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104 Eolou St., 105 64 Athens, Greece,
Tel. +30 210 32 19 557, Fax +30 210 33 16 358,
E-mail: info@valueinvest.gr | Value Invest – www.valueinvest.gr

CONTENTS

Predicting payment default: a search for financial and non-financial predictors using two-way effects*

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Erkki K. Laitinen, Professor of Accounting and Business Finance**

Abstract –The importance of two-way effects in predicting payment defaults in Finland is assessed. For estimation, 1500 default firms and 1500 non-default firms are randomly selected and 62164 firms are left for validation. The study first makes use of simulation experiment to hypothesize how two-way effects affect the performance of the models. Two different kinds of general linear (GL) models are estimated: models based on main effects and models based on both main and two-way effects. The estimated models are based on three data sets: financial variables, non-financial variables, and both financial and non-financial variables. The results largely support the hypotheses.

JEL classification: M Business Administration and Business Economics Marketing; Accounting, M4 Accounting, M41 Accounting

Key words: default prediction, general linear model, financial ratios, non-financial variables, two-way effects

1. Introduction

Payment default is a form of business failure. It can be defined as the inability of the firm to pay its financial obligations when they come due (Beaver, 1966 and Altman, 1968). In this situation, the firm suffers from lack of financial resources and is unable to get such resources in time, to pay the mature obligations. For obvious reasons, failure prediction is traditionally based on financial statement variables (for a review see Zavgren, 1983, Jones, 1987, and Laitinen & Kankaanpää, 1999). However, it has been shown that non-financial variables may bring additional information over financial ratios (Keasey & Watson, 1987, Wilson, Summers & Hope, 2000, and Back, 2005) in payment default prediction. The statistical methods of failure prediction differ from each other in the functional form, which they apply to these variables. However, many methods make use of a version of linear functions in estimation. For example, the linear discriminant analysis and the linear regression analysis apply a linear function to the original variables. The logistic regression analysis applies a logistic function to the linear logit of the variables. In addition, the proportional hazard survival analysis applies an exponential function to the linear log-relative hazard, and the neural network analysis may apply complicated non-linear functions to the linear combinations of original or standardized input variables (see Laitinen & Kankaanpää, 1999). The linear function only includes the main effects of the variables. Thus, the application of this function may result in an ineffective prediction model. It omits the relationships between the variables and may lead to a miss-understanding of the cause-and-effect relationships in

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** Department of Accounting and Business Finance, University of Vaasa, POB 700, FIN-65101 Vaasa, Finland, phone: +358-6-3248 275, fax: +358-6-3248 344, email: ekla@uwasa.fi

default analysis. *It is the main objective of this study to show how both the main effects and the two-way effects of the variables can be together utilized in default prediction.*

The difference between the main effects (linear) analysis and a two-way effects analysis can be demonstrated by the following example. Let us assume that the task is to predict a binary status variable *Z*. *Z* equals unity when the firm is a non-default firm and is zero when the firm is a default firm. If the model includes two independent variables and has a linear form, the resulting equation without any error term can be presented as follows

$$Z = b_0 + b_1 X_1 + b_2 X_2 \tag{1}$$

where b_0, b_1, and b_2 are the regression coefficients and X_1 and X_2 the independent variables, say the return on investment (profitability) and the logarithmic net sales of the firm (size). If b_1 and b_2 are statistically significant and positive, the model (1) implies that the profitability (X_1) and the size (X_2) have both a separate and positive (main) effect on the likelihood of non-default.

When including the main and two-way effects in the model, the resulting model may however have the following statistically significant effects

$$Z = b_0 + b_1 X_1 + b_3 X_1 X_2 \tag{2}$$

where the cross-product of the independent variables ($X_1 X_2$) describes the two-way effect. The equation (2) can be transformed to

$$Z = b_0 + X_1 \left(b_1 + b_3 X_2 \right) \tag{3}$$

which shows that the size has only a significant two-way effect on the dependent variable. Thus, in reality the size does not directly affect the likelihood of non-default but it acts as a contingency (moderator) variable that transforms (moderates) the relation between the return on investment and the likelihood to default (see Luft & Shields, 2003). If b_1 and b_3 are positive, it shows that the profitability has a positive main effect on the non-default likelihood and that the total effect is the larger, the larger is the size. Hence, it is only the profitability, that directly affects the non-default likelihood but the effect is dependent on the size. The interpretation of the model (3) is thus that in large firms profitability is more important than in small firms in avoiding payment defaults.

The situation described above can be realized, when the independent variables correlate with each other, which contradicts with the assumptions of the linear model. When using financial variables to explain and to predict payment default, the independent variables are usually correlated. This is because of the default process deteriorates both the income statement and the balance sheet items which makes several financial variables (ratios) to change in the parallel way. Thus, the inclusion of two-way effects may improve the fit of the model and to result in such estimates which allow interpreting the default process properly. However, because the independent variables are correlated with other, it may not remarkably change the (rank) order of firms with respect to the default likelihood. Thus, it may not significantly improve the classification accuracy. In addition, it will be shown in this study that the distributions of the covariates largely determine the degree of improvement in the goodness of fit. The degree of improvement may be remarkable if the two-way effect of a positively skewed variable and a negatively skewed variable is introduced in the model. Financial variables include both types of variable but non-financial variables are typically positively skewed. In addition, the distributions of non-financial variables have often a high kurtosis which diminishes the degree of improvement. However, non-financial variables may include significant additional information over financial variables, since they measure different dimensions and are not remarkably correlated with them. The hypotheses of the study will be based on these arguments.

The present paper is organized as follows. The introductory section presents the framework of the study. The second section presents a simulation experiment to show the potential of two-way effects. This experiment is based on 100 simulated observations. The general linear model (GLM) is used to estimate the main effects and two-way effects models. Then, hypotheses on the two-way effects are extracted from the experiments. The third section includes a justification for the choice of the independent variables to predict payment defaults. Six financial variables and eight non-financial variables are selected for the empirical analysis. In ad-

dition, this section presents the empirical data and the method of the study. The estimation data is restricted to 1500 default firms and 1500 non-default firms. The classification results of the main effects and two-way effects models will be validated in a large sample of 592 default firms and 61572 non-default firms. The GLM will be used to estimate the prediction models. The fourth section presents the results. First, the results for the financial variables are presented. The differences in the interpretation between the main effects and two-way effects models are discussed in detail. The purpose is to show how two-way effects can be used to interpret how different financial variables affect the default process of the firm. Secondly, the estimation results for the non-financial variables are reported. Thirdly, the results for the combined models of the financial and non-financial variables are discussed. Finally, the last section concludes the study.

2. Simulation experiments on the two-way effects

2.1. Framework for simulation

The potential of two-way effects is difficult to analyse without a numerical analysis. Therefore, a simple deterministic simulation experiment is performed. It is clear that the relationship of the covariates to the default likelihood and to each other affect the results. In default prediction, the covariates are correlated with the status variable and generally also with each other. Financial variables are usually correlated more that financial and non-financial variables. Thus, the two-way effects may not reflect any pure moderator-variable interaction but merely an independent-variable interaction (Loft & Shields, 2003: 174). The distributions of the independent variables may be quite different. Thus, the simulation will include several experiments (cases) for different types of distributions of correlated variables. The experiments are based on 100 simulated observations. There are 50 observations for default firms (Z=0) and 50 observations for non-default firms (Z=1). These observations are presented in the rank order so that observations i=1,...,50 are default firms and i=51,...,100 are non-default firms. The default is predicted by two correlated variables described respectively by the first-order and second-order Pascal distribution as a function of i. These variables are constructed by the following functions

$$pj(i) = p^i \tag{4a}$$

$$qj(i) = (1+i)q^i \tag{4b}$$

where p and q are the parameters of the functions and j refers to the values of p and q used in experiments j. In all, nine experiments will be carried out (j=1,...,9).

