Assessing counterparty risk at private companies in energy industry

A descriptive survey of credit models

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Acknowledgments

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Abstract

Within the scope of this master thesis the author aims to perform an overview of contemporary credit risk measurement and management models on the subject of their application in energy trading sector. For that task, selected models are considered and the advantages and drawbacks for the particular application are discussed. The study is supported with specialists’ opinion and an example from successful energy trading practice from US energy industry.

The study also intends to prepare a theoretical framework for undertaking a further large-scale study among Swedish power traders. Regarding the last ambition, author’s outlook is guided by energy market surveys and reports of relevant authorities and energy companies in Sweden. It is also supported with insights about the market obtained through an interview with a power trader at one of the leading energy trading companies in Sweden. Materials obtained for the present study are confined to those available in the English language.
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1. Introduction

Industrial companies have recently faced additional issues of dealing with foreign markets and regulations together with recent technological advances, tendencies to economic globalization and overall cross-border expansion for new business benefits. Companies have to closely scrutinize their more concentrated and often distant credit risks representing one of their main hindrances to growth. Due to the improving economies’ openness and competition. Key reasons for recent intensively addressed credit risk management issues, which many academics agree upon, could be summarized as follows:

1. Challenging economic conditions and structural increase in bankruptcies, reflected in "stronger mandates for transparency into risk and balance sheet health" \(^1\),
2. Disintermediation and deregulation encouraging innovations and enabling new entrants to act in various economic sectors, by changing the outlook for role of trading and other mark-to-market activities in the firm \(^2\),
3. More competitive margins and relative maturity of many of the industries,
4. Declining and volatile values of collateral as well as the substantial increase of collateral agreements,
5. The growth of off-balance-sheet derivatives and respective risk-return analysis,
6. Advances in analytical techniques and methodologies: econometric techniques, neural networks, optimization models, portfolio management approach etc,
7. New regulatory developments and business evidences in financial risk management, i.e. BIS capital adequacy recommendations, robust control across firms, standardization of financial instruments and risk reporting.

Credit risk is a complex category and sometimes represents a greater challenge than both market risk (to predict when and under which conditions a counterparty might default), and the purely endogenous operational risk. Credit risk undeniably depends on market risk, but while market risk can be made homogeneous by category, like for example, interest rate risk, foreign exchange risk, credit risk is so to speak much more personalized. At the same time in energy industry, for example, electricity producers and traders show high performance sensitivity to market conditions, i.e. electricity price fluctuations, which makes credit risk and market risk inseparable for strategic analysis and resumes their joint modeling.

\(^1\) http://www.euco.com/conferences/december_03/enterprise_conf.htm
\(^2\) ibid
Another aspect of assessing credit risk is evaluating each counterparty individually or at a combined risk-portfolio level. The former approach is known as traditional, based on credit expert opinion, and is presently considered as a passive credit risk management tool while encountering for a numerous valuation methods and techniques. Managing credit risk within a portfolio is a relatively recent approach. The groundwork in this area belongs to H. Markowitz, “Portfolio Selection”, Journal of Finance, 1952.

Further to the increased application of portfolio methods in credit instruments’ valuations, recent practice within corporate risk management reveals a growing interest for integrated risk management at entire company level rather than determining and managing different risks at divisional level. This approach is known as Enterprise-Wide Risk Management (EWRM), where much of the efforts of companies’ management is put into the integration of existing risk modeling tools, and aggregate stress testing of various risks. “EWRM system may be necessary to pull together all the different threads”1.

There are different ways of managing credit risks for different companies: for financial institutions the mechanisms of handling credit risk issues are mainly embedded in various credit derivatives, while for non-financial companies those are mostly involved in the legibly formulated contract terms. At the same time, however, we are observing erasing the conceptual distinctions between financial and nonfinancial companies due to the same more competitive environment and globalization processes.

It is a known fact that generally speaking industrial companies are not well-equipped in the credit risk measurement area can also be because their potential losses are easier mitigated due to the fact that their credit risks are relatively low. “Trade receivables are generally high-quality assets because companies are very reluctant to jeopardize their relationships with the partners”2. In addition, trade receivables of industrial companies are relatively short-term in nature and thus the collection procedure is relatively easier.

However, credit risk of trade intermediaries, i.e. power traders, not being backed with as large tangible assets as energy generators, and earning a competitive profit margin on energy trade, might be considered as a category of players needing to model their credit risks at a most advanced level by replicating the already mature financial companies’ expertise.

The present study addresses the above underlined issues in a more detail while having a particular focus on credit risk issues in the energy sector.

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2 Caouette et all, 1998 p. 48
1.1 Background

After several tarnishing bankruptcies in the US energy industry, i.e. Enron and Pacific Gas & Electric company (PG&E), and the subsequent series of credit rating downgrades by Rating Agencies, many industrial companies started to realize that one of their most important risks, counterparty risk, is significantly undermanaged. While market risk is the most watchful and largest risk faced by energy companies, particularly for gas and power marketers, credit risk is the next important factor.

When considering credit risk issues on the Swedish energy market, it can be said that most of them are related to the recent electricity market deregulation in 1996, continuing regulation and system development, redistribution of productive forces among market participants etc. Along with its positive contributions for healthy market competition, deregulation also created a lot of tasks necessary in developing an efficient market mechanism, and hence a highly liquid electricity trade. The opportunity of using financial derivatives to hedge the ‘dry-years’ enables the protection of the energy companies’ profit. However, this market, i.e. trading at Nord Pool – Nordic Energy Exchange, and OTC market, needs further improvement with respect to trading terms and achieving better liquidity of traded contracts. For instance, among the Nordic countries presently forming a common electricity trade area, the Swedish electricity market is far more centralized with respect to energy productive forces. It is evident that electricity producing/generating companies generally face less risks than trading companies because the formers are integrated with their own supply/trading companies, and that they trade or hedge at NordPool more or less the excess or the shortage of the necessary power. Besides, while big energy producers face counterparty risk with a limited number of partners - mostly from NordPool - the largest volume of energy trade is subject to risks on the OTC market. It should however be mentioned that the present level of bilateral trading is decreasing in favor of NordPool due to the tendency of designing customer-tailored contracts which are gradually becoming a part of trading instruments at NordPool because of their increasing recognition by market participants.

Presently a number of analytical methodologies corporate risk management software solutions are widely available for application at various economic areas. Among these are integrated risk modeling packages for financial institutions, investment and insurance companies, multinational corporations as well as industry-tailored risk valuation methodologies. These risk management solutions and frameworks are based on notable advances in option pricing theory, appearance of new tools like VaR and its variations, and newly designed financial instruments, as for example energy derivative contracts.
Despite the fact that best known credit risk models were initially developed for financial institutions, with their large customer credit information, large industrial corporations also increasingly benefit from these model applications. The specific feature to differentiate between financial institutions’ and industry-wide approaches to credit risk assessment is that the formers dispose large databases of customer credit information, and are the first directly facing the effect of unfavorable economic changes in form of customers’ defaults of both high frequency and severity. Distinction between financial and non-financial companies is necessary to point out because the formers have different financial statement characteristics: on average they have more a leveraged structure and because of their risk-taking function are thoroughly regulated with respect to capital requirements. Non-financial (industrial) companies are traditionally backed with relatively stable value bearing assets against short liquidity problems and receivables collection issues, and thus their operations are, not generally, perceived to be as risky as those at financial institutions.

The above mentioned issues relating to the importance of credit risk measurement and mitigation among power traders, have contributed to the formulation of the problem for the analysis and study purpose to be explored within the present thesis.

1.2 Problem discussion

Many energy market specialists presently point to the importance of design and implementation of appropriate credit risk management systems within energy industry. It is reflected in a conceptual shift from focusing on receivables collection as one of few reported financial statement lines pointing to the size of carried counterparty risk. Nowadays industrial companies recognize that the “replacement costs” of long-term contracts carry significantly larger loss potential.

Measuring counterparty credit risk involves capturing the threat of potential future exposure, specifically, how much the counterparties could owe to a given company in the event of solitary or mass default. A significant part of this risk is likely to be the replacement cost of the long-term contracts, very common to energy trade. Analysts following energy industry point that while risk managers at energy firms are aware of the necessity to improve their firm’s credit risk management capabilities by closer monitoring, managing, and mitigating them, most managers still remain focused on current exposure measurement, i.e., current mark-to-market exposure, plus outstanding receivables, and collateral management. The problematic side of this approach
is the extensive attention to the presently more quantifiable risks which falls short in providing an acceptable indication of credit risk at future points. Hence, many economy theorists and practitioners currently exploit measures capturing potential credit exposure, given potential and seasonal fluctuations of electricity price\(^1\) as well as trying to capture the maximum likely potential exposure or probable maximum level of losses.

Taking into account business characteristics of the energy industry, many analysts define *mitigation and limiting exposure to energy market volatility and optimization of electricity generation and distribution asset profitability*\(^2\) as the most vital factors for company prosperity. However, these issues seem to be crucial for the industry in general or electricity generators and network owners, while power traders can focus on achieving somewhat different goals.

*Thr Swedish energy sector*, as any other country, has its own specific market structure, regulation and traditional operating relationships among the players. Presently, in this sector there is no revealed signs of potential exposure in form of massive unpayment by energy end-users, both households and enterprises. Besides which the country has sources for large energy imports which makes the energy supply nearly insensitive to seasonal fluctuations in energy generation. These factors significantly decrease the pressure on energy price and make risk of rationing nearly non-existent. Among the current issues can be mentioned the increased flexibility of production sight versus consumptions areas where despite of occasional interruptions the failure risk is low; partial dissatisfaction of end-users with the high energy prices caused by still potential rationing risk.

Along with the mentioned factors one should notice that few highly vertically integrated market leaders, namely the four major producers amounting about 90% of total electricity generation in the country, are in a much more favorable situation rather than a large number of electricity traders (about 130 companies) managing relatively small-size portfolios of end-user energy provision contracts. Those energy traders who have their own energy generating capacities can better match their output potential to the forecasted consumption levels, and thus better fulfill their “balance resposibility”.

It has already been estimated that electricity price will continue to rise in Sweden “as a result of European integration, stricter environmental demands and, in the longer term, by the need for new capacities”\(^3\). Among various issues under current consideration, the energy market leader Vattenfall specifically

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\(^2\) [http://www.kwi.com/products/PaR_asset риск.htm](http://www.kwi.com/products/PaR_asset риск.htm)

\(^3\) Vattenfall, Electricity Market Report 2002 p.3
points out that “Nordic power markets perform well at wholesale level, but from a customer’s perspective there is room for improvement”. This refers to a quite complicated schedule of bill payments due estimated on historical average rather than actual consumption.

