

# PREDICTING CREDIT RISKS

## *Using Sustainability Criteria into Credit Risk Management*

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*Many researchers have reported that there is a correlation between a company's environmental performances with its financial performance. The role of criteria pertaining to sustainability and environmental orientation could play important roles in credit risk management process. The sustainability criteria can be used to predict financial performance of a debtor and, thus, improve predictive ability of a credit rating process. This article tests the relationship by using three sustainability measures as independent variables and traditional rating as dependent variable in a stepwise regression model. The result shows improvement in prediction. However, the use of additional criteria will increase cost in the prediction process. Further cost-benefit analysis related to the addition of those criteria would be valuable for credit risk management practices.*



*Keywords: Credit risk rating, risk management, traditional rating, sustainability ratings.*

### Abstract

**A**re there any significant influences of commercial debtor's economic, environmental, and social performance in terms of sustainability to its credit risk rating? Will adding criteria such as those which aimed at assessing environmental, social or sustainability practices improve traditional financial rating criteria? It is important to pay attention to the basic definitions of sustainable development and use them in credit management in banking businesses. The application could contribute to sustainable development and long term survival (Jennings and Zandberger, 1995; Rosch 2005).

In addition to natural resource based viewpoint, sustainability of a company is also demonstrated by its ability to manage ecological sustainability (Jennings and Zanberger, 1995; Shrivastava, 1995; Rosch, 2005). It is possible to broaden these views by incorporating social and economic sustainability (Galdwin et al., 1995). There are necessary conditions for firms to be called sustainable (Callens and Tyteca, 1999; Perly, 2004). The next section of this article will describe what sustainability could mean for credit business. The sustainability will be divided into three aspects: economy,

environment, and social concerns. Arguably, sustainability might only be achieved by fulfilling a minimum level of the three aspects.

### **Credit Risk Management**

Let us begin with a description of the credit management process. There is a chain from the risk of the borrower to the risk of the lender. Many factors influence the borrower's capital stock or its liquidity and, therefore, must be rated by the lender. These factors influence a borrower's ability to repay his loan and as a result influence the bank's credit risk. In credit risk management, a company's balance sheet, its quantitative indicators, and its qualitative indicators (such as management skills) are among the indicators used to identify and manage the risk of a borrower (Caouette et al., 1998; Saunders, 1999; Werber, 2001).

In this study, concentrating on the so-called counterparty credit risks, which are mainly influenced by the following key factors (Saunders, 1999; Lyubov, 2003; Rosch, 2005): The reputation of the debtor, including its willingness to repay and its repayment history, the ability to repay, which is a reflection of the debtor's earnings, the debtor's capital and its ratio to debt, the

value of the collateral, sustainability risks could significantly influence these factors (Altman, 2002). In the following paragraph there are some examples: A debtor's earnings could be influenced by increased costs of prescribed investments into environmental technologies. These investments, in turn, decrease the debtor's liquidity and therefore the ability to repay the loan. Moreover, the need for additional capital to invest in environmental end-of-pipe technologies results in a decrease in the borrower's capital-debt ratio, which in turn leads to an increase in the bank's credit risk. In addition, the site a commercial borrower used as collateral can depreciate, thus increasing the credit risk for the bank. There can also be indirect influences that affect a borrower's earnings; non-adequate wages in developing countries, for example, can result in consumer boycotts, putting a borrower's reputation at risk.

Obviously, the economic conditions of a country or within a sector also influence the debtor's risk. In this case, however, can paid special attention to the specific risks that are caused by or could be influenced by the debtor. Scientific analyses of the management of sustainability credit risks in banks have concentrated mostly on

banks' environmental risk management. An analysis of the environmental performances of different sectors showed that banking belongs to the group of sectors with the least activity (Springett, 2003). One result of this finding could be that in about 10% of all credit losses in German banks, environmental risks were involved (Scholz et al., 1995). In a follow up study, Weber (1997a) deduced that the main reasons for credit losses attributable to environmental issues were a reduction in securities from contamination; expenditures to resolve environmental issues forced by a regulatory body, environmental disasters, and environmentally caused market changes.