The functions (4a) and (4b) are used to give numerical values for the two covariates. The first-order Pascal (geometric) distribution (4a) is monotonic and decreasing in p ($p < 1$). Thus, it is negatively correlated with Z. For each $k > 50$ and $i \leq 50$, $pj(k) < pj(i)$. In addition, it is always skewed right and the skewness has positive values. However, the degree of skewness depends on p. In addition, p determines the degree of kurtosis. The lower p, the higher is the skewness and the kurtosis. The second-order distribution (4b) is decreasing in q when $q \leq 0.50$. However, it has a peak when $q > 0.50$. The peak is reached for the observation k that fulfils the condition $q/(1\text{-}q) > k > (2q\text{-}1)/(1\text{-}q)$. For values $q < 0.50$, the distribution has the same statistical properties as the first-order distribution. However, for q close to 1, the skewness of the distribution is negative and the kurtosis is quite low. When selecting q, it is possible also to make the skewness close to zero and the kurtosis negative. For the numerical experiments, p is assumed to have three different values, 0.750, 0.925, and 0.985. When $p = 0.750$, the skewness and the kurtosis of the distribution are high. When p = 0.985, these statistics are close to zero. In the same way, q is assumed to have values 0.450 (no peak), 0.950 (peak for $i = 20$), and 0.985 (peak for $i = 66$). For $q = 0.450$, the distribution has a high skewness and a high kurtosis. When $q = 0.985$, the variable is negatively skewed with a low kurtosis. When combining all the values of p and q, the number of cases will be nine.

2.2. Simulation results and hypotheses

The hypothetical data of nine cases with 100 observations for one dependent variable (Z) and two covariates (qj and pj, j=1,2,...,9) were constructed based on the selected values of p and q. The data were analyzed by the SPSS. Because the target is to analyze the main and two-way effects in payment

default prediction, the univariate general linear model (GLM) is applied. The GLM is a flexible statistical model that incorporates normally distributed dependent variables and categorical or continuous independent variables. The univariate GLM can be used in this analysis, because there is a single dependent variable (payment default), but two independent variables (covariates). The univariate GLM is used to compare differences between group means and estimating the effect of covariates on a single dependent variable. The statistical significance of the main effects and the two-way effects is tested by the *t* statistic. The goodness of fit is measured by the coefficient of multiple correlation (R^2). The classification accuracy of the estimated GL models is analyzed by the linear discriminant analysis (LDA). The classification results are also cross-validated by the Lachenbruch method.

Appendix 1 shows the estimation results for the nine cases. Table 1 presents a summary of the results. The three first cases (cases 1, 2, and 3) are calculated for $q = 0.450$ which leads to a distribution of *qj* with a skewness and a high kurtosis. When the second variable (*pj*) is also characterized by a high skewness and a high kurtosis, the resulting main effects and two-effects models have a poor goodness of fit and also a low classification accuracy (case 1). However, when $p = 0.985$, the skewness and the kurtosis are close to zero, the goodness of fit and the classification accuracy are excellent. The two-way effect is statistically significant but does not remarkably affect the goodness of fit and the accuracy. The only remarkable effect on the accuracy is resulting, when $p = 0.925$ (a moderate skewness and a moderate kurtosis). The next three cases (4, 5, and 6) are presented for $q = 0.950$, which leads to a distribution with a zero skewness and a negative kurtosis (a flat distribution). For this value of *q*, the goodness of fit and the classification accuracy are excellent for any value of *p*. However, the quality of results increases in *p*. Generally, the two-way effects only make a minor improvement on the results. However, when $p = 0.925$, the improvement in classification accuracy is remarkable, when the two-way effect is included in the model. In that case, the resulting classification accuracy is 100%. The last three cases (7, 8, and 9) are based on $q = 0.985$ resulting in a negatively skewed distribution with a low kurtosis. When $p = 0.750$ (a high skewness and a high kurtosis) or $p = 0.985$ (skewness and kurtosis close to zero), the significance of two-way effect is not remarkable. However, when $p = 0.925$ (a moderate skewness and a moderate kurtosis), the two-way effect is extremely significant on the goodness of fit (case 8). In addition, it improves the classification accuracy.

Thus, it seems that the two-way effect may significantly improve the fit of the model, when one covariate is slightly negatively skewed and the latter covariate is slightly positively skewed, and both covariates have a moderate kurtosis. In this case,

TABLE 1. Summary of the simulation experiments on the two-way effects.

	Covariate q		Covariate p		2-way effect qp	R^2		Classification accuracy	
Case	**Skewness**	**Kurtosis**	**Skewness**	**Kurtosis**	**Significance**	**Main**	**2-way**	**Main**	**2-way**
1. Case 1: q =0.450 & p=0.750	6.17	40.70	4.81	25.01	0.0852	0.310	0.331	0.650	0.650
2. Case 2: q =0.450 & p=0.925	6.17	40.70	2.17	4.12	0.0035	0.636	0.667	0.780	0.800
3. Case 3: q =0.450 & p=0.985	6.17	40.70	0.52	-0.89	0.0005	0.970	0.974	0.950	0.950
4. Case 4: q =0.950 & p=0.750	0.19	-1.44	4.81	25.01	0.0000	0.962	0.977	0.980	0.980
5. Case 5: q =0.950 & p=0.925	0.19	-1.44	2.17	4.12	0.0000	0.958	0.974	0.970	1.000
6. Case 6: q =0.950 & p=0.985	0.19	-1.44	0.52	-0.89	0.0000	0.981	0.997	0.980	0.990
7. Case 7: q =0.985 & p=0.750	-1.53	1.28	4.81	25.01	0.0210	0.661	0.679	0.830	0.850
8. Case 8: q =0.985 & p=0.925	-1.53	1.28	2.17	4.12	0.0000	**0.636**	**0.893**	0.820	0.860
9. Case 9: q =0.985 & p=0.985	-1.53	1.28	0.52	-0.89	0.0000	0.999	1.000	0.980	0.980

Legend: Main = model based on the main effects

2-way = model based on the main effects and the 2-way effect

the effect also improves the classification accuracy but not as significantly as the fit. These effects are diminishing, when the skewness of the distribution of the former covariate is approaching zero. These results are valid when the covariates are correlated which usually holds in default prediction.