If considering a case of an extremely “bad-year”, where the existing capacities would be insufficient and accompanied with some other coincided difficulties a possibility of prices crisis could occur (the case is rather hypothetical), for which power traders could be the first to face difficulties. Here one can point out that against extreme credit events, i.e. defaults of high frequency and severity due to critically dry-year, or using insurance terminology - catastrophe risk, companies have various opportunities to insure themselves. In general, electricity trading with the underlying product’s high seasonal price volatility, large number of buyers and sellers, and fungible physical products, stimulates development of futures trading. In these conditions the concept of Power Exchange with efficient and liquid clearing and netting system allows for significant counterparty risk mitigation.

Regarding the current state in the Swedish electricity market, and in the Nordic market as a whole, it is a fact that despite the already existing specialized marketplace for organized electricity trade, i.e. NordPool, according to Svenska Kraftnät, only 35% of actual trade is performed through NordPool. The prevailing trade is arranged via OTC bilateral/trilateral contracts, where counterparty risks are still of much importance.

It should be mentioned that there is a great variety of literature and explorative studies of credit risk management issues for public financial institutions and its valuation. As it has already been mentioned, credit risk issues are traditionally less vital for industrial company’s risk profile than for financial institutions. However, industrial companies are currently feeling uncomfortable with their credit risk mitigation approaches and recognize a lack of self-contained default model frameworks and methodological approaches, despite the several recent initiatives from the leading rating and consulting agencies for assigning credit scores reflecting default probabilities for private companies.

The above stated concerns about counterparty default risk faced in general by energy industry have induced the author of this paper to focus on the existing credit risk models and their industry applications. The particular interest towards the energy industry became the reason for considering Swedish power traders as the risk takers. When summarizing the above section, several questions appear to be crucial for this study:

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1 ibid, p.11.
1. What is the importance for power traders to model internally their counterparty risk?
2. To what extent can power traders assess their credit risks to their non-listed counterparties by applying credit risk models (appropriate analytical techniques or simulation software)?
3. If not measured internally, how do energy traders assess their counterparty risk?

Thus, the main problem of this study is to contribute to the addressed issue of internal credit risk valuation procedures by energy traders with respect to their end-user counterparties.

1.3 Purpose

To solve the problems formulated in the previous section, the author aims to review traditional and contemporary credit risk assessing methodologies on the subject of their industry application, that is presently less empowered with analytical procedures and sophisticated credit risk mitigating tools. For the reasons discussed in the previous section, the author chose the energy sector as an application industry, i.e. counterparty risks faced by power traders with respect to their customers, energy end-users.

The author perceives that the mentioned purpose would be achieved through an evolving solution to the following objectives:

1. Revealing the importance of assessing counterparty risk faced by energy traders in Sweden,
2. Reviewing selected credit risk models with respect to their possible application in energy industry as well as presenting successful implementation of internally developed methodologies and expert opinions,
3. Addressing possible ways of transferring counterparty risk as an alternative form of managing them.

1.4 Scope and limitation

The present paper covers methodologies for assessing default probabilities of private non-rated companies (energy end-users) faced by their service providers (power traders). Public companies or those listed at stock exchanges are believed to be well evaluated by the market, and thus their probability of default is presumably
easier to ascertain by analyzing their stock performance and volatility, as well as by studying yield curves and spreads on their corporate bonds. Conversely, private companies usually have a limited number of owners with untransferable shareholdings; their financial stability greatly depends on the wealth position of the company’s owners, and more importantly, their earnings and financial stability is quite volatile. Despite many of them presently being monitored by industry analysts, credit bureaus, consultative agencies, and various supervisory authorities, the common opinion is that the market reacts to their performance issues with a significant delay.

Because of better opportunities for monitoring by financial analysts, public companies are not covered by this study. Instead, private enterprises and individual consumers are forming a customer focus group to be tested on potential risk of default. This fact is supposed to be an additional complication into the current analysis. This paper also does not intend to cover the start-up companies, recently merged or restructured ones, because there are difficulties with valuing highly volatile financial statements and tracing their performance trend and average growing rates.

It should be mentioned that energy traders as well as their counterparties could be of different ownership structure, represent retail or whole trade sector, be integrated as both energy generation and supplier/distributor or be only a retail supplier with or without balance responsibility, be managers of portfolios of end-user contracts, etc. In this situation it is quite difficult to identify a particular group of companies on which to focus the study. Instead, the author decided to define the area of operations which are certainly covered by respective companies depending on their market share and thus the level of their internal credit risk assessment. In particular, the area of operations covered within this study is the energy wholesale trading, which in turn supposes modeling of company risks at different managerial levels, namely at the front-office, middle-office and back-office levels.

**Front-office** mainly performs strategic role of transation and deal pricing, modeling optimal bids, developing portfolio optimization techniques and reporting on the overall market positions of a company;

**Middle-office** has the key function of measuring and controlling credit risk, extensively employs risk metrics for statistical and correlation analysis of energy trade developments, as well as modeling asset’s productivity and reports on performance of the limits set.

**Back-office** is rather the execution chain of company’s policy. It is the performer of the transaction along with their physical and financial settlement, deals with collection issues, as well as reports on transaction tenor thus promoting to company’s responsiveness to the market evolvements.
As long as the studied issues of counterparty risk measurement and mitigation are assessed within the operations performed by the middle-office at energy trading companies, the present survey addresses both their problems and tools available for respective solutions. At the same time a concrete company apparently adapts relevant risk models to their risk patterns to achieve better application outcomes.

Another aspect to mention is the application of credit derivatives (CDs) which proved to be an effective hedging tool against unexpected market outcomes and credit risk mitigation. They are designed to minimize an exposure from loans, investments, guarantees and other customer financing commitments. While realizing the significance of applying CDs to mitigate electricity price risk, within the facet of this study the specific features and applicable strategies of using CDs are not studied. Instead, they are perceived as an effective tool useful at the later stage of credit risk analysis after the expected and potential credit exposure is estimated and needs to be mitigated.

1.5 Reliability and validity

The author’s view is that the reliability of this study is supported by the prudent expertise and high reputation of presented credit risk models’ developers, models’ high popularity among financial institutions and overall strong performance. For the validity of this study contributes the fact that the models are presented accurately, and are supported by the critical opinion and comments from leading market specialists and academics within the field. Besides, regarding the analysis of energy sector, the studied publications are complemented by an interview conducted with a expert following energy trading at one of the leading energy trading companies in Sweden. The author believes that the feasibility for the present study would be achieved by obtaining answers for the stated objectives and by the ability to underline useful and contributive features of existing approaches for industry application.

1.6 Thesis outline

The purpose of current study and the problems’ solution are supposed to be met via following steps of analysis:
1. Studying academic literature and modern theoretical approaches, successful business models and internal practices for measurement and mitigating counterparty risk, starting with expert system to more advanced statistical models.
2. Reviewing modern risk valuation approaches and internally developed risk measures among some of the energy industry players.

3. Revealing the important issues related to counterparty risk in energy trading sector of Sweden, and referring to the issues of the Nordic electricity market where relevant to the subject studied.

4. Presenting energy market specialists’ opinion about the practicability of applying one or another model in companies’ internal risk valuation methodology.

5. Make an concluding analysis about the practicability of applying certain credit risk measuring tools for counterparty risk mitigation by energy traders.

To perform the underlined tasks, selected credit risk models are suggested by the author to assess counterparty default issues for energy industry, with respect to counterparty risks taken by power traders against electricity end-users, where the credit events themselves presently can be considered as rather hypothetical.

The sections “Writing research theses or dissertations” on the webpage of the University of New Castle upon Tyne, and “Advice on Academic Writing” on the webpage of University of Toronto were used as a guideline for structuring the present paper was used. Of great assistance was the book by Swales and Feak1 with a lot of useful information about the contents of academic paper specific sections, important features and criteria to be met. The book has many useful and explanatory tips for writing and structuring an academic paper. At the same time the general sequence of headlines within the paper is organized the way the author believes is relevant for the stated problem discussion and elaboration.

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1 See the Reference list for books
2. Methodology

Hereinafter follows a description of how the study was conducted. It includes approaches and methods employed, sources of obtained data and the general argumentation for performing the study.

2.1 Research approach

When surveying selected models for credit risk modeling the author intentionally does not present a comprehensive discussion of how the models had been developed, and the analysis of how they are working, since these models are quite accessible and widely discussed. Most of the issues having direct or indirect effect on credit risk measurement have been underlined in the problem background and problem discussion sections and are further referred to within the context of model exploitation. At the same time the aim of this study is free of a criticism of the previously conducted studies, it includes only the commonly perceived advantages and drawbacks of the models.

Thus instead of discussing the models themselves, an attempt is made to carry out a survey about the contemporary tools for obtaining solutions to the stated problems, and classify the models from the point of their relevance to energy sector application. It seems to be more important to address particular models’ underlying concepts and assumptions, positive features and shortcomings in an extracted form, as well as to discuss and analyze the ways of these models’ possible adaptation and applicability by industrial players, namely within the energy sector.

The author hopes that this way the conducted study can contribute to a refreshment of appropriate theoretical and practical background for energy traders’ internal credit risk modeling through adaptation of available tools to the needs and objectives of their companies. Besides, despite dealing with quantitative models the present study is believed to meet the requirements of a qualitative study in form of a structured analytical discussion of the stated problems, and in this way contributing to the purpose achievement.

Issues presented in the problem discussion and the formulated purpose indicate a deductive approach employment. According to P. Hall, 1994 “deductive approach seeks particular applications of general principles which science has uncovered”1. We are given theoretical models for credit risk measurement, widely applicable at financial institutions, which has to be deductively applied for various industry players for the better management of credit risk issues. To

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approach formulated problems based on the concerns announced by different energy sector representatives, the author considers it important to present a review of existing theoretical framework and practical approaches for the problem solution.

Numerous sources of information, expert opinions and initiative studies are available about credit risk management, among them are also those that are sometimes not enough verifiable and authenticated in electronically available articles, company publications in internet. The authors view considers that it is the ‘right’ outlook to present and make parallels between different views. By doing so one can effectively address the vital problems formulated by companies. The academic literature, of course, serves as an supporting tool for understanding the underlying relationship of the stated problems.

2.2 Data

With respect to sources of information, the most primary data concerning credit risk assessment by industrial companies was obtained through academic literature study, initiative research papers and explorative articles, conference materials, certain companies’ internally developed methodologies available on their web pages, as well as sources of financial information at Gothenburg University’s library.

In particular, the sources of information processed to assess the defined problems are studies and methodologies developed by leading financial academics and analysts, one of the most reputable rating and consulting company (Moody’s Investors Service), one well known American electricity producing and trading corporation (Ameren Energy Corp.), and a joint study of financial analysts following credit risk issues in energy sector.