These risks indicate that banks should place increasing importance on environmental credit risk management in their corporate lending operations (Lyubov, 2003; Katchova and Barry, 2005). To accomplish this, they need decision support tools to systematically analyze and manage their environmental credit risks in a standardized way (Gladwin et al., 1995). Furthermore, macro level analyses of banks' environmental risks showed that assuming full liability creates an internalization of environmental risks by lenders, thus fostering the integration of sustainability aspects into the credit rating

process. In spite of this, Weber (2001) and Coulson and Monks (1999) analyzed decision makers in the lending business with respect to how capably they managed environmental risk, and those studies indicated that very little expert knowledge of environmental credit risk has been put into practice. This could be one of the reasons why the banking sector scored so low in its rating with respect to sustainability (Springett, 2003).

The effects of risks to sustainability, however, are not limited to credit risk, but also include a debtor's financial performance. A debtor with a good capital basis and liquidity is able to negate environmental risk by reversing the effect of environmental damage such as decontaminating a contaminated site easier than a debtor with little capital. While the former could be a good, low risk client to a bank, the latter could be very risky. In spite of this, most banks manage risks to sustainability separately from traditional credit risks, because they do not perceive them as being that influential (Fenchel, 2003).

### **Economic Sustainability in Credit Risk Management**

One basic definition of economic sustainability is the preservation of the capital basis (van

Dieren, 1995), based on the definition by the Brundtland Commission. According to this view, sustainable development is interpreted as "sustainable growth". El Serafy (1997) presented a similar view arguing in favor of "greening the national accounts". According to this view, growth is only sustainable when the welfare for present generations does not involve a reduction in welfare for future generations (Faucheux and Nicolai, 1998). Stavins et al. (2003) outlined these concepts by defining an economy as sustainable "if it is dynamically efficient and the resulting stream of welfare functions is non-declining over time". It is not easy, however, to apply these economic concepts of sustainability to the level of a firm (Jennings and Zandberger, 1995). According to Welford (1995), to be sustainable, a firm should minimize its use of non-renewable resources and its emissions of pollutants. Moreover, the firm should contribute to a reduction of unemployment and use long-term considerations and indicators of success. These Indicators are similar to the long-term economic aspects described by Callens & Tyteca (1999).

How can economic sustainability be applied to the level of the lending business? Commercial lending is traditionally very

close to the neoclassical view of sustainable development. The main benefit of a loan for the debtor is to invest the money to generate income and pay back the interest out of a part of the return on the investment (Stavins et al. 2003). Thus, repayment of a loan should not decrease the capital stock of the borrower, including externalities. The major task of a bank is to understand credit risk. Credit risk is defined as the probability that a borrower will pay back a loan and the accrued interest within the contracted period of time. Thus, sustainable credit risk is the probability that a borrower will repay a loan and its interest on time using money from the return he received on the invested loan, rather than from his capital stock. In order to fulfill this demand, sustainable credit ratings should concentrate not only on the analysis of a borrower's securities, but also on his ability to create a sustainable positive return on the loan. Traditional loan evaluations have mainly analyzed such things as a company's past financial performance, its management systems, its legal compliance, and its securities, while economically sustainable credit ratings need to have a future oriented view of a borrower's development and interaction with the environment and society.

Thus, it is becoming ever more important in the commercial lending business to rate such economically sustainable criteria as the future development of an enterprise's management as well as the environmental impact of the production process or of its products.

### **Environmentally Sustainable Credit Risk Management**

Current literature discusses new impacts on the performance of a firm, such as environmental or social impacts. By using stock market measurement, Klassen and McLaughlin (1996) were able to measure the link between strong environmental management and future financial performance of companies. There seemed, however, to be special conditions, which influenced the interaction between the environmental and the financial performance of firms. Russo and Fouts (1997) stressed the interaction between environmental and financial performance in rapidly growing industries, while Christmann, (2000) showed that firms require relatively high output price levels to be induced to invest in environmental technologies. Furthermore, regarding the firms' performance in terms of sustainability, scientists concentrated on capacity building and stressed the importance of the firms' capacity to act proactively (Sharma and

Vredenburg, 1998; Christmann, 2000; Stavins et al. 2003).