The skewness of financial variables can be either negative, zero, or positive (Karels & Prakash, 1987, McLeay, 1986, McLeay & Omar, 2000). The skewness largely depends on the existence of bounds. For example, quick ratio and current ratio have a lower bound (zero), and are usually positively skewed. This also holds for a size measure such as the number of employees or net sales. However, in statistical analysis the size measure is presented usually in a logarithmic form, which diminishes the skewness and may even make it negative. In addition, such financial ratios as profit margin, traditional cash flow to net sales ratio, and book equity ratio have an upper bound (100) which may make the distribution negatively skewed. Such a ratio as the return on investment has neither a lower bound nor an upper bound, and can have skewness close to zero. The kurtosis of financial variables is typically moderate, because they do not usually have general target values other than maximization. However, for example current ratio has a general target value (norm) of 2. Thus, the firms may strive towards the norm both upwards and downwards which may lead to a high kurtosis around the norm. Finally, usually financial variables are correlated. *Thus, it is hypothesized that two-way effects have a significant effect (1) on the goodness of fit, when financial covariates are used. However, the effect (2) on the classification accuracy is not significant (H_1).*

There may different kinds of non-financial covariates (see Keasey & Watson, 1987, Laitinen, 1999 and Back, 2005). In general, the covariates may refer to the characteristics of the firm, the environment of the firm, or a special type of behaviour. The variables that measure the characteristics or the environment may have a distribution with a low skewness and a low kurtosis, when there are no bounds for the variable. If there are bounds, the distributions of non-financial covariates are often skewed positively due to a lower bound. For example, the age of the firm and the industry propensity of default have a lower bound resulting in a positive skewness. However, a logarithmic transformation (if applicable) may eliminate the skewness. The behavioural covariates tend to be the most significant non-financial predictors of default (Laitinen, 1999 and Back, 2005). These variables have a special distribution of their own. These variables refer to a special type of behaviour that is only observed in a very few (usually risky) firms. For example, board member resignations and observed payment delays are examples of such covariates. These kinds of variables have a lower bound leading to a positively skewed distribution. In addition, the positive observations are concentrated in a small group of firms, which makes the distribution to have a high kurtosis. Thus, it seems that non-financial variables are usually skewed positively and may have a high kurtosis. *Therefore, it is hypothesized that two-way effects do not have a significant effect (1) on the goodness of fit and (2) on the classification accuracy, when non-financial covariates are used (H_2).*

Financial and non-financial variables may be slightly correlated. However, they measure different dimensions of the firm. Financial measures are drawn from the financial process of the firm (financial statements) while non-financial measures typically refer to the phenomena observed in the operational process. Financial statements contain lagged and incomplete information of the phenomena in the operational process. Thus, it is expected that non-financial covariates include significant additional information when predicting a payment default. This means that non-financial covariates may improve the goodness of fit and the classification accuracy of financial models. Because non-financial variables typically are skewed positively, they may have significant two-way effects with negatively skewed financial variables. However, the most significant non-financial (behavioural) variables have a high kurtosis, which may diminish the two-way effects on the goodness of fit and on the classification accuracy. *Thus, it is expected that non-financial covariates include significant additional information over financial covariates that improves (1) the goodness of fit and (2) the prediction accuracy (H_3). In addition, it is hypothesized that two-way effects have a significant effect (1) on the goodness of fit, when both financial and non-financial covariates are used. The effect (2) on the classification accuracy is however not significant (H_4).*

3. Empirical data and methods

3.1. Empirical sample of the study

The data available for the study include financial statement and background information from 2092 default (failed) and 63072 non-default (non-failed) firms. The empirical data have been obtained in an disguised form from Finska (Suomen Asiakastieto Oy) for research purposes (see http: www.asiakastieto.fi). From these data, a sample of 1500 default and 1500 non-default firms were randomly selected for estimation (estimation data). In addition, the rest of the data was used in validation of the classification results (test data). Estimation data is constructed to include two equal groups because the aim is to give equal weights to default and non-default firms. These data include a majority of Finnish firms which publish annual financial statements according to the Accounting Law. Thus, it forms a statistically representative sample of this particular population.

The population does not however correspond to the size distribution of all Finnish firms, because very small (micro) firms are missing. These small firms have not to present their financial statements publicly. However, the average size of the firm is very small. In the estimation sample, the average default firm employs 11.6 persons, while the non-default firms on an average employ 26.0 persons. The average age for the default and non-default firms is 10.4 and 14.7 years, respectively. The estimation sample includes 28.3% trade, 23.4% service, 15.5% manufacturing, and 13.2% constructing firms. The data include financial statements from the firms for the accounting year 2003. The background information is gathered 13.12.2003. The financial statement data and audit reports have been published until the end of April 2004 and deal with the situation at the end of 2003. The payment default to be predicted has emerged after the end of 2003 but before 30th April 2005.

3.2. The variables of the study

Dependent variable

Empirical studies use very different definitions to explain failure. These definitions include negative net worth, non-payment of creditors, bond defaults, inability to pay debts, over-drawn bank accounts, bankruptcy, reorganization, and liquidation (see Karels & Prakash, 1987, Table 1). In this study, the target phenomenon is payment default that can in general terms be defined as the inability of the firm to pay its financial obligations when they come due. In Finland, the most common types of payment default are private-judicial draft protest published or unpublished, unaccounted tax withholdings and value-added tax installments published by the tax authorities, insolvency or other impediment stated in connection of execution proceedings, and judgment by default on demand for payments. In fact, more than 40% of the payment defaults in Finland are private-judicial draft protests. These types of default are not as serious as bankruptcy or liquidation. In fact, a firm can continue operations even though it gets such a payment default. However, bankruptcy as a payment default usually refers to a discontinuation of operations. Thus, payment default firms are very heterogeneous with respect to symptoms for financial distress although a binary dependent variable (default or non-default) is employed. In this study, a binary variable (Z) is used to measure default so that 0 refers to a default firm and 1 to a non-default firm. This variable is called here the likelihood of non-default.

Financial variables

The choice of independent variables should be related to the purpose of predicting payment default of different kind based on symptoms of such financial distress. For example, Beaver (1966), Altman (1968), Scott (1981), Jones (1987), Karels & Prakash (1987), Laitinen & Kankaanpää (1999) discuss which financial dimensions should be selected into the analysis on theoretical and empirical grounds when predicting financial distress. Leverage, profitability, liquidity, cash flow, size, and growth are supported by theory and empirical evidence (Scott, 1981, Jones, 1987, and Laitinen, 1991). Thus, six independent financial variables are chosen on the basis of these dimensions. In this study, size is measured by logarithmic net sales and growth consistently by rate of change in net sales. Profitability is measured by return on investment ratio. Quick ratio is used to assess traditional liquidity. Traditional cash flow to net sales ratio refers to the cash flow dimension. In this dimension, traditional cash flow is preferred to the operating one (see Laitinen, 1994). Finally, leverage (capital structure) is measured by the equity ratio based on book value of assets. It is expected that the equity ratio will have the most im-

portant direct (main) effect on the default prediction model based on the financial variables (see Laitinen, 2005). In addition, it can be expected that the size and the growth do not have significant main effects but will have important two-way effects. These variables mainly act as contingency factors affecting the profitability and the finance which may be direct reasons for default.

Non-financial variables

The choice of non-financial dimensions is not as straightforward. Keasey & Watson (1987) however discuss these dimensions. They pay attention to such dimensions as managerial structure, inadequacy of accounting information system and audit lags, submission lags, audit qualifications, changes in auditors, and gearing. In their analysis, number of directors and submission lags were important predictors of distress. Laitinen (1999) used several non-financial variables to explain risk assessments made by financial analysts. He showed that prior payment history and characteristics of directors are most significant dimensions. Back (2005) classify non-financial dimensions in his study into the following classes: characteristics of management, prior payment behavior, group membership, and age. His analysis showed that the dimension of prior payment behavior is the most important dimension in explaining financial distress. In addition to the dimensions above, industry and age of firm have proven to be significant dimensions in distress prediction (see El Hennawy & Morris, 1983 and Shumway, 2001). Thus, prior studies present a large number of non-financial variables which may be useful in default prediction.