With respect to information sources about the Swedish energy sector, there were various but limited materials in English language from Svenska Kraftnät, energy companies webpages, initiative market research studies by Vattenfall AB and other energy companies, electricity market reports, etc.

2.3 Research design

As already mentioned, any study that aims to make a contribution to the analyzed problem begins with an extensive literature study within the subject as well as of some related areas and applications. This way the study can avoid repetition and the rediscovering of “known” relationships. Also in the present work, an extensive literature study in credit risk management (CRM) was conducted with respect to reviewing the traditional methods for ongoing and
long-term credit decisions up till the examination of some of the contemporary internally developed companies’ CRM frameworks.

2.3.1 Descriptive survey

This study is assumed to be of a nature of a descriptive survey with respect to presenting an overview of the most advanced and self-contained credit risk measuring and mitigating methodologies. The author also reviewed the most popular software solutions for credit risk modeling in energy industry, and presents and short description of the selected ones.1

The author also believes that a descriptive survey is the right form of research design for the present paper. By the definition of descriptive study it is “a study that tries to reveal patterns associated with a specific issues without an emphasis on pre-specified hypotheses”. Sometimes these types of studies are called hypothesis generating studies (to contrast them with hypothesis testing studies)2. A descriptive study can aim to:

1. help in planning resource allocation
2. identify areas for further research
3. provide informal diagnostic information.

In a broad sense, a descriptive survey focuses on revealing the issues, preparing a background for their possible solutions rather than testing the relationships or quantifying the problem. Within such a study one can estimate the development of the problem, the possible tools for its solution, as well as presenting critical attitudes and expert opinion about the issue.

This study can be considered as a preparation for a large-scale research about energy trading companies’ credit risk issues arising due to temporary liquidity problems caused by seasonally fluctuating electricity price.

2.3.2 Case study

Besides the descriptive nature of this study it aims to create a credit risk modeling framework for the application for Swedish energy traders. This case study is supported by an interview with a power trader at one of the Swedish electricity trading companies. As previously mentioned, interviews represent an important step of any survey, carrying opportunity to assess the stated

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1 See Appendix II
2 http://www.cmh.edu/stats/definitions/descriptive.htm
questions by transposing the summarized practical knowledge and expertise from the relevant survey group of credit professionals, as in the present case. This interview, being performed according to the questionnaire\(^1\), had essential contribution to a deeper understanding of the current issues of the Swedish electricity market as well as clarification of certain practical details not highlighted in general market publications or possibly inaccessible to the author, because of language considerations. It should be noticed as well that the mentioned interview presents the only source of primary data obtained by the author.

\(^1\) See Appendix I
3. Theoretical framework

In this chapter the author reviews the theoretical background of the issues of modelling credit risks associated with private companies.

3.1 Traditional approaches to credit valuation

Most credit scoring models are either *expert systems*, based on judgmental criterion and attempt to duplicate a credit analyst’s decision making process, or *statistical systems*, relying on quantitative factors that according to the model vendor’s research, are indicators of default. An example of expert systems include Moody’s RiskScore® etc, while examples of credit risk quantifying models include Zeta®, KMV’s Credit Monitor®, Moody’s RiskCalc®, and Standard & Poor’s CreditModel®.

Traditional, or presently referred to as passive, approach to credit risk management encompasses expert systems, credit-scoring and rating systems. A very detailed methodology of assessing a single counterparty’s credit risk is presented by H. A. Schaeffer, 2000. Another methodology of assigning credit scores was developed by Altman (1968) presently extended into a wide framework of credit valuation, the advantageous simplicity of which competes with statistically complicated approaches. The most advanced model of this type is the Moody’s RiskCalc™. Rating systems are based on transaction or counterparty credit limit, defined by customer’s externally assigned credit rating, transaction’s tenor, and cumulative exposure level.

A very convenient, extensive and self-contained review of the credit risk models is presented by Saunders, 1998 and an extended discussion about the models and issues around them is done by Caouette et al., 1998.

3.1.1 Expert systems

This valuation system is quite expensive to maintain, due to high costs of preparing and maintaining a qualified and experienced personnel, training expenses etc. Within this system credit decisions depend on lending officers’ appraisal of counterparty’s creditworthiness by evaluating certain parameters (business reputation, borrower’s capital structure, capacity or ability to repay, collateral, and cycle of economic conditions).

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1 “Rating Credit Risk”, p.7
2 see Reference list.
3 see Reference list.
Professional investment management firms, for example, operate with far less manpower than do banks and, in general, have less confidence in their ability to select the right borrowers. Therefore the formers have begun to incorporate credit skills that are normally associated with banks. The biggest concern with this approach is that portfolio concentration cannot be avoided, because to become a good expert an individual must focus on a relatively narrow set of companies within a single industry. At the same time according to portfolio theory, breadth of activity, i.e., diversification is more important than the selection of individual risks. This approach is out of rules to a typical financial analyst as with a potential loan extension to unknown sectors, regions or customer groups. However, at present financial institutions are increasingly inclined to syndicate, securitize, or otherwise diversify their originated portfolios.

### 3.1.2 Credit-scoring systems

One type of these systems is the well-known Altman’s Z-score model¹. As with most credit risk assessing models, the objective of scoring systems is to maximize measurable risk. Credit policy devises the ways to increase the predictive capability of credit analysis by estimating counterparties’ probability of default, and in this way to enhance the amount of risk controlled. Although the timing of evolution to a score based approach and technology has been vastly different for the credit card, mortgage, auto and commercial lending industries, the results have been similar: it led to a faster, more consistent, unbiased, and more accurate approach to lending. The simple way of presenting the underlying process of accessing the probability of default is:

\[
P(A \text{ and } B) = \text{Corr}(A,B) \times \left[ P(A)(1-P(A)) \right]^{1/2} \times \left[ P(B)(1-P(B)) \right]^{1/2} + P(A) \times P(B)
\]

If the two default events are independent, then the correlation is 0; in this case “purchasing a credit protection” or in other words, risk diversification will bring the probability of loss from \( P(A) \) down to \( P(A) \times P(B) \).

### 3.1.3 Rating systems

This approach entails a risk-weighted asset valuation to calculate capital reserves against unexpected losses, and loan loss reserves against expected loan losses. Ratings are simple way to transform a discrete event (default) to a

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¹ Altman, 1968.
continuous variable (rating change)\(^1\). It is well-known that a continuous variable is easier to handle and to obtain the dynamics than discrete events. Some apprehension with this concept exists due to a quite widely shared opinion that there is no useful information to be obtained from ratings, as they are too slow to adjust and reflect rating agencies’ management as much as true credit changes. Others show that there is little information in rating upgrade (all the information has already been incorporated into market prices) but there is some in rating downgrade\(^2\). Other authors have addressed stability (or instability) of rating migrations and established a methodology to adapt rating migrations to changes in a business cycle, the country or industrial sector\(^3\). Nevertheless, in general this approach of treating business counterparties by the credit rating assigned by reputable rating agencies are of high practicability for the companies and many of them heavily rely on external ratings in their credit decisions.

Finally it should be mentioned about the common disadvantage of the traditional credit rating systems: they typically do not provide with a strong form of differentiation across the borrowers and the relevant risky assets, and do not offer a consistent framework for forecasting and avoiding credit losses.

### 3.2 Selected credit risk models for private companies

Credit risk assessing tools and methodologies available to financial institutions are extensively addressed in the academic literature. This is mainly because the largest databases of credit performance and default frequencies are maintained by financial institutions, and thus they have larger opportunities for theoretical and technical explorations of credit risk issues.

Presently several conceptual tools are available to measure counterparty’s creditworthiness, on individual basis or within a portfolio, depending on the purpose of measurement. Some models stress the importance of constructing a distribution of portfolio possible outcomes, while others focus on assigning credit ratings to companies according to the quality of their outstanding debt etc. All these models can classified into two main groups:

- **Structural models**, focusing on evaluation of company’s strength by looking at the financial statements, and
- **Default intensity models**, considering the default as a random variable with the roots covered by economic factors rather than internal company’s structure, being similar to actuarial approach in insurance.

\(^1\) Caouette et all, 1998 p. 203.
\(^2\) ibid.
In connection with the mentioned trends, the largest industrial companies presently have their own subsidiaries to handle the broad financial aspects of their activity, e.g., corporate treasury departments, insurance companies, investment companies and even their own banks enabling them to access and authority to operate in financial and capital markets. From this credit information, financial information and qualitative appraisal of the majority of companies is generated by various multinational agencies and/or locally at each country’s official business statistic report in form of master file data, combination of application and demographic data, as well as one relatively new source as transaction data, which is predictive for certain applications. Master-file data enable the users to score their customers on a monthly basis, according their “payment behavior”, while transaction data enable credit grantors to score customers dynamically. With the latter approach lenders can react quickly to changes in customer profile and change customer treatment as required1.

However, it should also be mentioned that the procedures of dealing with credit risk issues is still a matter of internal practice, expertise, financial power and sometimes conservative confidentiality at most companies in any business field.

Until recently industrial companies had not considering credit issues as an integral part of their business portfolios and instead tended to be conservative in their credit policy by making credit judgments on an individual basis. In case of increased risks over certain limits, industrial companies were handling them by demanding more strict credit terms: collateral, deposits, or up-front payments2.

Historically, producers were managing their credit risks by demanding letters of credit (L/Cs) or were selling the trading receivables to factor companies. However, the bigger a company becomes the more is its own potential for managing receivables collection and developing more extended terms for contracting, payments etc.

Presently credit risks are rarely considered on a stand-alone basis because of greater interrelations between the same industry participants within the production chain, and thus greater correlation or common responsiveness to same macroeconomic conditions. Thus, application of portfolio methods for mitigating credit risks is becoming more and more popular among industrial companies. These more active credit risk measurement and mitigating techniques assume regular credit reviews, collateral agreements, downgrade triggers, termination clauses, and usage of credit derivatives3.

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1 Hollis, p.172.
3 http://www.skora.com/risk.htm
The models presented in the following sections are selected on the basis of their increasing popularity and feasibility for an appropriate application by industry players.

### 3.2.1 Altman’s Z-score for private companies

Altman’s Z-score model\(^1\) is based on accounting data and applies a multivariate approach built on the values of both ratio-level and dichotomous univariate measures. These values are combined and weighted to produce a credit risk score that best discriminates between firms that fail and those that do not. This kind of analysis is possible because failing firms show ratios and financial trends that are different from financially sound companies. Credit experts would reject a credit application of their prospective partners or subject them to increased scrutiny if the actual credit score of a credit applicant falls below a critical benchmark. The Z-score model was constructed using multiple discriminant analysis that analyzes a set of variables to maximize the between-group variance while minimizing the within-group variance\(^2\).