The above studies showed that there are factors that positively influence the performance of a company, such as having implemented green innovations or working conditions consistent with socially acceptable standards. By way of contrast, Weber (2001) showed that there are environmental factors that negatively influence the financial risk of a firm for example, the realized risk of a contaminated site or a reputation risk such as the use of materials that have a negative impact on the environment.

### **Social Sustainability in Credit Risk Management**

The social aspects of sustainable development include such considerations as participation, salary fairness, job safety, health standards at the workplace, and creation of new jobs (Callens and Tyteca, 1999). The results of a study by Pava & Krausz (1996) support the assumption that social criteria have an impact on a firm's performance. Using a meta-analysis, they identified and reviewed 21 empirical studies that addressed the interaction between social performance and financial performance. "Nearly all

empirical studies to date have concluded that firms which are perceived as having met social-responsibility criteria have either outperformed or performed as well as other firms which are not (necessarily) socially responsible." (Pava and Krausz, 1996). Other studies, however, could not find a correlation between a firm's social performance and its financial performance (Christmann, 2000).

Socially sustainable credit risk management incorporates the non-monetary interests of society and individuals into the decision making process. A loan decision that is socially oriented will not only take the consequences for the lender into consideration, but also take the consequences for the social environment. These include salary fairness, workplace health standards, job safety, and new job creation. If a commercial debtor ignores these, it may lead to severe financial risk, affecting himself, his creditworthiness, and his ability to repay the loan.

An example is a company that supports child labor or pays wages lower than the minimum living wage. There is a risk of consumer boycotts, labor strikes in response to the bad working conditions, and a possible future internalization of costs, if large numbers of

employees are dismissed. Thus, by putting more emphasis on assessing the social performance of a borrower and its relation to economic performance, a bank can predict loan outcomes more accurately (Rosch, 2005).

### **The Rating Methods of Commercial Loans**

Chose commercial loans for this research because banks' lending decisions have a decisive influence on companies' investments. If banks derive benefit from incorporating sustainability criteria into their credit management, they will do so, hence influencing both their own risk management and the business strategies of their debtors. The classified loans into two groups according to risk: good loans and bad loans. The good loans, contained loans in which the client fulfilled all of his contractual loan agreements. The contained bad loans, which were financially negative for the bank. This includes loans, which required cost intensive supervision measures or resulted in credit default.

It is obvious; however, that loan risk is a continuum. Classifying loans is mainly a methodological strategy. In this study, the participants rated loans in order to assure

that sample contained both high and low risk loans. Using a risk continuum, the range of risk of the loans is more uncertain and irreproducible. While on the one hand, classifying the loans in two groups is simple and comprehensible, on the other hand, statistical methods like discriminant analysis reinstate a continuum of loan risk, using the distances between the scores of the cases centroids of the two categories as indicators of the risk of a case (Caouette et al., 1998; Rosch, 2005).

The Industrial banking in Indonesia, as the participants was credit officers who mainly give loans to small and medium sized firms. They were not specialists in rating the environmental practices or sustainability of their debtors. The credit rating process in these cases is based on traditional scoring or rating. Additionally, knowledge about the debtor plays an important role. Generally, the credit officers know their debtors personally and have established a long-term business relationship with them. Thus, decisions about loans are based on a mixture of a formal credit rating process and the credit officer's individual knowledge of the debtor (Weber, 2001).

There was no centralized training or strategy for handling environmental or sustainability criteria in these banks. Not surprisingly, found that degrees of knowledge about using environmental and sustainability criteria in the credit rating process varied greatly (Michalik et al., 1998). There was no case in which sustainability criteria were already part of the standardized rating process. Thus, the credit officers' judgments about the sustainability criteria were based solely on their personal knowledge. At the beginning of a session, asked the loan officers to classify the loans as positive or negative for the bank based on the description above, in order to calculate the prognostic validity of the criteria.