In the present analysis, the number of non-financial variables is however restricted to eight. This is because the number of two-way effects will rapidly increase with the number of variables. If there are n variables, it will be result in $(n^2\text{-}n)/2$ two-way effects. When $n = 8$, there are in all 8 main effects and 28 two-way effects. Thus, a set of eight variables are used to measure age, industry, characteristics of the board (directors), and prior payment behavior. The age of the firm is measured by logarithmic age in months. The industry effect is assessed by industrial propensity to default. This measure relates the number of default firms to all firms in industry. The characteristics of directors are measured by four variables: number of members in board, number of resigned board members during the last half year (%), number of board member personal payment defaults, and number of board member links to payment default firms. The prior payment behavior is measured by two different variables. First, negative payment behavior is measured by the number of payment delays (negative payment observations) observed during the last 12 months. These delays are not official payment defaults but refer to an overdraft of allowed payment periods. Second, positive payment behavior is measured by the cumulative number of signals about taking care of the payments in time (positive payment observations). It is expected that the prior payment behavior variables have the most significant main effects (see Laitinen, 1999 and Back, 2005).

3.3. Statistical methods

The empirical statistical estimations in this study are made by the SPSS. In addition, the univariate general linear model is applied in the same way as in the simulation experiments. The statistical significance of the main effects and the two-way effects is tested by the t statistic. Only the variables with a statistically significant coefficient (p = 10%) are included in the prediction models. The goodness of fit is measured by the coefficient of multiple correlation (R^2). It is expected that the coefficient is not high, since the dependent variable is binary. Linear discriminant analysis is again applied to assess the classification accuracy of the GL models. The classification results are validated in the test data.

The first hypothesis assumes that two-way effects improve the fit of the financial prediction models (H_1). This hypothesis is tested by comparing the coefficients of multiple correlation calculated for the main effects model and for the model with the main effects and the two-way effects. The estimated models are used in LDA to classify the estimation sample and the validation test sample in default and non-default firms to calculate classification accuracy. The associated hypothesis in H_1, which assumes that the two-way effects do not remarkably improve the classification accuracy, is tested by comparing the classification accuracy of the two models. The second hypothesis on the insignificance of the two-

way effects in the non-financial prediction model is tested in the same way (H_2). The third hypothesis assumes that the non-financial variables bring additional information into the financial variable model improving the goodness of fit and the classification accuracy (H_3). The additional information is measured by the change in the multiple coefficient of correlation and the improvement in classification accuracy by the change of the number of correctly classified firms, when non-financial covariates are introduced.

4. Empirical results

4.1. Financial variable models

Estimation results

Table 2 shows descriptive statistics of the six financial variables. The distribution of the quick ratio shows a high skewness and a high kurtosis. This is mainly due to that the distribution of the ratio is restricted by zero from the left and has a norm value. The size measure (logarithmic net sales) shows a negatively skewed distribution with a moderate kurtosis. The negative skewness is due to the logarithmic transformation. The original size measure (net sales) is strongly positively skewed with a very high kurtosis. This is due to that the sample includes a high proportion of very small firms and only a couple of very large firms. The deviations from the normality contradict with the assumptions of the GLM. There are 520 missing observations for the growth rate. In all, there are only 2432 valid observations when the missing observations are list wise dropped.

Table 3 presents the parameter estimates for the GLM only based on the main effects of the six financial variables. The results largely correspond to the prior expectations. The coefficient of multiple correlation is only 22.0%. The equity ratio is the most significant independent variable with a very high *t* value. However, the next significant variables are the size and the growth (with a negative coefficient). The profitability variable and the cash flow variable are statistically significant only at the level of 5%. When the financial main effect model is used to interpret the payment default factors, the result is that the default is mainly affected by the equity ratio, the size, and the growth of the firm. The effect of the quick ratio is as significant as that of the growth. The profitability and the cash flow have statistically only a minor effect. The higher the leverage and the size, and the lower the growth rate, the lower is the likelihood to default.

Table 4 shows the results for the estimated GLM based on both the main effects and the two-way effects of the financial variables. This table show the parameter estimates only for the statistically significant effects at the level less than 10%. The coefficient of multiple correlation is 25.0% that exceeds that of the main effects model. This result supports the hypothesis H_1. The table gives a different perspective of the default factors than the model only based on the main effects. The profitability, the liquidity (the quick ratio), the cash flow, and the leverage (the equity ratio) seem all to have about an equally significant main effect. The estimated coefficients for the profitability and to the leverage are negative. However, the size and growth have not

TABLE 2. Descriptive statistics of the six financial variables.

Financial variable	Valid observations	Mean	Standard deviation	Skewness	Kurtosis
Logarithmic net sales	3000	11.91	3.03	-2.22	7.16
Growth in net sales (%)	2480	13.87	57.05	1.67	3.47
Return on investment ratio (%)	3000	11.87	44.08	0.53	3.25
Quick ratio	2947	2.39	6.12	5.98	39.92
Cash flow to net sales ratio (%)	2853	3.73	26.82	-1.32	6.52
Equity ratio (%)	3000	26.64	44.94	-0.87	1.07
Valid observations (listwise)	2432				

TABLE 3. Parameter estimates of the main effects of financial variables.

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	0.03932	0.06573	0.59819	0.54977	0.09186
Logarithmic net sales	0.02739	0.00516	5.31189	0.00000	0.99960
Growth in net sales (%)	-0.00057	0.00016	-3.48486	0.00050	0.93618
Return on investment ratio (%)	0.00051	0.00026	1.94939	0.05136	0.49552
Quick ratio	0.00627	0.00182	3.43602	0.00060	0.92985
Cash flow to net sales ratio (%)	0.00086	0.00044	1.94680	0.05167	0.49449
Equity ratio (%)	0.00444	0.00024	18.37589	0.00000	1.00000

Coefficient of multiple correlation (R^2) 0.2200

Adjusted R^2 0.2180

TABLE 4. Parameter estimates of the main and 2-way effects of financial variables.

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	0.35149	0.01090	32.24437	0.00000	1.00000
Return on investment ratio (%)	-0.00736	0.00179	-4.11651	0.00004	0.98442
Quick ratio	0.02549	0.00828	3.07846	0.00210	0.86806
Cash flow to net sales ratio (%)	0.00191	0.00046	4.16504	0.00003	0.98622
Equity ratio (%)	-0.00601	0.00139	-4.31818	0.00002	0.99078
Logarithmic net sales * Return on investment ratio	0.00061	0.00014	4.38429	0.00001	0.99229
Logarithmic net sales * Quick ratio	-0.00163	0.00077	-2.12748	0.03348	0.56621
Logarithmic net sales * Equity ratio	0.00088	0.00012	7.61849	0.00000	1.00000
Growth in net sales * Return on investment ratio	-0.00001	0.00000	-4.00880	0.00006	0.97968
Growth in net sales * Cash flow	0.00002	0.00001	4.17635	0.00003	0.98661

Coefficient of multiple correlation (R^2) 0.2500

Adjusted R^2 0.2480

significant main effects, but they act as important contingency factors in the two-way effects. In fact, statistically the most significant effect in the GLM is the two-way effect of the size and the leverage.