To arrive at final profile of variables the following procedures are used:

1. Testing statistical significance of various alternative functions, including determination of the relative contributions of each independent variable,
2. Estimation of inter-correlations among the model variables,
3. Observation of the predictive accuracy of the model,

The basic Z-score model has endured until the present day and has also been applied to private companies, manufacturing firms, and emerging market companies. The model uses five ratios contributing to estimating the company’s credit score:

1. Working Capital/Total Assets, which is a measure of company’s net liquid assets relative to total capitalization.
2. Retained Earnings/Total Assets. This is a measure of cumulative profits which appears to be greater for mature companies, and thus at some extent discriminates against young players more subjected to failure\(^3\).
3. EBIT\(^4\)/Total Assets, as a measure of productivity power of the company’s assets.
4. Book Value of Equity\(^5\)/Book Value of Liabilities, reflecting the leverage level of the company.

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\(^1\) Altman, 1968, 1993.
\(^4\) Earnings Before Interest and Taxes
\(^5\) For public companies the measure of Market Value of Equity is used.
5. Sales/Total Assets. This measure mainly points to the counterpart’s ability to deal with competition challenges. At the same time, this ratio shows a wide variation among different industries.

After assigning certain weights to each of the variables incorporating their importance and contribution to the score for private firms, Altman obtained the following discriminant function:

\[ Z = 0.717(X_1) + 0.847(X_2) + 3.107(X_3) + 0.420(X_4) + 0.998(X_5) \]

When testing the significance of each of the model’s variables and performing different replications when choosing various subsets to the suggested method, it appeared that the most important ones are measures for profitability, then leverage ratio and liquidity level. Altman revealed also a sample bias and additional tests using secondary samples were needed, meaning that companies need to carefully approach this model when gathering accounting information and selecting a sample of various companies for the Z-score estimation. The application of Altman’s Z-score is convenient when dealing with the issues of setting credit policy, conducting credit reviews, making a lending decision or arranging an asset securitization.

3.2.2 KMV’s EDF for private companies

The initial model’s output EDF (Expected Default Frequency) relies on the market value of company’s assets to predict its default probability. To arrive at EDF the data about public companies within the same industry are used to develop an estimation model for the market value of assets and the asset volatility, for which it is assumed the private companies behave identically to public firms, once the effects of size, industry and country are encompassed\(^1\). To obtain EDF one needs first to estimate the market value of a company and its asset volatility.

1. Market value of the firm is modeled as a measure swinging between two extremes values: operating value and liquidating value. This measure is EBITDA adjusted for a country and industry factor: when it is high it is approaching the operating value, when it is low – to liquidating value.

2. Asset volatility of a private company is derived from assets volatility of a traded companies by modeling it as a function of sales size, industry and asset size. The contribution of each of the mentioned parameters is determined with the help of a multivariate statistical technique.

3. Using company’s market value and asset volatility measures the methodology arrives at EDF estimated as the distance-from-default ratios on the basis of the public firm default experience\(^2\).

\(^1\) Caouette et all, 1998, p. 147.
\(^2\) ibid
However, the initial assumption about the similar behavior of traded and non-traded firms could be arguable taking in consideration the tendency of the stock market to overreact to the new market information about companies. Besides the mapping between distance to default and EDF is slightly different between private and public companies because of using estimated rather than market values\(^1\). The Moody’s RiskCalc\(^{TM}\) model presented in the next section eliminates the main drawback of the described model.

### 3.2.3 Moody’s RiskCalc\(^{TM}\) for Private Companies: Nordic Region

The well-known credit rating agency Moody’s KMV “recognizing the growing need for benchmarks in rating the middle market companies”\(^2\), i.e., non-rated private companies, developed models for estimating companies’ probabilities of default by using accounting data. This model can be considered as relying on Altman’s Z-score and KMV’s EDF concept, incorporating their useful features and extending them conceptually and technically. The model dataset does not incorporate the following types of companies: listed companies, small companies, startup companies within first two years of establishment, financial institutions, real-estate companies and public sector institutions. The model is calibrated to a one-year and a cumulative five-year horizons.

In assessing the importance of a fundamental default database to build an intuitive and predictive model of credit risk, RiskCalc leverages the world’s largest private company database, Moody’s KMV Credit Research Database\(^{TM}\) (CRD). The CRD has information from 4 million financial statements on 1 million firms and 70,000 defaults for private companies and was built in partnership with over 40 financial institutions globally\(^3\).

There are three steps in the RiskCalc modeling process: transformation, modeling and mapping. First, the “noisy” raw data are transformed into more useful homogeneous data. Then the transformed variables, or mini-modeling, are statistically combined into a multivariate model to produce a risk score. With the last step the score is mapped into calibration curve from which the empirical default probability rates are estimated.

The following tools are employed within this rating methodology: capital allocation concept, credit process optimization, pricing and securitization. The model uses seven factors falling within the following categories:

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\(^1\) ibid
\(^2\) Moody’s RiskCalc\(^{TM}\) For Private Companies: Nordic Region, p.1.
\(^3\) RiskCalc\(^{TM}\) Fact Sheet.
leverage/gearing, profitability, debt coverage, liquidity and current asset structure. For each factor, the model assigns so-called relative weights. Particularly, leverage/gearing has 34% contribution, profitability ratio – 20%, debt coverage ratio – 25%, liquidity ratio – 6%, and the ratio for current asset structure – 15%.

The model input-factors are:

1. Leverage/Gearing:
   a) \( \text{Leverage} = \frac{\sum \text{Liabilities}}{\sum \text{Assets}} \); b) \( \text{Net Indebtedness} = \frac{\text{Short Term Debt} - \text{Cash at Hand}}{\sum \text{Assets}} \)

2. Profitability:
   \( \frac{\text{Pretax Profit & Loss}}{\sum \text{Assets}} \)

3. Debt Coverage:
   a) \( \text{Debt Coverage} = \frac{\text{Ordinary Profit & Loss}}{\text{Financial Expenses}} \); b) \( \text{EBIT} = \frac{\text{Earnings Before Interest & Taxes}}{\text{Short Term Debt}} \)

4. Liquidity:
   \( \frac{\text{Current Assets} - \text{Short Term Debt}}{\sum \text{Liabilities}} \)

5. Current asset structure:
   \( \frac{\text{Cash at Hand & in Bank}}{\text{Current Liabilities}} \)

Thus this model’s specific strength is that it captures and integrates a non-linear problem, performs out-of-sample tests and is able to produce a benchmark or cut-off score from the power curve\(^1\). Within the sample companies being assigned a score below certain level would be rejected in their credit applications, etc. Besides fundamental data on private firms (i.e. leverage, profitability, liquidity, asset efficiency, sales growth, and size of private firms) are lined up with extensive observations of default to capture the predictors and their impact on default.

The model builders also demonstrate that the credit risk drivers for studied private companies differ across countries\(^2\). Since the model is intended specifically for private companies in Nordic region, additional measures were taken in selecting and optimizing the factors for individual countries. The model also differentiates the companies by size and industry affiliation. The

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\(^1\) i.e. an illustrated percentage of firm rating starting with those “worst” rated.
\(^2\) RiskCalc\(^{TM}\) Fact Sheet.
“weights” for the factors are also chosen to be consistent across the region, and after that the estimated model is individually calibrated to each country.

Another and advantageous feature of this model is that it integrates seamlessly with various credit risk modeling frameworks like Moody’s KMV Credit Monitor® platform, Moody’s KMV Portfolio Manager™ which is very useful for comprehensive analysis of public and private firms.

Thus the key features of this method can be summarized as follows:
1. Producing highly predictive Expected Default Probabilities measures for private firms,
2. Producing estimates for one- to five-year time horizons,
3. Detailed reporting on financial ratios and their individual contributions to risk,
4. Flexibility in counting for the new information from financial statements,
5. Ability to capture country specific risk effects,
6. Ability of being integrated with various credit risk modeling frameworks,
7. Unbiased and fundamental private firm data for model building, calibration and validation.

Moody’s benchmarking approach with its not complicated methodology and tools, as well as relatively easy obtainable data makes it accessible for nearly all companies in addressing their counterparty creditworthiness issues.

**Model performance with Swedish accounting data**

It should be mentioned that according to the model test for performance in Nordic countries, the accuracy of ratios (overall and by sectors) of RiskCalc as well as Z-score are the lowest for Sweden - 60.3% and 43.2% respectively. This means that during the univariate analysis that - among other countries involved in the study - with the Swedish data it was generally harder to identify from financial statement information those firms that would subsequently default.

At the same time the shorter time period covered by the Danish and Finnish data sets relative to Sweden, reflects the impact of data privacy laws/agreements in the former. Given that together with the fact that in GDP terms it is the largest Nordic country, it was unsurprising to the model developers that the dataset was largely dominated by Swedish firms.

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2. ibid.
3.2.4 Summary credit risk elements and risk-measurement systems

The conceptual approach of all of the above described models can be summarized into a framework or policy for assessing credit risk within a company. This task can be approached by looking at the two key ingredients of companies’ credit risk pricing and risk-measurement systems, which include:
1. Sources of risk (or risk factors) and their joint probability distribution, and
2. Methodologies for measuring changes in credit quality and default over a large set of counterparties.

A very convenient schematic presentation of the building blocks to measure and mitigate company’s credit risk is presented by Duffie and Singleton:

Figure 3. Key elements of credit risk pricing and measurement systems

Counterparty Databases captures information positions within the constructed portfolio, including specification of each contract’s type and particulars, such as its collateralization and netting opportunities.

Counterparty Default Simulator addresses firstly credit-rating transition risk for a single counterparty and then assesses the correlation of default and transition risk among multiple counterparties.

Rate and Price Simulator explores implications of alternatively parameterized risk factors driving credit portfolio performance outcomes.

Derivative Valuation Models include the ways of efficient estimations of changes in values of credit positions and further changes in credit quality, including default.

Along with digging up into the model’s useful features there is one important point, which is sometimes not fully appreciated, that is “the best choice about

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1 Duffie & Singleton, 2003 p. 29.
2 ibid.
modeling techniques often depend on the modeling application”\(^1\). The perfect model should be able to differentiate between correct decision and incorrect decision with respect to the different costs associated with them.