This research used 33 criteria for the traditional credit risk assessment (xtrad), basing it on a standardized credit risk rating system. The remaining 58 items were sustainability criteria, which extracted from the theory section above. To checked the homogeneity of the items in the four groups with a reliability analysis using Cronbach's alpha.

As a result of the reliability analysis, selected 85 items for the later analysis. The 85 items were those that did not decrease the alpha

of the scale. Thirty-one of the items were economic sustainability criteria (xecon), 15 were environmental criteria (xenv), and 6 were social criteria (xsoc). All of the groups scored a Cronbach's alpha of .75 or higher, which is considered satisfactory. After the reliability check, merged the items into the four categories using the mean of the single items. Furthermore, researcher used the participants' experience with sustainability risks (experienced vs. inexperienced), the debtor's categorization as belonging to the service sector or production sector, and the type of bank (state bank vs savings bank) as categorical control variables.

Researcher used the following guidelines for operationalizing the control variables. The participants who were already experienced with sustainability risks by already having had to rate sustainability risks in their job as experienced. Furthermore, Researcher distinguished between the service and production sectors, because some types of risk, such as the risks associated with a contaminated site, could appear significantly more frequently in one of the sectors. As a third control variable, researcher used the categorization of banks as either state or savings banks; these differ, mainly in the sizes

of their balance sheets and credit clients, but they belong to the same association.

Using multiple linear regression and linear discriminant analysis to model the integration of sustainability criteria into the credit management process. Using multiple regression analysis, researcher tried to predict the traditional ratings, which were quantitative. The sustainability criteria, which were quantitative as well, were independent variables. Discriminant analyses can be used to predict group membership on the basis of quantitative predictor variables. They are standard methods of credit risk prediction (Saunders, 1999). The linear discriminant analysis for the traditional credit scoring, which is also widely known to be the z-score model, has the following form (Altman, 2002):  $z = b_{trad}x_{trad} + e_0$  (Equation 1) with:  $x_{trad}$  = traditional lending criteria  $z$  = critical value to classify a borrower as good or bad  $e_0$  = other unsystematic risks Integrating sustainability criteria into the linear discriminant analysis changes it to the following form:  $z\zeta = b_{econ}x_{econ} + b_{env}x_{env} + b_{soc}x_{soc} + e_0$  (Equation 2) with:  $x_{econ}$  = economical sustainability criteria  $x_{env}$  = environmental sustainability criteria  $x_{soc}$  = social sustainability criteria

$b_l$  = weight,  $e_0$  = other unsystematic risks in approach, combined traditional ratings and sustainability ratings by adding them together. The new linear discriminant function had the following form:  $z\zeta = b_{trad}x_{trad} + b_{econ}x_{econ} + b_{env}x_{env} + b_{soc}x_{soc} + e_0$  (Equation 3) with:  $x_{trad}$  = traditional lending criteria  $x_{econ}$  = economic sustainability criteria  $x_{env}$  = environmental sustainability criteria  $x_{soc}$  = social sustainability criteria,  $b_l$  = weight,  $e_0$  = other unsystematic risks or errors In this function (Equation 3), the combination of sustainability criteria and traditional credit assessment criteria predicts the z-value, which classifies a borrower as good (category 1) or bad (category = 0). A z-score bigger than 0 indicates that the borrower belongs to the group of good loans and a z-score lower than 0 indicates that the borrower belongs to the group of bad loans. The z-scores, however, are continuous, indicating that the higher the z-score, the higher the risk of loan.

One type of validity in discriminant analysis is predictive validity, measured by correct classification of the loans. If the integration of sustainability criteria improved the predictive validity of the discriminant analysis, there should be a significant improvement in the correctness of the classifications. This test

is typically used in a repeated measures situation, in which each subject's response is elicited twice. In this case, researcher did so first only using traditional criteria and second using a combination of traditional and sustainability criteria. The McNemar Test determines whether classification by traditional ratings and classification by a combination of traditional and sustainability ratings are equivalent. This test is useful for detecting changes in responses in before and after designs, which researcher used in this analysis. Researcher used a single-sided test, because hypothesized that integrating sustainability criteria would increase the correctness of the classifications.