Table 5 presents the classification results for the main effect GL model and for the model with both the main and the two-way effects. Panel 1 shows that the overall classification accuracy of the main effects model is in the estimation data is 74.0% that is almost same as in the test data (74.7%). Panel 2 shows that the overall accuracy of the two-way effects model is in the estimation data almost equal to that of the main effects model. For the theoretically selected cut-off point, this model however leads to fewer classification errors in default firms. In the test sample, the proportion of non-default firms is very high which makes the overall accuracy of the two-way model clearly lower (71.5%). In the estimation sample, the Spearman rank correlation coefficient between the main effects model prediction and the two-way effects model prediction is 95.5%, which shows that the classifications are quite similar. Figures 1 and 2 present scatter diagrams for these predictions, when the logarithmic net sales (size) is used as the vertical axis. These figures show that the two-way effects model gives predictions, which avoid large errors better than the competing main effects model. In summary, it seems to give a better goodness of fit although it does not lead to better classification accuracy. These results give support to the first hypothesis (H_1).

TABLE 5. Classification accuracy of financial variable models.

PANEL 1. Classification accuracy of the main effects model.

	Estimation data:			**Test data:**		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	839	327	0.720	353	122	0.743
Non-default firms	305	961	0.759	13132	38756	0.747
Overall accuracy			0.740			0.747

PANEL 2. Classification accuracy of the main & 2-way effects model.

	Estimation data:			**Test data:**		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	879	287	0.754	372	103	0.783
Non-default firms	355	911	0.720	14823	37088	0.714
Overall accuracy			0.736			0.715

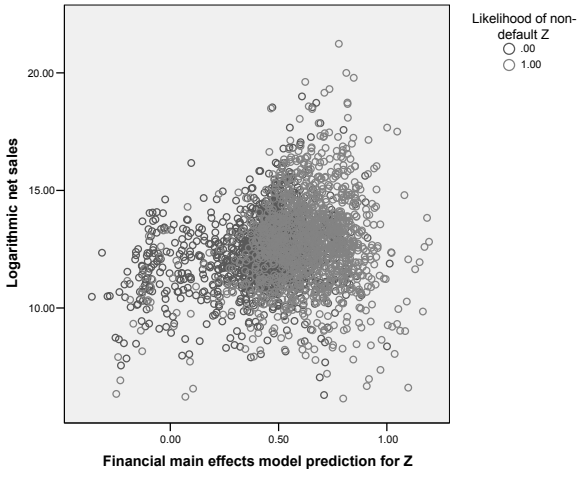

FIGURE 1. Financial main effects model prediction for Z.

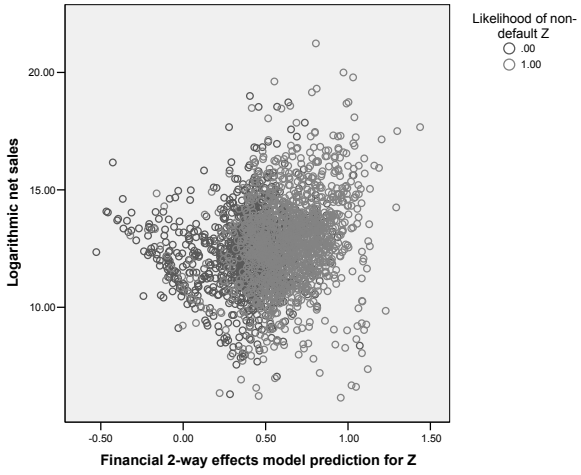

FIGURE 2. Financial two-way effects model prediction for Z.

Numerical analysis

The sign and height of the parameters are difficult to interpret because of the different scales of the variables and the two-way effects. Therefore, a numerical analysis is needed. Panel 1 in Appendix 2 shows the percentage fractiles for the financial variables from 5% to 95%. Panel 2 shows the size of the main effects calculated for the different fractiles of the six variables. These main effects are calculated by multiplying the parameter estimate of the main effect in Table 2 with the fractile in question. In general, the panel shows that the main effect of the size is dominating the prediction for the independent variable Z (the likelihood of non-default). When predicting Z (0 or 1), the main effect of the size is over 40%, when the 90% fractile is considered. The main effect of the equity ratio (leverage) is comparable with the size effect only for very small (5%

fractile) and very large ratios (higher than the 90% fractile). The main effects of all other variables are quite small. However, when the growth rate is very high, it may have a considerable negative effect to the likelihood of non-default. Thus, the main effect GL model implies that payment defaults are largely determined by the size of the firm.

Appendix 3 shows numerical experiments for the GL model with the main effects and the two-way effects. The size is only a contingency variable for the quick ratio and for the equity ratio. Thus, the effect of the ratio on the likelihood of non-default depends on the size. Panel 1 shows the coefficient of the quick ratio for the fractiles of the size. In addition, the panel shows the effect of the ratio on the likelihood calculated for the median value of the quick ratio. The effect is decreasing in the size but negligible anywhere. Panel 2 shows the similar figures for the equity ratio. This panel shows that the effect of the equity ratio is quite significant already for small firms below the 25% fractile. However, it is very strong for large firms greater than the 90% fractile. For the large firms, the effect is triple the effect for the small firms. Thus, it can be concluded that in order to avoid a payment default, the effect of the equity ratio is much more important for large firms than for small ones.

Panel 3 of Appendix 3 presents the figures for the cash flow ratio. The effect of the cash flow on the likelihood depends on the growth as a contingency variable. The effect is negative for negative growth rates and positive for positive growth rates. However, the absolute effect is quite negligible irrespective of the growth rate. Panel 4 shows the coefficients and the effects for the profitability ratio. This ratio has both the growth rate and the size as contingency variables. The effect of the profitability is increasing in the size but decreasing in the growth. For small firms with a low growth rate the effect is positive but small. However, for small firms with a higher growth rate the effect is negative. When the firm grows faster than the 90% fractile, the effect is negative also for large firms. However, this combination of growth and size may exist only seldom in business life. In summary, it can be concluded that that the effect of the profitability depends on both the size and the growth. However, the absolute effect is not strong.

4.2. Non-financial variable models

Table 6 presents descriptive statistics for the eight non-financial variables. The distributions of the logarithmic age and the industry propensity to default have both distribution with a low skewness and a low kurtosis. However, for the distributions of other six non-financial variables the skewness and the kurtosis are positive and exceptionally high which contradicts with the normality assumption. However, the characteristics of the distributions are consistent with expectations presented in the second section. These variables typically refer to an exceptional behaviour in terms of board member or prior payment characteristics. Thus, these distributions include a large number of observations with the lower bound value of zero. Typically, the variables are associated with a negative sign characteristic to distress firms. For this rule, the number of positive payment signals is an exception. This variable has a distribution with extremely high skewness and kurtosis. The non-financial variables do not include any missing values. Thus, there are 1500 default and 1500 non-default firms in the estimation of the GLM.

Table 7 shows the estimation results for the main effects of the GLM based on the eight non-financial variables. The coefficient of multiple correlation is 28.4% that clearly exceeds that for the financial variables model. The parameter estimates are all statistically significant. The number of delays in payment is the most significant independent variable with a very high t value. The next statistically important variables are the number of members in board, the industry propensity to default, and the number of board member personal defaults. The t values for these three variables are quite close to each other. Thus, it seems that the previous payment behaviour is the most significant non-financial predictor of payment defaults, which conforms to the prior studies (Laitinen, 1999 and Back, 2005). However, also the industry of the firm and the characteristics of the board are important predictors, when only main effects are used in the model.

Table 8 presents the estimation results for the GLM, when both the main and two-way effects are used as independent variables. This table only includes the parameter estimates that are statistically significant at the level of 10%. It is remarkable that the coefficient of multiple correlation is now less

TABLE 6. Descriptive statistics of the eight non-financial variables.