### 3.3 Current trends in addressing credit risk

Among other tools extensively used in credit risk measurement and mitigation are: *survival analysis, neural networks, mathematical programming, deterministic and probabilistic simulation, and game theory*. These various analytical and numerical methodologies from statistics to operations research have all contributed to credit risk problems solution. For example, simulation is forward looking method, but the algorithm cannot go back and change a decision made in a prior period based on a realization in a subsequent period. Thus any tool can be as much useful as carry under- or overestimation disadvantages. Thus the main trends as the following:

1. Along with growing popularity and proved efficiency of portfolio asset modeling method, companies seek to **turn from univariate (single ratio analysis) to multivariate analysis**.
2. Conceptual change in corporate risk valuation is the **turn from balance sheet valuation** where issues such as company’s age, capital structure, ratio analysis are still of great importance to **cash flow valuation**. For example, there appeared a common caution about the measure EBITDA/Interest Due: when it falls below 1.5, an account should need special attention.
3. **Standard portfolio optimization method** called also asset-normal which assumes that asset returns are jointly normally distributed. The author however, does not present this model, because it is mainly applied for an asset return optimization of a large number of assets. Thus obviously this approach is out of scope of the present paper.
4. The more recently introduced concepts are **the diversity index\(^2\)** and **the economic capital approach**, the methodological background of which is intensively applied for modeling energy price risks.\(^3\) The concept of economic capital is addressed extensively in Chapter 4 devoted to models and approaches for energy industry application.

Along with all the advantages and increasing opportunities offered by the above presented models and risk valuation tools, it is evident that the effectiveness of employing new financial tools depends absolutely upon the skills, motivations and attitudes of the people using them. Thus the last thought can sound as: “employ the right tools and the right risk culture”\(^4\).

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\(^1\) J. Gruenstein, 1998, p. 111.
\(^2\) Duffie & Singleton
\(^3\) For a discussion of these approach application see in Chapter 4.
\(^4\) Shimel, 2002 p.
4. Contemporary credit risk mitigation approaches within energy sector

4.1 General considerations about credit risks in energy sector

As was already mentioned, the author chose energy sector for application of contemporary counterparty risk measurement and mitigation techniques. This choice was driven by the industry’s high unpredictability and volatility, and hence inherent necessity for extra-protective credit strategies. All these market challenges have arisen along with the recent energy market deregulation processes over the world. The new competitive conditions led to design of new energy trading instruments and establishing country or region specific trading competences. More and more industrial companies got both opportunities and challenges for creative readdressing credit risk issues, mainly to measure the effects of energy price fluctuations. In particular, the recent pressure on energy stock prices and credit ratings, increased market and regulatory forced energy companies to place unprecedented efforts in management of their credit risks. In fact, managing credit risk on a more real-time basis has become a primary concern for any company engaged in trading of physical energy commodities and financial derivatives. In approaching this task of industry application various existing methodologies are developed for energy industry companies. Within this study a particular attention is paid to the initiatives towards counterparty risk mitigating frameworks applicable for energy trading.

Thus, the deregulation processes had, to certain extent, stimulated the extensive adaptation and application of the mature credit risk models presently employed by financial sector. There are number of energy industry specific features and challenges to take into account when approaching their internal credit risk, the most important of which are the following:

✓ Energy market is shaped by a much larger number of risk factors than the financial derivatives market. For example, this industry while also growing and developing has the very unpredictable weather factor for energy trading. The recent electricity market deregulation processes all over the world had immediate effect on energy pricing, the troublesome behavior of which subjected energy traders with simultaneous pressure of market, operational, credit and legal risks. These risks can significantly worsen companies’ liquidity positions;

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1 EnFORM Consulting http://www.enform.com/
Contract portfolios of energy firms typically contain many highly structured and long-dated trades, often with large doses of embedded optionality written into them. This is particularly true for energy trading firms, but it is also the case for firms that hold energy operating assets;

The market for financial derivatives has simpler netting requirements. This is particularly the case for energy companies trading with both physical and financial contracts. However, since the largest volume of traded contracts are not-standardized, those are often not eligible for netting.

In general, many specialists mention that everywhere but in NordPool a general discussion of electricity options has to start with assumption that the options must be priced in the OTC market. Along with the present weakness of the most energy exchanges to become a real marketplace for energy trading, many intermediary companies are seeking to offer a packages various of services that futures contracts successfully provide. However as the practice shows, “in the long-run, energy companies cannot avoid to be energy traders”, and assumes continuous work on the development and improvement of new energy products for overall energy trading risk mitigation.

4.2 Ameren Energy: an example of successful business practice

Ameren Energy is US based corporation which provides energy services to 2.2 million customers in Missouri and Illinois. About 95 percent of company’s $3 billion revenues flow from electric sales, with the remainder from sales of natural gas. The company bases its credit risk assessing model on concepts employed by CreditRisk+ with modified computational methodology, as its assumptions are legitimate for Ameren’s credit risk management.

The internal approach at Ameren presented below has proved to be an efficient tool for quick assessment of counterparty risks. The model differentiates between energy producing utilities and energy traders, based on whether they own significant generation assets or operate as stand-alone energy trading companies. This methodology presumes two-stage valuation.

1. Single counterparty risk limits

The transaction credit limits are determined by the measures of size and maturity of the exposure, probability of default, systematic or concentration risk of counterparty.

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3 Methodology is presented with shortening, full version: www.financewise.com/public/edit/riskm/crenergy
Credit limits are approved by the Ameren’s IRCO (Independent Risk Control Office). The counterparty credit analysis is primarily ratings-driven, accompanied by the analysis of financial statements. For counterparties with a credit rating assigned by rating agencies Moody’s Investors Service and Standard&Poor’s, the IRCO first reviews these ratings, and the lower of the two determines the maximum allowable credit limit. The measure of total exposure is obtained by Current exposure and Potential exposure:

1. **Current exposure**\(^1\) = Replacement exposure + Settlement exposure,
where Replacement exposure, or mark-to-market exposure, is the estimated cost of replacing the unsettled position with another counterparty, in case of the latter’s default. Settlement or delivery exposure, is accounts receivable after performing contractual obligations.

2. **Potential exposure** = Potential incremental replacement exposure + Potential incremental settlement exposure,
where Potential incremental replacement exposure represents potential exposures at some period in the future, based on the applicable holding period and confidence interval, using the assumed price distribution of the underlying commodity. Potential incremental settlement exposure is the potential incremental credit exposure from accounts receivable for settlements from transactions that will occur in the near time.

The other two measure, given that maturity is known initially, are: Statistical probability of default by the counterparty, estimated from historic data, and Recovery rate - the amount of the defaulted position for which a compensation is expected, also derived from historical default database.

### 2. Portfolio risk

The second stage of Ameren’s credit risk quantifying method addresses assessment of the credit risk within the whole portfolio. The model’s objectives are to measure the unexpected and expected portfolio credit loss, determine the economic capital reserve in support to the credit risk of the portfolio and emphasize the assets that contribute the most risk within the portfolio\(^2\).

This model relies on Standard & Poor’s mean default rates, default rate standard deviations, counterparty exposure, credit ratings and sector analysis as inputs. The model is also required to calculate the amount of capital necessary for a credit capital reserve, to define more precisely the size of the portfolio credit risk, to determine if and when the use of credit derivatives is necessary and to run stress testing and scenario analysis on Ameren’s credit risk at a

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\(^1\) While presenting methodology developed by companies author intentionally keeps the original paper’s terminology unchanged. E.g. the words ‘risk’ in the rest of the paper and the original ‘exposure’ term. are used interchangeably in the present context.

\(^2\) http://www.financewise.com/public/edit/riskm/crenergy
portfolio level. Other benefits of analyzing portfolio credit risk involve diversification and concentration of risk\(^1\).

As known, assessing credit risk by each counterparty separately does not allow for diversification of risk and may therefore overstate the credit risks. Portfolio approach helps them to manage the company’s concentration risk resulting from groups of counterparties that are affected by the same industry risks and its cyclic recurrence, which may cause the correlated defaults incidence even though there was no evident correlations between them. The four mentioned measures along with the potential risk of netting create an overall picture of the risks enabling the floor traders to monitor, manage and control credit risk by counterparty.

Thus the measure of available credit per counterparty is calculated as:

\[
\text{Available credit} = \text{Credit limit} - \text{previous month A/R} - \text{current month A/R} - \text{MtM sales} - \text{MtM purchases} - \text{VaR per counterparty}\(^2\),
\]

where the value of the Account receivables, company Sales and Single counterparty VaR is obtained as:

a) **Account receivables (A/R):** Prior month A/R is the gross receivable for the counterparty for the previous month’s activity, based on the notional value of all sales transactions with a delivery period in the prior month. Current month A/R is the potential settlement exposure for the counterparty, based upon the notional value of sales transactions delivered and/or scheduled to deliver in the current month.

b) **Mark-to-market:** Sales mark-to-market is the net mark-to-market value on all forward sales to the counterparty with delivery periods beyond the current month. If the sales mark-to-market value is a negative amount, only the amount which offsets the previous and current month’s A/R will be considered in the calculation for the available credit. Purchase mark-to-market (liquidation value) is the sum of all positive mark-to-market values on all forward purchases from the counterparty with delivery periods beyond the current month.

c) **Value-at-risk:** The diversified VAR is calculated according to the counterparty’s forward activity. Price change is calculated based on a daily volatility and forward price. As they assume price return to be normally distributed, an exponential equation can be used to calculate a price change at a certain confidence interval (95%) and liquidation period. Long positions use a negative sign, and short positions a positive sign in the exponential equation to estimate a potential price move. Daily volatility is adjusted to different risk horizons by multiplying a square root of time factor. Once they calculate a

\(^1\) ibid
\(^2\) ibid
price change, undiversified VaR per bucket is calculated using second-degree Taylor expansion (Delta and Gamma approximation)”.

In the practice there could be occasions when counterparty credit limits override because of the periods of energy price extreme volatility. From a business point of view, it is simply not practical to cease trading with a critical portion of counterparties during these periods, thus significantly limiting hedging options and liquidity. In these circumstances when many of the counter traders can exceed their credit limits, not all of them could received override positions, based on percentage increases which are computed by stress variables. Above that level no further transacting is allowed until appropriate protective measures are undertaken, like letter of credit, upfront payments, third-party guarantee etc.

4.3 Portfolio approach for CRM at energy companies

Recent high-profile defaults underscore the need for energy companies to improve their enterprise risk management capabilities. Energy companies have begun to realize the necessity of a framework that allows them to evaluate market risk, business risk, and counterparty credit risk on an apples-to-apples basis. The leading energy companies have adapted the Economic Capital approach developed first in the banking industry. This allows them to link risk to required capital, and a “cost of risk” – thus linking risk management, corporate finance, and strategic and tactical decisions.