**Results**

In different regions, can the savings banks and state banks with a balance sheet of higher than 1 million € to participate in this study by having three representatives at a time analyzing one bad loan and one good loan. Out of the 40 banks, 70% participated. The main business of the banks was lending to private and commercial clients able to analyze 180 loans by 74 loan officers, if a bank was not able to provide three representatives, the remaining representatives to analyze

more than two cases. Eight percent of the participants had had between 1 and 5 years of job experience, 34% had had between 6 and 9 years, and 58% had had more than 10 years. The age of the majority of the participants was between 30 and 39 years old. Looking at job experience and age, assert that the participants were very experienced in the credit rating process. In **Table 1** the descriptive statistics for the ratings.

The influence of covariates by using Chi Square tests to evaluate whether there is a significant relation between the classification of a loan as bad or good and the covariates "type of bank" (savings banks vs. state banks, Chi Square = .280, df = 1, p = .596), "sector" (service sector vs. production sector, Chi Square = .479, df = 1, p = .489), and "experience of the participants with sustainability ratings" (experienced vs. nonexperienced, Chi Square = .340, df = 1, p = .560), found no covariate to be significantly related to the classification of a loan as good or bad. Furthermore, analyzed whether there are significant differences between the covariates and the ratings (traditional and sustainability), using three 2 x 4 ANOVAs for repeated measurement (traditional rating, economic sustainability, environmental sustainability, and social sustainability as the

**Table 1. Descriptive Statistics for the Ratings**

Variables	Group	N	Mean	Std. Deviation
Traditional Criteria	all	134	3.23	0.55
	bad	65	3.02	0.43
	good	112	3.34	0.40
Economic Sustainability	all	143	3.04	0.48
	bad	132	3.32	0.38
	good	55	3.23	0.39
Environmental Sustainability	all	120	3.20	0.56
	bad	33	3.15	0.66
	good	67	3.26	0.64
Social Sustainability	all	134	3.21	0.67
	bad	32	2.76	0.4
	good	98	3.34	0.54

N for the criteria groups is different because of missing values

four levels of the repeated measurement). Researcher did not find that the type of bank (df = 1, F = 2.86, p = .093), the sector (df = 1, F = 2.72, p = .102), or the experience (df = 1, F = 2.31, p = .131) had a significant effect on the ratings. Analysis of the interactions between the covariates and the ratings did not indicate that these interactions were significant either. Researcher did not find significant interactions between the type of bank and the ratings (df = 3, F = 0.30, p = .993) or between the sector and the ratings (df = 3, F = 1.50, p = .219) or between the experience and the ratings (df = 3, F = .269, p = .848).

What were the results of the rating process using traditional, economic, environmental and social sustainability criteria? To answer this question need conducted a two-step

analysis. In the first step, can analyzed how accurate sustainability criteria (independent variables) are at predicting credit risks according to traditional criteria (dependent variable, risk rating by the traditional rating system) using multiple regression analysis. In a second step, can analyzed whether combining traditional and sustainability criteria as independent variables improved the validity of discriminating good loans from bad (categorized dependent variable, categorization by the participants) using discriminant analysis.

**Predicting Credit Risks Using Sustainability Criteria**

As mentioned above, in first step can analyzed the influence of the sustainability ratings on

the financial performance of the borrower using the three sustainability ratings as independent variable and the traditional rating as a dependent variable in a stepwise regression model. With R Square = .790 (adjusted R Square = .614), the independent variables economic, environmental and social sustainability were able to predict a significant amount of the variance of the credit risk operationalized by the traditional ratings. Economic sustainability was entered (R Square = .737, p F change <.0001), social sustainability was entered (R Square = .771, p F change <.0001), and environmental sustainability was entered (R Square = .790, p F change = .003). Collinearity statistics did not indicate collinearity of the variables, as the tolerance of all variables was greater than .1 and the VIF was smaller than 10. Collinearity diagnostics did not indicate collinearity either, because all condition indices were much smaller than 30 (Rosch, 2005).