Non-financial variable	Valid observations	Mean	Standard deviation	Skewness	Kurtosis
Logarithmic age in months	3000	4.72	0.74	-0.03	0.21
Industry propensity to default (%)	3000	5.56	2.56	0.46	0.00
Number of members in board	3000	2.80	1.53	3.69	22.40
Number of resigned board members (%)	3000	0.04	0.19	7.27	67.68
Number of board member personal defaults	3000	0.56	2.16	9.61	160.05
Number of board member links to default firms	3000	0.23	0.90	6.93	62.20
Number of delays in payment	3000	1.25	3.03	4.17	23.79
Number of positive payment signals	3000	4.25	14.50	17.19	414.07
Valid observations (listwise)	3000				

TABLE 7. Parameter estimates of the main effects of non-financial variables.

Non-financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	0.28875	0.05809	4.97117	0.00000	0.99869
Logarithmic age in months	0.06722	0.01093	6.14783	0.00000	0.99999
Industry propensity to default (%)	-0.02874	0.00311	-9.23930	0.00000	1.00000
Number of members in board	0.05064	0.00531	9.54371	0.00000	1.00000
Number of resigned board members (%)	-0.09853	0.04144	-2.37802	0.01747	0.66177
Number of board member personal defaults	-0.03086	0.00377	-8.18233	0.00000	1.00000
Number of board member links to default firms	-0.05255	0.00914	-5.75270	0.00000	0.99992
Number of delays in payment	-0.05451	0.00258	-21.11778	0.00000	1.00000
Number of positive payment signals	0.00313	0.00055	5.68833	0.00000	0.99990

Coefficient of multiple correlation (R^2)
0.2840

Adjusted R^2
0.2820

than the GLM based on only the main effects. There are only three non-financial variables having statistically significant main effects in the present GLM. Clearly, the most significant effect is the main effect of the industry propensity to default with an exceptionally high *t* value. This variable is of a special importance, because it is represented in the model also by three significant two-way effects. The variables of the previous payment behaviour also have statistically significant main effects and are represented by significant two-way effects. However, the results show that for non-financial variables, the two-way effects do not add to the goodness of fit in the GLM. They show that the industry is an important predictor of default, both as a direct variable and as a contingency variable. Thus, the results support the first part of the second hypothesis (H_2).

The classification accuracies of the estimated non-financial GL models are presented in Table 9. For theoretically chosen cut-off values, the accuracies for the default firms are lower and for the non-default firms higher than in the financial GLM. These results may be due to the high skewness and to the high kurtosis in the distributions of the non-financial variables. The overall accuracy of the models slightly exceeds that for the financial models. The two-way effects increase the classification accuracy for the default firms but decrease that for the non-default firms. Thus, these effects make the distribution of the prediction more symmetric but do not increase the overall classification accuracy. Thus, the results give support to the second part of the second hypothesis (H_2).

TABLE 8. Parameter estimates of the main and 2-way effects of non-financial variables.

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	0.75086	0.02132	35.21622	0.00000	1.00000
Industry propensity to default (%)	-0.07781	0.00415	-18.74459	0.00000	1.00000
Number of delays in payment	-0.06264	0.00972	-6.44273	0.00000	1.00000
Number of positive payment signals	0.01859	0.00258	7.21675	0.00000	1.00000
Industry propensity to default * Number of members in board	0.01394	0.00116	11.98606	0.00000	1.00000
Industry propensity to default * Number of delays in payment	0.00598	0.00102	5.84127	0.00000	0.99995
Industry propensity to default * Number of positive payment signals	0.00068	0.00030	2.27861	0.02276	0.62473
Number of members in board * Number of delays in payment	-0.01239	0.00291	-4.25495	0.00002	0.98909
Number of members in board * Number of positive payment signals	-0.00260	0.00032	-8.25199	0.00000	1.00000
Number of resigned board members * Number of positive payment signals	-0.01760	0.00298	-5.89549	0.00000	0.99996
Number of board member personal defaults * Number of board member links to default firms	-0.00338	0.00089	-3.79958	0.00015	0.96700

TABLE 9. Classification accuracy of non-financial variable models.

PANEL 1. Classification accuracy of the main effects model.

	Estimation data: Predicted:			**Test data:** Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	1021	479	0.681	409	183	0.691
Non-default firms	225	1275	0.850	9248	52324	0.850
Overall accuracy			0.765			0.848

PANEL 2. Classification accuracy of the main & 2-way effects model.

	Estimation data: Predicted:			**Test data:** Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	1080	420	0.720	427	165	0.721
Non-default firms	269	1231	0.821	10734	50838	0.826
Overall accuracy			0.770			0.825

4.3. Financial and non-financial variable models

Table 10 presents the estimation results for the GL models based on the main effects of both financial and non-financial variables. The main effects are all statistically significant at the level of 10%. Statistically, the most important variables are the number of delays in payment and the equity ratio. These variables were the most significant variables also in the non-financial and financial GL models, respectively. The statistical significance of the non-financial variables exceeds that of the financial variables. The next significant variables are the number of members in board, the industry propensity to default, and the number of board member personal defaults. The financial ratios except for the equity ratio have a quite low *t* values. The coefficient of multiple correlation for the model is 37.8% which remarkably exceeds the coefficients of the financial and non-financial GL models. Thus, non-financial information brings significant additional information over financial variables in the estimation of default likelihood, which conforms to the third hypothesis (H_3).

The estimation results for the combined two-way effects GL model is presented in Table 11. This table only includes the main effects and two-way effects that have a *t* value higher than 2. The coefficient of multiple correlation for the model is 40.6% exceeding that for the main effects model. Thus, the two-way effects improve the goodness of fit but not remarkably. There are not large differences in the significance between the variables in the model. The highest significance is obtained by the two-way effect of the logarithmic net sales and the equity ratio. However, close to that is also the two-way effect of the number of delays in payment and the equity ratio. In all, the equity ratio has six statistically significant two-way effects. The main effects of the number of board member personal defaults, the number of delays in payment, and the number of positive payment signals have also a high *t* value. The only financial ratio that has a statistically significant main effect is the return on investment ratio.

Table 12 shows the classification accuracy for the main effects model and for the two-way effects model. The classification accuracy of the combined models remarkably exceeds that for the financial and non-financial models implying that non-financial variables include such additional information over financial variables, which is useful in classification. Again, the two-way effects model classifies the default firms more accurately than the main effects model. However, it classifies less accurately the non-default firms so that the overall classification accuracies are identical for the models, when there the proportions of default and non-default firms are equal. Thus, although increasing the goodness of fit slightly, the two-way effects have no additional value in classification. Figure 3 and Figure 4 show the scatter diagrams for the predicted values

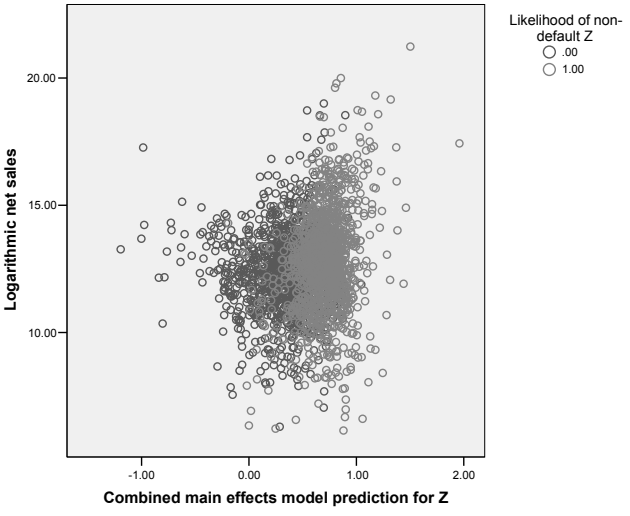

FIGURE 3. Combined main effects model prediction for Z.