One of the applications of this approach is the paper “Credit Risk Management – A Portfolio View” by Jim Rich and Curtis Tange. They address the necessity for portfolio approaches application and long horizon thinking supposing reconsidering the approached to receivable collection procedures. Portfolio risk management concept assumes risk distribution over a range of different and thus less correlated assets, in case of energy company – various counterparties, and over a long time horizon. It should be mentioned that long-term contractual relationships are typical for energy companies. The effect of the portfolio approach is that the actual carried losses are less than average losses per individual counterparty, while occasional large losses are driven by market conditions, and thus mostly unpredictable themselves. The large severe losses

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1 The previous three paragraphs are presented full-length, source: Ameren Energy, Methodology for Assessing Counterparty Exposure, http://www.financewise.com/public/edit/riskm/crenergy
due to simultaneous defaults are more infrequent, the illustration of which see in the figure below:\[1\]:

\[\text{Figure 1: Portfolio Perspective of Annual Credit Losses}\]

![Figure 1: Portfolio Perspective of Annual Credit Losses](image1)

The authors of the mentioned article suggest adaptation of the concept of Economic Capital, usually applied by financial institutions, with appropriate adjustments to energy sector. The concept of Economic capital presumes counting for some additional ‘reserve capital’ over the measurable Expected loss from historical loss rates.

\[\text{Expected Loss} = \text{Probability of Default} \times \text{Expected Exposure} \times \text{Loss Given Default}\]

Economic Capital measure along with the same three components for Expected Loss measure, includes two additional drives: Portfolio Concentration and Correlation, and Target Debt Rating.

The properly designed framework of counting for Economic Capital contributes for improvement of the areas in the firm-wide financial management such as capital adequacy, credit approval and limit monitoring, business opportunity analysis, prudence reserve management and portfolio management\[2\].

\[\text{Figure 3: The Metrics of Credit Risk}\]

![Figure 3: The Metrics of Credit Risk](image2)

\[\text{ibid.}\]
\[\text{http://www.erisk.com/Research/Research_Info/ERisk_Credit_Risk_Measurement.pdf}\]
5. Credit risk approached by Swedish energy sector: case study

5.1 Market and Players: issues & developments

The Swedish electricity market consists of many independent players, which are:
- electricity producers,
- network owners,
- the system operator - Svenska Kraftnät,
- electricity consumers,
- electricity traders in the role of electricity suppliers and/or balance providers,
- marketplaces, primarily the power exchange NordPool.

The picture below describes the relationships between the different players and how power is transmitted.

Within the scope of this study we are interested with the relationships between the Trading companies and End-consumers, as well as about the level of operations intermediated by the market or energy exchange.

- The Power Trading Company sells electricity to the final customers. The energy trader can have the role of Electricity Supplier and/or Balance Provider. Both roles can exist within the same or different companies.
- The Consumers, everything from industries to households, take electricity from the electricity network and consume it. Consumers must have an agreement with an electricity trader to be able to buy electricity as well as need to have an agreement with the network owner to be connected to the network.

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1 Svenska Kraftnät, Nov. 2001, p.2, Svenska Kraftnät - utility that owns and operates the national electricity grid
Organized marketplaces, for example, the power exchange Nord Pool, various types of brokers, providing standard agreements and making it easier for the players on the market to do business to each other. However, the largest volumes of energy trade takes place via bilateral agreements between electricity producers and electricity traders.\footnote{Svenska Kraftnät, Nov. 2001 p.3.}

According to the new Electricity Act, which came in force in Sweden in 1997 (SFS 1997:857), there is a clear distinction between electricity production and sales on the one hand, and electricity transmission on the other. Production and sales became open to competition, while network operations, remaining to be a monopoly, continue to be regulated and supervised by a Network Authority within the Swedish National Energy Administration.

The electricity market reform has changed the roles as well as the number of the players. As commonly perceived, it has been largely successful for the Nordic electricity sector, although some obstacles to full competition are still present.

The recent energy market reform entailed significant flow of consumers changing their suppliers. Moreover, a new category of players has emerged – electricity suppliers without balance responsibility\footnote{Svenska Kraftnät, 2001, p.9.}. Even though a large part of the trade in electricity is done bilaterally, the exchange-price functions as a reference point for these deals. A general assessment is that the electricity prices for Swedish industry have fallen by just over 15 percent since the electricity market reform was implemented\footnote{ibid.}. At the same time “production has shown more flexibility rather than consumption, interruptions are present but failure probabilities are low. End-consumers partly are very dissatisfied with the high prices which mainly occur in response to the risk of rationing\footnote{ibid.}.”

The current issues faced by electricity market players periodically arise or remain as the key difficulty to better predictability of energy industry evolvements. To number the most important issues needed to cope with in the nearest future, one should mention the following\footnote{Electricity Market, year 2002 at http://www.svenskenergi.se/elaret2002_eng.pdf}:

1. The general deterioration of electricity output balance due to the closure of some production plants, mainly of coal and nuclear power in Sweden, and implementation of new capacities based on wind and gas power however still requiring improvements in transmission capacity;
2. Isolated price areas due to transmission bottlenecks between countries;
3. The need for standardization and extension of hedgeable operations, power hedging products design and trading;
4. The need for changes of inflexible system of requirement on placing guarantees by the market players: the higher the electricity price, the more intense are guarantee requirements both from Nord Pool’s spot and futures market, and from Svenska Kraftnät. This leads to large money flows and intensifies periodically occurring liquidity pressures;
5. Issues related to the coming euro introduction at Nord Pool in 2006;
6. Further to recent developments in Swedish electricity market, a significant customer mobility is observed, which assumably will be stabilized soon;
7. Competition issues with respect to reduced number of market players within both electricity production and trading sector. Five companies are currently responsible for 93% of Swedish electricity production, and three corporations cover approximately 70% of the end-customer market;
8. Continuing increase of taxes: particularly, during last ten years the energy tax has more than doubled.

The recent market survey also reports that “large import possibility together with nuclear and thermal power makes the risk of rationing nearly non-existing”1.

### 5.2 Assessing credit risk by energy traders

As is widely known, the common procedure with credit risk mitigation issues follows the below stages:
1. Definition of the major risks and mapping the value distributions for each risk type,
2. Constructing aggregate distributions while incorporating inter-risk correlations
3. Calculation of Economic Capital by applying solvency standard or credit limits to the aggregate value distribution,
4. Distribution of the estimated total Economic Capital to each activity based on its risk contribution,
5. Measuring the expected return for each activity and in combination with Economic Capital to arrive at the risk-adjusted return on capital.

To perform the above analysis the energy trader needs a tool, or credit risk modeling framework, which best addresses its respective issues. Namely, among the various existing credit risk methodologies the most suitable is the

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one which is able to estimate the full loss distribution, assess the default event that could subject to credit losses as well as does not require much data input.

At the same time as companies develop their trading and integrating with other operations within the enterprise, along with popular VaR measure an importance of PaR (profit at risk) is stressed. The importance of PaR is stressed for the cases when the trading portfolio includes generation output or retail load\(^1\). PaR measures cumulated possible losses that might occur over a specific period, usually a year, while VaR is measuring potential losses during certain period, mostly from one to ten business days, in the future when the trade position is not yet ceased.

VAR is based on generally optimistic assumptions about the market and portfolio. It works on the basis that market liquidity is both reliable and stable, and that all market positions can be closed. PAR, on the other hand, takes a more pessimistic approach. It assumes that market liquidity cannot be guaranteed, volatility may change over time, as indeed may the correlation between market products. It also assumes that market positions may be uncertain and forecasts inaccurate\(^2\).

The question as to which methodology should be used depends on the aspect of interest: if one need to find out the portfolio risk at any given moment, then VaR is the right measure assuming also the confidence in market liquidity. At the same time if one needs to measure a cumulative financial risk over a certain operating period, then the appropriate measure is PaR.

What follows from the above features of the two measures is that the need for both VaR and PaR is essential for energy companies when entering the more complex and sophisticated trading.

### 5.3 Interview

Hereinafter the author substantiates and summarizes information received via an interview with an energy trading expert at one of the leading energy trading companies in Sweden.

With respect to assessing credibility of end-users, it appeared that power traders do not internally maintain a long-run customer performance databases. Most of their information is received from credit bureaus and residential databases such as Kreditupplysning, Upplysningscentralen (UPC), Personuppgiftslag (PUL). Most credit information about the private companies is collected at the time of

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\(^2\) ibid
contract origination and is not subject to a thorough update. Besides the common protective instruments like collateral, letters of credit, etc., are not currently employed. This was perceived as not sufficient protection necessary against unexpected energy price outcomes. The company was extensively employing modern risk modeling software, such as POMAX Theorem by OM Technology, Norway. To date, this company has implemented their technology at 14 energy marketplaces worldwide and in fact 83% of all exchange traded power in Western Europe runs through the risk modeling solutions from OM. This company among all also provides solutions for wholesale and retail traders, for the needs of grid operators and market settlement performance.

It is the author’s view that when weighing the opportunities to hedge with forwards, futures and option, wide application of portfolio modeling and optimization techniques versus many facts speaking for the high trustworthiness and reliability among partners, the mentioned protective financial tools currently might be considered as extra costs for the energy traders.
6. Summary and conclusions

As a consequence of energy market deregulation energy companies faced a lot of issues, specifically:
1. They needed to reconsider the value chain with their customers not willing to accept over-priced energy contracts;
2. Had to be able to benefit from competitive pricing versus the formerly convenient cost-plus-profit approach;
3. Had to assume greater risk along deal with fallen earnings.

Among the energy market players, power traders are perceived to be ones most subjected to the price volatility due to their intermediary nature and their narrow (wholesale or retail) profit margins. The major risks faced by them are electricity spot price, energy trading volumes and credit risks\(^1\). Energy generating companies, by contrast, are usually integrated with a supply chain and need to hedge themselves against the price risks only for the cases of unexpected energy excess or shortages.

In response to market changes as well as when coping with its specific nature, energy traders have already undertaken serious steps for mitigating their risks and improving earning. Among them could be mentioned their active involvement in setting up trading operations, enabling them to acquire market awareness and re-establishment of marketing channels, and integration of their trading operations with energy assets and operations.

One of the crucial issues for energy traders to have fully-integrated operations is an appropriate trading and risk management software. “At a technical level, the key issues are front-to-back office integration and scalability”\(^2\).

While the challenging needs to forecast and estimate the level of credit losses, etc., into the traditional credit risk management process is quite expensive to perform and is time consuming, many energy industry players are seeking the way of transferring their credit risks to a diversified market players. Presently, their role is assumed by NordPool and the prevailing OTC market.

Currently, due to availability of credit rating assigning methodologies for private companies, like the one developed by Moody’s, many energy traders can benefit from extensive application of methodologies like the present one of Ameren Energy. Recall, that was based on external rating availability. Moreover, the same RiskCalc by Moody’s can be internally applied by companies to arrive at their own internal rating of their counterparties.