The result that loans with higher ratings in economic and social sustainability (positive beta weights), but lower ratings in environmental sustainability (negative beta weights), have higher ratings in traditional risk rating demands deeper analysis. Thus, researcher distinguished between good

and bad cases and correlated traditional ratings with environmental sustainability ratings. This correlation analysis indicated a significant positive correlation between traditional criteria and environmental criteria for the good cases ( $r=.316$ ,  $p=.005$ ), but no significant correlation for the bad cases ( $r=.019$ ,  $p=.905$ ).

#### **Combining Traditional and Sustainability Criteria to Predict Credit Risks**

To analyze whether integrating sustainability criteria, in addition to traditional criteria, could improve the prediction of credit risks, can conducted a multiple linear discriminant analysis to determine whether four predictors traditional rating, economic sustainability, environmental sustainability and social sustainability could predict whether a loan would be good or bad as categorized by the credit officers. Researcher subsequently conducted a McNemar Test for related samples to compare the result with the number of correct classifications from using only traditional criteria. The overall Wilks's lambda of the discriminant function was significant (Lambda = .494,  $df = 4$ , Chi Square = 81.04,  $p<.0001$ ), indicating that overall the predictors differentiated good loans from bad. In the table, the beta weights

and the significance of the variables in the discriminant function.

As expected, traditional criteria showed the highest weights. The second highest weights showed economic sustainability. Environmental criteria again as in the regression analysis showed a negative weight, while social sustainability showed a positive weight. To predict whether a loan belonged to the group of good loans or bad loans, the able to classify 86.6% of the loans in this sample correctly with 85% correct classification for the bad loans and 87.3% correct classification for the good loans. In order to take chance agreement into account, can computed a kappa coefficient and obtained a value of .706 (a value of 1 indicates perfect prediction). Finally, to assess how well the classification procedure is able to make predictions in a new sample, can estimated the percentage of loans accurately classified using the leave-one-out technique and found that correctly classified 85.7% of the cases.

As a next step, to compare the results of the discriminant analysis above to the prediction of good and bad loans using only traditional criteria. The overall Wilks's lambda of the discriminant analysis that used only

traditional criteria was significant as well (Lambda = .625,  $df = 1$ , Chi Square = 83.45,  $p<.0001$ ). This indicates that overall the predictor was able to differentiate between good and bad loans. When tried to predict whether a loan would belong to the group of good loans or to the group of bad loans, able to correctly classify 78.9% of the loans in this sample, with 80.6% correct classification for the bad loans and 77.9% correct classification for the good loans. In order to take chance agreement into account, computed a kappa coefficient and obtained a value of .564. Researcher conducted a McNemar Test for repeated measurement, in order to analyze whether the integration of sustainability criteria improved the number of correct classifications. This test evaluates whether the proportion of correct classifications using only traditional criteria differs from the proportion of correct classification using traditional and sustainability criteria.

The use of a test for repeated measurement is reasonable, because the participants had rated the loans using traditional criteria and sustainability criteria. While traditional criteria correctly classified only 5 loans, which had not been correctly classified by the combination of traditional and sustainability ratings, the

combination of traditional and sustainability ratings correctly classified 13 loans, which could not have been correctly classified by traditional criteria alone. A one-sided McNemar test of dependent proportions indicated a significant improvement of correct classifications by integrating sustainability criteria into the discriminant analysis (exact pone tailed = .048, N=119).

### Conclusion

Additional research analyzing the efficiency of incorporating sustainability criteria into the credit risk management process would be valuable. The result show an improvement in the prediction. The Use of additional criteria, however, increases cost. Thus, further analysis of the cost benefit relation between using additional criteria and improving risk management would be of value booth for science and for the industry. ■

environmental performance considerations within bank lending decisions," *Eco-Management and Auditing*, 6: 1-10.

