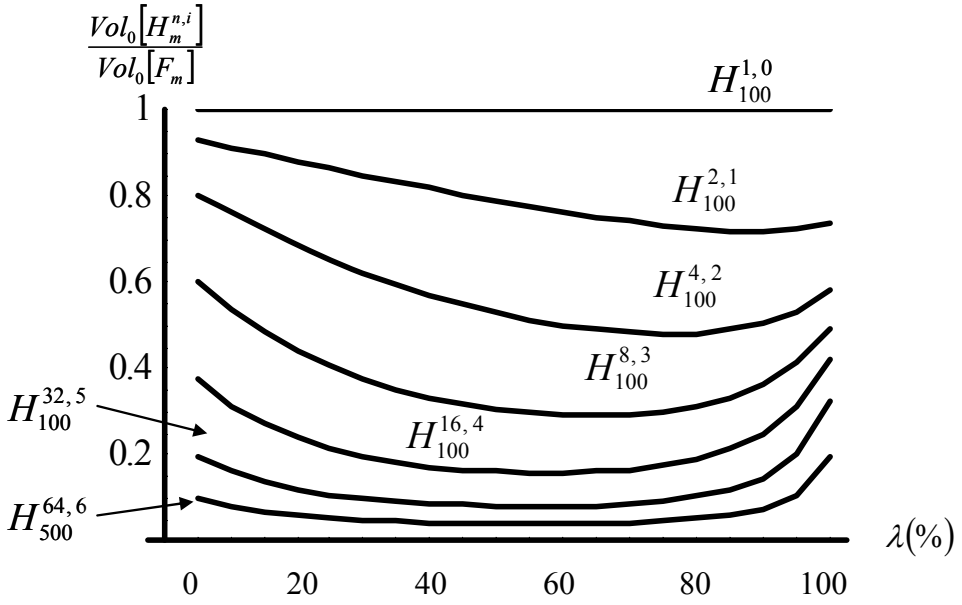
Hypothesis 6

With a given swap term, the maximum reduction of the future volatility of the PB process for any future time can be achieved with a periodically refreshed balanced swap basket, and therefore this represents the ideal swap strategy for any long-term increase of debt capacity.

Hypothesis 7

The volatility of the original PB process of the company may be reduced close to zero with a sufficiently long-term, periodically refreshed swap basket even with weak mean reversion (as opposed to the volatility of the asset yield process). (See Figure 5)

Figure 5
Realized reduction in the volatility of corporate PB process using most frequently refreshed balanced swap baskets of different swap-terms at different reversion factors



$P_0 = 0.3, M = 0.3, \sigma_\varepsilon = 0.2, \sigma_e = 0, r_A = 0.2, \boldsymbol{t = 200}$

III.3. Empirical modeling of the shareholder added value achievable in the oil refinery industry

With the empirical research, I justified the following hypotheses (except for Hypothesis 11):

Hypothesis 8

Being strongly explanatory in nature, the market (industrial) risk present in MOL Group's earnings (asset yield) can be described with the use of factors, which are linearly transformed forms of observable market risk factors, are orthogonal to each other, and one of them is the diesel crack spread itself

As a result of the principal components analysis, it can be demonstrated that using the diesel crack spread and 4 additional latent factors being orthogonal to each other, 94.4% of the HUF-based earnings, being the dependent variable, can be described, and the diesel crack spread explains 55% of the variance of the operating earnings.

Hypothesis 9

The diesel crack spread follows a mean reversion process.

For the period from January 1990 to February 2005, the US diesel crack spread could be described with the following mean reversion parameters to be interpreted on a monthly level: 14.6 $/ton as the long-term mean value *(M)*, 0.34 as the reversion factor *(λ)*, while the normally distributed noise of the process *(ε)* has expected value of 0 and monthly standard deviation of 9.4 $/ton.

Hypothesis 10

Asset yields of refineries being similar to MOL can be properly described with a mean reversion process.