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\(^1\) http://www.om.com/index1.asp?area=energy
6.1 Which model to choose?

To be able to answer the stated question the author turns again to energy trader’s opinion and market expertise. The same Ameren Energy’s credit risk managers analyzed the methodologies of two leading credit models: Credit Suisse Financial Products’ CreditRisk+ and JP Morgan’s CreditMetrics. While comparing the methodologies by their useful features, they chose a modified version of CreditRisk+ for the below presented four main reasons:

- “CreditRisk+ is an analytical model, which can quickly calculate a full credit loss distribution. CreditMetrics, however, has a simulation methodology which is more time consuming and needs to change all the input variables, such as exposure, credit rating migration, recovery rates and correlation.
- CreditRisk+ focuses on the default events that might expose a company to credit risk. CreditMetrics is more suitable for a fixed-income portfolio because it considers the probability of changes in credit rating and default events across a portfolio.
- The data requirements in the CreditRisk+ methodology have been kept as low as possible, which minimizes the error from parameter uncertainty.
- The company’s opinion is that CreditRisk+ methodology offers greater flexibility in its adaptation to utility and energy credit risk management purposes.\(^1\)

The CreditRisk+ model was adapted by Ameren to assess the potential risks of different maturities, since default rates are exponentially increasing over longer time horizons.

Other analysts\(^2\) following energy industry, suggest two measures for potential exposure envelopment in energy sector: Expected Potential Exposure (EPE). This measure is useful for capital adequacy and deal pricing decisions. The second measure, Maximum Likely Potential Exposure (MLPE), measure is similar to the market risk metric of value at risk, for credit limit-setting and stress-testing performing. For limit setting the relevant time horizon for MLPE can extend to deal maturity while stress-testing horizons are typically less than a year but longer than the single-day horizon common to a typical VaR framework.

In case an energy traders cannot assess the respective risks internally, still another solution exists entailed in transferring the risks to third-parties by either insuring them or entitling specialized market traders to manage them for a predetermined fee.

\(^1\) www.financewise.com/public/edit/riskm/crenergy
\(^2\) J. Rich & C. Tange, 2003(1)
6.2 Enterprise-Wide Risk Management - new business culture

Recent developments in corporate governing reveal the trend to manage company’s risks within the general management frameworks and common business solutions. Risk management increasingly becomes an inseparable part of corporate management being involved among all other parameters to be counted for in company’s everyday decision making process. The experience of many practitioners\(^1\) shows the accordance in decentralization of risk management within each business unit rather than assigning a separate risk reporting unit within the company, usually company’s treasury department. Currently, many energy companies’ management focus on design or already implementation issues of EWRM. This procedure precludes upgrading company’s organizational structure, drawing appropriate technical infrastructure. The strategic risk management at corporate level functions through extending risk mandates by Chief Executive Officer (CEO), Chief Financial Officer (CFO), The Board of Directors to particular business units, and within the authorities of company risk controlling and monitoring bodies such as Corporate Treasury and Internal Audit departments.

To summarize the above section, we need to emphasize that counterparty credit exposure needs to be managed on ongoing basis, with respect of businesses carried, counterparties, financial instruments employed, etc., and embedded in transaction pricing, capital allocation and portfolio approach constructing decisions. Companies across all energy segments are approaching the radical credit risk management processes and technologies in order to benefit from:

- Improved business insights into the composition and structured credit risk from an enterprise perspective,
- Increased confidence to their risk control process and procedures from rating agencies, business partners, regulators, general public,
- Improved timely and accurate decision making ability to protect their assets against counterparty credit risk,
- Improved ability to provide credit sensitive pricing and counterparty risk management\(^2\).

6.3 Contribution

The practical contribution of the present survey is that it reviews traditional and contemporary credit risk measuring and mitigating methodologies on the

\(^1\) Shimel, 2002 p.215.
\(^2\) EnFORM Consulting http://www.enform.com/Ind-CreditRisk.asp
subject of their applicability at energy trading companies. As a particular application the energy sector of Sweden was chosen. The paper presents various initiative methodologies by energy traders, financial risk experts’ and academics’ opinion in the attempt to in-depth coverage of the stated problems. The author believes that within this study it became possible to create a background for the issues surveyed and to prepare for a large-scale research among energy trading companies’ credit risk issues. For this purpose the questionnaire appearing in Appendix I could be extended and used for a representative survey among electricity trading companies in Sweden or other NordPool member country(ies) presumably having many common energy market issues.

6.4 Line for further research

An empirical study about the level of application of the contemporary risk measurement and management software in Sweden could be initiated. In this case a lot of practical information would need to be collected through large-scale interviewing and revealing the companies’ needs for credit risk assessing methodologies as well as in form of relevant software support. Performing this task could significantly enrich the present paper and might also become a subject for further research.
Reference list

Books


Articles, research papers and reports


Master thesis:


Internet sources

1. Writing research theses or dissertations”
5. Credit Monitor at http://www.kmv.com
8. “Counterparty risk analytics” source: www.erisk.com/Products/Energy_Solutions/Counterpartycreditrisks.asp
17. http://www.erisk.com/Products/Energy_Solutions/Counterpartycreditrisks.asp Counterparty risk analytics
Selected definitions

**Actuarial approach** – actuary is a specialist in the mathematics of risk, especially as it relates to insurance calculations such as premiums, reserves, dividends, and insurance and annuity rates. They work for insurance companies to evaluate applications based on risk. **CAT risk** stands for both Catastrophe and Non-catastrophe risks.

**Credit risk** - the risk that an issuer of debt securities or a borrower may default on his obligations, or that the payment may not be made on a negotiable instrument.

Credit risk refers to debtors or counterparties, creditworthiness of customers, financial capacity and willingness to honor obligations.

**Counterparty risk** - term used interchangeably with the term **Credit Risk**.

**Default risk** - the risk that an issuer of a bond may be unable to make timely principal and interest payments. Also referred to as Credit risk (as gauged by commercial rating companies).

**Enterprise-Wide Risk Management (EWRM)** - a coordinated approach to assessing and responding to all risks that affect the achievement of the entity’s strategic and financial objectives, including both upside and downside risks.

**Expected Default Frequency (EDF)** – the probability that the given counterparty will go into default.

**Economic capital** = Portfolio Loss - Expected Loss

**Factor models** - multivariate statistics based on a matrix of correlation coefficients, applied in credit risk models, for identifying underlying drivers of correlated defaults and for reducing the computational efforts regarding the calculation of correlated losses.

**Structured models** – models specially designed for the need of special groups of customers, products, etc. The instruments included in these models combine traditional securities with various types of derivatives.

**Mortality tables** - Actuarial tables used in the insurance industry to predict the life expectancy and the death rates for various types of people.

**Multivariate normal asset return** – return of a portfolio of assets following normal distribution

**Replacement cost** – costs associated with a replacement of the current contract with another one in case of partial or total failure of a counterparty to perform its contractual obligations.
APPENDIX I

Questionnaire

To: Companies’ risk management analysts and electricity traders

1. Please specify which risks are identified and managed at your Company in connection with electricity trading?

2. What procedure does your Company apply to mitigate the counterparty risks in connection with electricity trading to: private individuals, small enterprises and large corporations?

3. What sources of externally available information (databases, etc) does your company use in credit/contracting decisions when the partner’s credit rating is not available?

4. Please specify the qualitative and quantitative criteria which are applied for permissible exposure to the approved counterparties and for the approval of new credit application.

5. If an internal statistical group for the analysis of risk management issues is employed, which of the following approaches for credit risk valuation does your company practices: expert system, rating system, credit-scoring system? If other approach is used, please specify which one(s).

6. Which form of financial analysis as a part of counterparty risk valuation does your company perform? E.g., common size, trend analysis, ratio analysis and/or comparison to industry standards.

7. Which proportion of risks is taken internally relative to the risks transferred to third parties and in which form? Instruments like: credit derivatives (please specify which ones), bank guarantees, standby L/C, irrevocable L/C etc.

8. Please specify which credit risk measuring model(s), tool/package is currently used at your Company (if possible specify the product/service name, vendor, the application areas, etc.).
APPENDIX II

Link to selected software for risk modeling in energy sector¹

1. **Algorithmics** Software & technical solutions, USA  
   **Link** [http://www.algorithmics.com/](http://www.algorithmics.com/)  
   Canadian based firm, Algorithmics, provides a range of enterprise-wide financial risk management software. **Algo Energy** is a system for managing cross-commodity, enterprise energy risk for multinational and domestic energy companies - it offers market, credit and liquidity risk management tools for utility managers, marketers, producers or traders. The site also provides news, events and research.

2. **Egar Technology** Software & Technology, USA; **Link** [http://www.egartech.com](http://www.egartech.com)  
   EGAR Technology provides a comprehensive suite of commodity trading and risk management solutions combining the expertise of technologists with the experience of market specialists, who have actually traded or managed the products that their systems cover. Their applications offer front, middle and back-office trading and risk management systems for energy companies, traders, corporate treasurers, hedge funds and money managers across most asset classes.

3. **E.Stradis** Software & Technology, Germany  
   **Link** [http://www.estradis.com](http://www.estradis.com)  
   Augsburg-based Software company which produces RMS (Risk Management System), a system which covers credit risk management for energy producers as well as for the back-office energy trading business, and RPAS (Risk and Performance Attribution System). Site provides information on products and services, clients, news and general company information.

4. **KWI** Software & tech. for institutions, UK  
   **Link** [http://www.kwi.com/](http://www.kwi.com/)  
   London-based KWI is a supplier of trading and risk management systems. Their main product is kW3000, a suite of applications to manage risk and trading in global energy markets, covering power, natural gas and oil. The site has information about their products and risk methodology, a news desk, articles, etc.

¹ Extended list of available software can be found at [www.financewise.com/public/unregistered/energy.htm](http://www.financewise.com/public/unregistered/energy.htm)
5. **Lacima Group** Consultancy, Software & Training, Australia  
   **Link:** [http://www.lacimagroup.com/](http://www.lacimagroup.com/)  
   Lacima Group provides software, training, and consulting services to both the financial and energy business sectors. LacimaEnergy software is designed specifically for application in the volatile energy and power markets. These tools have been developed by the principals of Lacima Group, recognized world leaders in energy modeling.

6. **Murex** Software & tech. for institutions, USA  
   **Link** [http://www.murex.com](http://www.murex.com)  
   Murex is a global provider of enterprise-wide trading and risk management solutions. Energy on Mx G2000 integrates power, natural gas, crude oil and refined crude oil products and the system provides extensive transaction and hedge coverage for financial and physical trading, from vanillas to exotics, including quanto and composite swaps, baskets, and spread options, along with commodity and interest rate hedges. Site currently being renovated.