FIGURE 4. Combined two-way effects model prediction for Z.

TABLE 10. Parameter estimates of the main effects of financial and non-financial variables.

Non-financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	0.20320	0.08743	2.32426	0.02019	0.64185
Logarithmic age in months	0.02774	0.01331	2.08349	0.03731	0.54885
Industry propensity to default (%)	-0.01858	0.00324	-5.72965	0.00000	0.99992
Number of members in board	0.03964	0.00553	7.17117	0.00000	1.00000
Number of resigned board members (%)	-0.09916	0.04958	-2.00020	0.04559	0.51577
Number of board member personal defaults	-0.02297	0.00423	-5.43580	0.00000	0.99974
Number of board member links to default firms	-0.04679	0.01137	-4.11699	0.00004	0.98443
Number of delays in payment	-0.04926	0.00278	-17.74934	0.00000	1.00000
Number of positive payment signals	0.00245	0.00055	4.42526	0.00001	0.99312
Logarithmic net sales	0.01107	0.00523	2.11832	0.03425	0.56260
Growth in net sales (%)	-0.00030	0.00015	-2.03048	0.04242	0.52782
Return on investment ratio (%)	0.00048	0.00024	2.03163	0.04230	0.52828
Quick ratio	0.00463	0.00163	2.83467	0.00463	0.80883
Cash flow to net sales ratio (%)	0.00075	0.00040	1.89691	0.05796	0.47462
Equity ratio (%)	0.00327	0.00022	14.69340	0.00000	1.00000

Coefficient of multiple correlation (R^2)
0.3790

Adjusted R^2
0.3750

TABLE 11. Parameter estimates of the main and 2-way effects of financial and non-financial variables.

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	0.40918	0.01196	34.21772	0.00000	1.00000
Number of board member personal defaults	-0.03602	0.00433	-8.31821	0.00000	1.00000
Number of delays in payment	-0.15968	0.02154	-7.41437	0.00000	1.00000
Number of positive payment signals	0.03587	0.00494	7.26709	0.00000	1.00000
Return on investment ratio (%)	0.00052	0.00021	2.45122	0.01431	0.68804
Industry propensity to default * Equity ratio	-0.00029	0.00006	-4.97144	0.00000	0.99869
Number of members in board * Equity ratio	0.00035	0.00009	3.78771	0.00016	0.96609
Number of board member personal defaults * Return on investment ratio	-0.00038	0.00009	-4.37222	0.00001	0.99204
Number of board member personal defaults * Cash flow to net sales ratio	0.00065	0.00030	2.18841	0.02873	0.59003
Number of delays in payment * Logarithmic net sales	0.00856	0.00159	5.37793	0.00000	0.99968
Number of delays in payment * Equity ratio	-0.00058	0.00006	-9.03908	0.00000	1.00000
Number of positive payment signals * Logarithmic net sales	-0.00170	0.00026	-6.57755	0.00000	1.00000
Number of positive payment signals * Equity ratio	-0.00009	0.00003	-3.25321	0.00116	0.90182
Logarithmic net sales * Equity ratio	0.00044	0.00004	10.84043	0.00000	1.00000
Growth in net sales * Cash flow to net sales ratio	0.00001	0.00000	2.23562	0.02547	0.60827
Cash flow to net sales ratio * Equity ratio	0.00001	0.00000	2.92650	0.00346	0.83282

Coefficient of multiple correlation (R^2)
0.4060

Adjusted R^2
0.4030

TABLE 12. Classification accuracy of financial and non-financial variable (combined) models.

PANEL 1. Classification accuracy of the main effects model.

	Estimation data:			**Test data:**		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	887	279	0.761	374	101	0.787
Non-default firms	169	1097	0.867	7111	44777	0.863
Overall accuracy			0.816			0.862

PANEL 2. Classification accuracy of the main & 2-way effects model.

	Estimation data:			**Test data:**		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	933	243	0.793	394	82	0.828
Non-default firms	204	1080	0.841	8514	44227	0.839
Overall accuracy			0.818			0.838

for the both combined models. The distributions of the predictions do not differ remarkably between the models. In summary, the empirical evidence supports the first part and the second part of the fourth hypothesis (H_4).

5. Summary of the study

The purpose of the paper was to assess the importance of 2-way effects in explaining and predicting payment defaults in Finland. First, a numerical simulation experiment was applied to extract hypotheses on the significance of the main effects and two-way effects in default prediction. This experiment was based on two correlated variables conforming to the first-order or second-order Pascal distribution over a binary-ranked set of 50 default and 50 non-default hypothetical firms. These distributions were used to demonstrate different degrees of skewness and kurtosis. It was shown that the two-way effect may significantly improve the fit of the prediction model, when one covariate is slightly negatively skewed and the latter covariate is slightly positively skewed. In addition, covariates should have a moderate kurtosis. In this case, the effect also improves the classification accuracy but not as significantly as the fit. These effects are diminishing, when the skewness of the distribution of the former covariate is approaching zero.

The significance of the two-way effects thus largely depends on the distributions of the covariates. Financial and non-financial variables have different distributions. Thus, it was hypothesized that two-way effects have a significant effect on the goodness of fit, when financial covariates are used. However, the effect on the classification accuracy is not expected to be significant (H_1). In addition, it was hypothesized that two-way effects do not have a significant effect on the goodness of fit and on the classification accuracy, when non-financial covariates are used (H_2). It was also hypothesized that non-financial covariates include significant additional information over financial covariates that improves the goodness of fit and the prediction accuracy (H_3). Finally, it was hypothesized that two-way effects have a significant effect on the goodness of

fit, when both financial and non-financial covariates are used. The effect on the classification accuracy is however assumed not significant (H_4).

For the financial covariates, the results showed that the size and growth have not significant main effects in two-way effects models. However, they acted as important contingency factors in the two-way effects. In fact, statistically the most significant effect in the model was the two-way effect of the size and the leverage. Graphical analysis showed that the two-way effects model gives predictions, which avoid large errors better than the competing main effects model. In summary, it seems to give a better goodness of fit although it does not lead to better classification accuracy. These results give support to the first hypothesis (H_1). Numerical analysis of the estimated models showed that the interpretation of the main effects model implies that payment defaults are largely determined by the size of the firm. However, numerical two-way analysis showed that the size is only a contingency variable for the quick ratio and the equity ratio. The dominant effect was based on the interaction between the size and the equity ratio. It was shown that in order to avoid a payment default, the effect of the equity ratio is much more important for large firms than for small ones.

Non-financial covariates gave different results. It seems that the previous payment behaviour is the most significant non-financial predictor of payment defaults, which conforms to the prior studies (Laitinen, 1999 and Back, 2005). However, also the industry of the firm and the characteristics of the board are important predictors, when only main effects are applied in the prediction model. However, the results showed that for non-financial variables, the two-way effects do not add to the goodness of fit in the prediction model. They show that the industry is an important predictor of default, both as a direct variable and as a contingency variable. The two-way effects increase the classification accuracy for the default firms but decrease that for the non-default firms. In summary, these effects make the distribution of the prediction more symmetric but do not increase the overall classification accuracy. Thus, the results give empirical support to the second hypothesis (H_2).