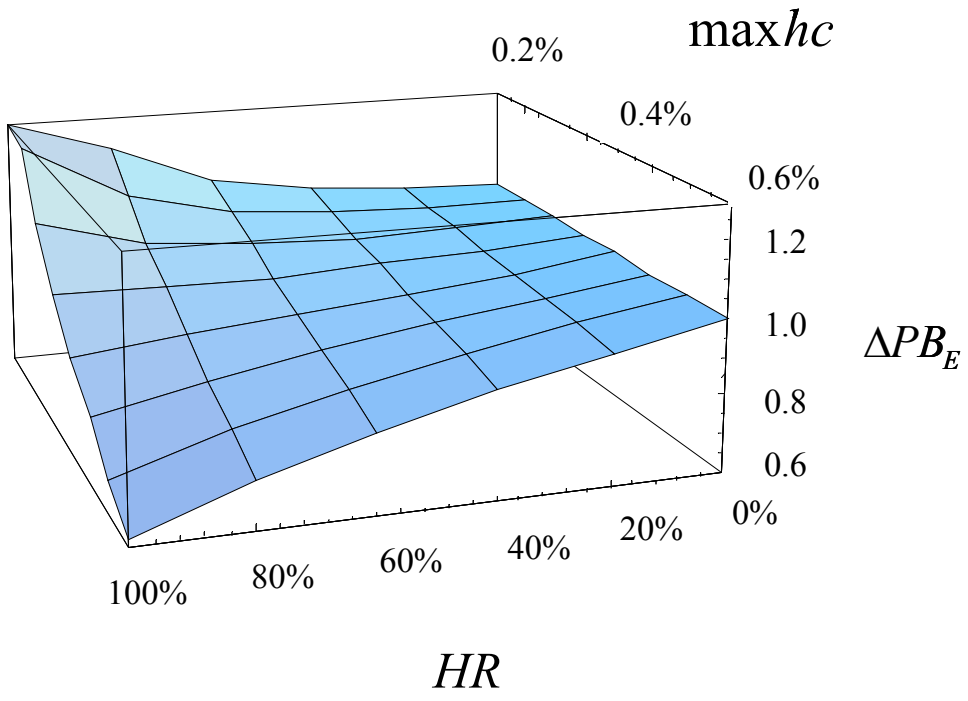
I have estimated the following mean reversion parameters: 2.7% as the mean value of quarterly asset yields *(M)*, 0.61 as the quarterly reversion factor *(λ)*, 0 as the expected value and 3.0% as the quarterly volatility of the normally distributed noise *(ε)*.

Hypothesis 11

In the case of an oil refinery being similar to MOL and operating with endogenous bankruptcy limit (bond financing), the permanent hedging of the diesel crack spread with a balanced swap basket of 1–1.5 year term and with a 50% hedging ratio potentially generates a considerable shareholder added value (in excess of even 20–30%) provided that the swap curve of the diesel crack spread is CAPM-conform, and max. 0.2% transaction costs are incurred with hedging.

The correlation suggested in Hypothesis 11 has been confirmed in terms of its direction, yet the shareholder added value that can be achieved with 50% hedging ratio is smaller than expected, only 6% in comparison to the foreseen 20–30%. Nevertheless, with the increase of the hedging ratio and any growth of assets in excess of the sectoral growth rate, shareholder added values may be realized even above 20–30% through the described value mechanism. Yet, it is extremely sensitive to the volume of transaction costs incurred with the given swap strategy: with the transaction cost level of the diesel crack spread swap being over 0.4%, for an average oil refinery company it does not pay off to follow a long-term hedging strategy on the diesel crack spread as an attempt to increase its long-term gearing. (See Figure 6).

Figure 6
Increase in shareholder value at different levels of hedge ratio and hedge transaction cost



$$Negyedéves: P_0 = 0.027, M = 0.027, \sigma_\varepsilon = 0.03, r_A = 0.02, r_F = 0.01, \hat{i} = 0.005,$$
$$\hat{a} = 0.005, tax = 0.4, L_0 = 0.2, Th = 0.1, t = 100, g = 0.01, \lambda = 0.61, bc = 0.22$$

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V. OWN PUBLICATIONS RELATED TO DISSERTATION

The following articles related to the topic of dissertation have been accepted for publishing throughout the first half of 2009:

- Acta Oeconomica: Shareholder value creation using asset yield swap contracts

- Hitelintézeti Szemle: A vállalati kockázatkezelés értékteremtő képességének rendszerezése és modellezése