7. **OM Technology Energy Systems** Software & Technology, Norway  
   **Link** [http://www.omgroup.no/](http://www.omgroup.no/)  
   Energy company whose product development encompasses systems covering the entire transaction chain, including central exchange systems, participant systems and risk-management systems. Site includes product and service details, news.

8. **Raft International plc** Software & tech. for institutions, UK  
   **Link** [http://www.raftinternational.com/](http://www.raftinternational.com/)  
   Raft International is a publicly quoted London based software company, with operations in Houston, Copenhagen and Stockholm and a state-of-the-art research and development centre in Mumbai. They specialize in leading edge risk management applications: *raft credit* for Credit Risk Management in Energy Trading and *raft radar* for Operational Risk Management in Banking. *raft credit* is an enterprise-wide credit risk management system that is the choice for leading energy trading companies. *raft credit* helps provide essential confidence to external stakeholders such as investors, rating agencies, investment analysts and regulatory bodies by demonstrating an ability to better analyze, measure, monitor, mitigate and report credit risk and capital requirements of companies.

9. **Real Time Engineering Limited** Software & tech. for institutions; UK  
   **Link** [http://www.rtx.org.uk/](http://www.rtx.org.uk/)  
   Developers of energy trading systems. Site provides details of their RT-Energy ExchangeTM (RT-XTM) which is designed to help utilities
companies manage energy trading in the deregulated marketplace, news.

10. **Sisu Group Inc** Software & Consultancy, USA  
   **Link** [http://www.sisugrp.com](http://www.sisugrp.com)  
   Sisu Group, Inc. is a Tulsa Oklahoma based software and consulting company. Their flagship product PetroMan is an Integrated Trade and Risk Management system for the Petroleum Industry. They also provide consulting and custom application development services.

11. **Sungard Trading and Risk Systems** Software & Consultancy, USA  
   **Link** [http://www.risk.sungard.com](http://www.risk.sungard.com)  
   Provider of integrated solutions for the management of energy and capacity trading, risk management and commodity scheduling. Its current energy product suite includes Epsilon and Panorama. Also offers consulting and integration services.
APPENDIX III

Contemporary credit risk models: comparison

1. Credit Monitor Model

This model was developed by KMV corporation, San Francisco, a boutique software firm nowadays owned by Moody’s Investors Service. CreditMonitor applies option pricing approach to arriving at default prediction model more known as Expected Default Frequency (EDF) measure.

EDF is determined by estimating the following model parameters:
- The market value of asset, which in turn is derived from the company’s stock price,
- The volatility of assets, by looking at the ‘historical’ stock performance,
- The default point estimation by comparing the assets value with the current liability value.

As new information about the borrower is becoming available the company’s stock price and its volatility reacts, as will its implied assets value and standard deviation of assets value. The amplitude of considered stock price fluctuations over the time has direct effect on the company’s value. Other parameters necessary to estimate the models are: the leverage ratio, the structure of liability, the average coupon payments, and the risk-free rate.

The greater sensitivity of EDF scores compared to both accounting-based ratio analysis and credit rating-based systems, comes from the direct link between EDF scores and stock market prices rather than discrete “historic” accounting data. Another advantage of KMV’s model over short horizon is that S&P and Moody’s calibrate their rating default experience over more than the past 20 years. Their probabilities therefore reflect a “cycle average” view. For actively traded firms, it would be possible, in theory, to update an EDF every few minutes. In practice, KMV can update EDF score frequently, in many cases monthly, for some 20,000 firms worldwide1.

Among the model’s important shortcomings are the following: EDF model need normality assumption of asset returns; while relying on Gaussian assumption the mentioned model underestimates extreme, systematic risks; it is difficult to measure EDF for private firms, for what additional assumptions are required; it doesn’t discriminate between different types of assets, the portfolio of loans in case of banks.

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KMV portfolio model and scenario analysis were the most widely cited techniques for analyzing portfolio risk, with the KMV model used primarily for large commercial credits. Some banks but not many are performing correlation analysis. KMV’s model and Zeta-score are increasingly used to derive internal risk ratings in banks as a starting point for all kinds of pricing.

2. Credit Metrics versus CreditRisk+

CreditMetrics was introduced by JP Morgan and its co-sponsors within Value at Risk (VaR) framework to apply for the risk valuation of nontradable assets such as loans and privately placed bonds. The main assumption of this model is that transition probabilities are stable across borrower types and across the business cycle. This assumption presently represents the model’s main shortcoming. CreditMetrics seeks to estimate the full VaR of a loan in portfolio by viewing rating upgrades and downgrades and the associated effects of spread changes in the discount rate as part of the VaR exposure of a loan. CreditMetrics is more suitable for a fixed-income portfolio because it considers the probability of changes in credit rating and default events across a portfolio. For the model we need to know:

a) borrower’s credit rating,
b) probability of rating change,
c) recovery rates of defaulted loans,
d) credit spreads and yields.

CreditRisk+ model is designed by Credit Suisse Financial Products (CSFP), and represents an insurance approach to credit risk measurement. In CreditRisk+, default events are modelled as a continuous variable with a probability distribution. Predictive usefulness of mortality rates very much depends on the size of the sample of loans/bonds from which they are calculated. To summarize the above we can say that, Credit Risk+ requires minimal data input, such as:

a) frequency of defaults,
b) severity of losses,
c) following the issue of varying mean default rate.

No data is required on credit spreads, and the model works as better as more loans are included in the portfolio.

The summary of the major differences between the models are presented below:

1 ibid, p. 264.
2 For more information see at http://www.riskmetrics.com/products/data, since the KMV doesn’t provide the very detailed model presentation.
CreditRisk+ is an analytical model, which can quickly calculate a full credit loss distribution. CreditMetrics, however, has a simulation methodology which is more time consuming and needs to change all the input variables, such as exposure, credit rating migration, recovery rates and correlation.

CreditRisk+ views risk as part of market risk rather than credit risk therefore only two states are considered - default and non-default, and the focus is on measuring expected and unexpected losses, rather than expected value and unexpected changes in value (VaR) as under CreditMetrics.

In CreditRisk+, default events are modelled as a continuous variable with a probability distribution. In CreditMetrics, the default probability in any year is discrete, as are the upgrade/downgrade probabilities.

The data requirements in the CreditRisk+ methodology have been kept as low as possible, which minimizes the error from parameter uncertainty.

Credit risk plus is not appropriate for mark-to-market credit risk model. In general the RiskMetrics is a collection of methodologies and data sets designed to help an institution to derive its portfolio value at risk. It provides a set of tools to map its products to standardized risk positions. These positions are fed into a variance-covariance matrix to derive the portfolio return and variance. RiskMetrics estimates this matrix using historic data and a multitude of techniques ranging from simple exponential smoothing to autoregressive moving average models and other sophisticated forecasting techniques.

### 3. CreditPortfolioView

This model introduced by Tom Wilson, McKinsey. The model is known as Macro Simulation Approach. CreditPortfolioView is exploring an empirical evidence that rating transitions, in general, may depend on the state of economy and that the probability of downgrades and defaults may be significantly greater in a cyclical downturn that in a upturn. Among the various approaches to deal with macro-factors, this one relies on direct modeling the relationship between transition probabilities and macro-factors. Furthermore, the model simulates the evolution of transition probabilities over time by generating macro-shocks. The model is similar to Credit Metrics and is intended for studying business cycles as well and is complementary to VaR.

### 4. “Comparative anatomy” of credit risk models

The first comparison among the contemporary models was done by M. Gory in his paper “A Comparative Anatomy of Credit Risk Models” also offers a comparative anatomy of two especially influential benchmarks for two credit

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1 Caouette et all, 1998 p. 150.
2 ibid p. 261.
risk models: J.P. Morgan's CreditMetrics and Credit Suisse Financial Product's CreditRisk+ in a very detailed and interesting way. Several authors present a comparative anatomy of the mentioned above models assessing credit risk measurement. For example, A. Saunders in his book ‘Credit risk management’, 1998 presents a comparative anatomy of the four out of the above five models presented by him; he shows similarities among them when compared according to six features. He suggests six key dimensions to compare the most prominent new models of credit risk measurement that are publicly available in complete or partial form.

1. Definition of risk: mark-to-market or default mode models
2. Risk drivers: firm asset values, volatility of asset values are key drivers of default risk for CreditMetrics and KMV, macro factors, such as unemployment rate for CreditPortfolioView, the mean level of default risk and its volatility in Credit Risk+
3. Volatility of credit events
4. Correlation of credit events
5. Recovery rates
6. Numerical approach to credit risk valuation

Another comprehensive illustration of cross-model comparison and analysis is done by Bluhm et all, 2001, illustrated in the figure below. The analysis of each of the models was already presented when above presented, except for the intensity models.

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1 See the table of model comparison in Appendix III.
At the same time, all the above described models have a common disadvantage for industrial companies. Their application requires extended database of loans and default rates over the long time periods which industrial companies don’t have (and probably don’t even need to have). Because of these facts many industrial companies turn to traditional risk measuring or demand extra protection for the risks taken.
Comparison among contemporary credit risk models\(^1\) (Saunders, 1998; Bluhm, 2001)

<table>
<thead>
<tr>
<th>Model Dimension for comparison</th>
<th>CreditMetrics(^2) (J.P. Morgan, RiskMetrics Group)</th>
<th>CreditPortfolio View (Tom Wilson)</th>
<th>Credit Risk Plus (CSFP) actuarial approach</th>
<th>KMV’s Credit Monitor</th>
<th>Intensity models</th>
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<td>Distance to Default or DM</td>
<td>MtM or DtD</td>
<td>Default risk only</td>
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<td>Macro factors</td>
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</tr>
<tr>
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<td>Constant</td>
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<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
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<td>Stochastic, via macro factors</td>
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<td>EDF concept, high migrat. probabil</td>
<td>Not implemented</td>
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<td>5. Correlation of events</td>
<td>Multivariate normal asset returns or equity value factor model</td>
<td>Factor loadings (implicit by macroeconomy)</td>
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<td>Random</td>
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<td>Simulation / analytic</td>
<td>Simulation</td>
<td>Analytic</td>
<td>Analytic</td>
<td>Analytic</td>
</tr>
</tbody>
</table>

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\(^1\) This is an extended table of Saunders, 1998, considering the more recent intensity models.

\(^2\) by Gupton, Finger, Bhatia. CreditManager tool of RiskMetrics Group was introduced before KMV’s, (Bluhm et all, p. 42)

\(^3\) Merton’s model for default probabilities from market info, produced output are Expected Default Frequencies.