Faucheux, S. and Nicolai, I., 1998, "Environmental technological change and governance in sustainable development policy," *Ecol. Econ.*, 27(3): 243-256.

Gladwin, T., Kennelly, J. J. and Krause, T.-S., 1995, "Shifting paradigms for sustainable development: Implications for management theory and research." *Acad. Manage. Rev.*, 20(4): 874-907.

Jennings, P. D. and Zandberger, P. A., 1995, "Ecologically sustainable organizations: An institutional approach," *Acad. Manage. Rev.*, 20(4): 1015-1052.

Altman, E., 2002, "Managing credit risk: challenge for the new millennium, economic notes 2-2002," *Review of Banking, Finance and Monetary Economics*, 201-214.

Callens, I. and Tyteca, D., 1999, "Towards indicators of sustainable development for firms - a productive efficiency Perspective," *Ecol. Econ.*, 28: 41-53.

Caouette, J. B., Altman, E. I. and Narayanan, P., 1998, *Managing Credit Risk: the Next Great Financial Challenge*, Wiley, New York, NY.

Christmann, P., 2000, "Effects of "best practices" of environmental management on cost advantage: The role of complementary assets," *Acad. Manage. J.*, 43(4): 663-680.

Coulson, A. B. and Monks, V., 1999, "Corporate

Katchova, A.L., Barry, P.J., 2005, "Credit risk models: An application to agricultural lending," *American Journal of Agricultural Economics* 87:195-206.

Klassen, R. D. and McLaughlin, C. P., 1996, "The impact of environmental management on firm performance," *Manage. Sci.*, 42(8): 1199-1214.

Lyubov, Z., 2003., *Evaluating Credit Risk Exposure in Agriculture*, PhD Thesis. University of Minnesota, Minneapolis, Minnesota.

Michalik, G., Weber, O. and Scholz, R. W., 1998, "Psychological factors of recognizing environmental credit risks," *Umweltpsychologie*, 2(2): 30-41.

Pava, M. L. and Krausz, J., 1996, "The association between corporate social-responsibility and financial performance: The paradox of social costs," *J. Bus. Ethics*, 15: 321-357.

Perli, R., Nayda, W.I., 2004, "Economic and Regulatory Capital Allocation for Revolving Retail Exposures," *Journal of Banking & Finance* 28, 789-809.

Rosch, D., 2005, "An empirical comparison of default risk forecasts from alternative credit rating philosophies," *International Journal of Forecasting* 21, 37-52.

Russo, M. V. and Fouts, P. A., 1997, "A Resource-based Perspective on Corporate Environmental Performance and Profitability," *Acad. Manage. J.*, 40(3): 534-559.

Saunders, A., 1999, *Credit Risk Measurement: New Approaches to Value at Risk and Other Paradigms*, John Wiley & Sons, New York, NY.

Scholz, R. W., Weber, O., Stünzi, J., Ohlenroth, W. and Reuter, A., 1995, "The systematic measuring of environmental risk," *Credit Defaults Caused by Environmental Risk Results of a First Study*. Schweizer Bank, 4: 45-47.

Sharma, S. and Vredenburg, H., 1998, "Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities," *Strategic Manage. J.*, 19: 729-753.

Stavins, R. N., Wagner, A. F. and Wagner, G., 2003, "Interpreting sustainability in economic terms: dynamic efficiency plus intergenerational equity," *Econ. Lett.*, 79: 339-343.

Weber, O., 1997a, "Credit management and sustainable industrial development," *Paper presented at Science for a Sustainable Society - Integrating Natural and Social Sciences*, Roskilde, Denmark.

Weber, O., 2001, "Assessment of enterprises environmental risks: Using photographs as perceptual stimuli," *J. Environ. Psychol.*, 21: 165-178.

Welford, R., 1995, *Environmental Strategy and Sustainable Development. The Corporate Challenge for the 21st Century*. Routledge, London.