The performance of the combined prediction models clearly exceeded that of the financial model and of the non-financial model. Non-financial covariates bring significant additional information over financial variables in the estimation of default likelihood conforming to the third hypothesis (H_3). In comparison, the goodness of fit in the two-way effects model slightly outperformed that in the main effects model. In the two-way effects model, the equity ratio had six statistically significant two-way effects. The main effects of the number of board member personal defaults, the number of delays in payment, and the number of positive payment signals had also a high significance. The only financial ratio that had a statistically significant main effect was the return on investment ratio. The two-way effects model classified the default firms more accurately than the main effects model. However, it classified less accurately the non-default firms so that the overall classification accuracies were approximately identical. Thus, although increasing the goodness of fit slightly, the two-way effects had no additional value in classification. In summary, the empirical evidence supports the fourth hypothesis (H_4).

The present study suffers from many limitations that should be carefully analysed in the further studies. First, the simulation experiments were based on numerical analysis of the Pascal distributions. It would be worth of considering also more general distributions. In addition, a symmetric distribution such as the normal distribution could lead to different results. It is also possible to draw analytical results to get evidence that is more general. Second, the set of the covariates analysed in the models was limited. Especially, non-financial variables may give potential for further analyses. There are a number of interesting additional non-financial variables such as audit qualification and submission lags, excluded from the analysis. In particular, negatively skewed non-financial covariates with a moderate kurtosis may be potential in increasing the performance of payment default models, when two-way effects are included.

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Appendices

APPENDIX 1. Simulation results of the two-way effects (N = 50 + 50).

PANEL 1. q = 0.450 and p = 0.750

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q1	0.00000	390.32258	10.00000	50.03330	6.17218	40.70186
p1	0.00000	250.00000	10.00000	36.63320	4.80986	25.01007

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	56.30858	2.59008	21.74010	0.00000	1.00000
q1	0.73110	0.18242	4.00782	0.00012	0.97767
p1	-1.31196	0.24915	-5.26584	0.00000	0.99943
R^2	0.3100	Adjusted R^2	0.2950		

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	56.77391	2.57737	22.02784	0.00000	1.00000
q1	1.62184	0.54298	2.98694	0.00358	0.84061
p1	-1.76066	0.35685	-4.93383	0.00000	0.99827
q1 * p1	-0.00264	0.00152	-1.73945	0.08516	0.40609
R^2	0.3310	Adjusted R^2	0.3100		

d) Classification accuracy of the main effects model

	Estimation data:			**Lachenbruch crossvalidation:**		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	15	35	0.30000	14	36	0.28000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.65000			0.64000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	15	35	0.30000	14	36	0.28000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.65000			0.64000

PANEL 2. q = 0.450 and p = 0.925

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q2	0.00000	390.32258	10.00000	50.03330	6.17218	40.70186
p2	0.03336	75.03086	10.00000	17.11314	2.17101	4.12414

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	65.34086	2.10697	31.01184	0.00000	1.00000
q2	0.20027	0.04872	4.11047	0.00008	0.98255
p2	-1.68436	0.14245	-11.82438	0.00000	1.00000

R^2 0.6360 Adjusted R^2 0.6290

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	66.42240	2.05773	32.27948	0.00000	1.00000
q2	2.10979	0.64035	3.29476	0.00138	0.90348
p2	-1.95353	0.16389	-11.91968	0.00000	1.00000
q2 * p2	-0.02569	0.00859	-2.99002	0.00354	0.84135

R^2 0.6670 Adjusted R^2 0.6570

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	28	22	0.56000	27	23	0.54000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.78000			0.77000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	30	20	0.60000	30	20	0.60000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.80000			0.80000

PANEL 3. q = 0.450 and p = 0.985

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q3	0.00000	390.32258	10.00000	50.03330	6.17218	40.70186
p3	4.31045	19.24579	10.00000	4.30475	0.52349	-0.89360

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	118.62810	1.35108	87.80259	0.00000	1.00000
q3	0.05119	0.01115	4.59272	0.00001	0.99516
p3	-6.86400	0.12955	-52.98303	0.00000	1.00000

R^2 Adjusted R^2
0.9700 0.9700

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	119.88190	1.31944	90.85848	0.00000	1.00000
q3	2.80282	0.75785	3.69839	0.00036	0.95555
p3	-7.02626	0.13003	-54.03695	0.00000	1.00000
q3 * p3	-0.14391	0.03963	-3.63119	0.00045	0.94894

R^2 Adjusted R^2
0.9740 0.9730

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	45	5	0.90000	44	6	0.88000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.95000			0.94000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	45	5	0.90000	44	6	0.88000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.95000			0.94000

PANEL 4. q = 0.950 and p = 0.750

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q4	1.55161	19.58301	10.00000	6.18419	0.19261	-1.44029
p4	0.00000	250.00000	10.00000	36.63320	4.80986	25.01007

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	95.20408	1.10555	86.11450	0.00000	1.00000
q4	-4.10802	0.09300	-44.17008	0.00000	1.00000
p4	-0.36239	0.01570	-23.08166	0.00000	1.00000

R^2 0.9620 Adjusted R^2 0.9610

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	94.55253	0.86096	109.82229	0.00000	1.00000
q4	-3.95353	0.07460	-52.99699	0.00000	1.00000
p4	-0.10451	0.03414	-3.06104	0.00286	0.85776
q4 * p4	-0.03617	0.00447	-8.08436	0.00000	1.00000

R^2 0.9770 Adjusted R^2 0.9730

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	48	2	0.96000	48	2	0.96000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.98000			0.98000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	48	2	0.96000	48	2	0.96000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.98000			0.98000

PANEL 5. q = 0.950 and p = 0.925

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q5	1.55161	19.58301	10.00000	6.18419	0.19261	-1.44029
p5	0.03336	75.03086	10.00000	17.11314	2.17101	4.12414

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	90.49187	1.14579	78.97779	0.00000	1.00000
q5	-3.16388	0.10603	-29.84076	0.00000	1.00000
p5	-0.83531	0.03831	-21.80147	0.00000	1.00000

R^2 0.9580 Adjusted R^2 0.9570

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	93.71556	1.01075	92.71884	0.00000	1.00000
q5	-3.70122	0.11091	-33.36992	0.00000	1.00000
p5	-1.33307	0.07310	-18.23507	0.00000	1.00000
q5 * p5	0.05053	0.00674	7.49660	0.00000	1.00000

R^2 0.9740 Adjusted R^2 0.9730

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	47	3	0.94000	47	3	0.94000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.97000			0.97000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	50	0	1.00000	49	1	0.98000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			1.00000			0.99000

PANEL 6. q = 0.950 and p = 0.985

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q6	1.55161	19.58301	10.00000	6.18419	0.19261	-1.44029
p6	4.31045	19.24579	10.00000	4.30475	0.52349	-0.89360

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	115.05973	1.03363	111.31632	0.00000	1.00000
q6	-1.03835	0.10967	-9.46791	0.00000	1.00000
p6	-5.41762	0.15755	-34.38620	0.00000	1.00000

R^2 Adjusted R^2
0.9810 0.9810

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	129.31795	0.82715	156.34200	0.00000	1.00000
q6	-3.17765	0.11465	-27.71698	0.00000	1.00000
p6	-7.02315	0.10389	-67.60270	0.00000	1.00000
q6 * p6	0.19136	0.00933	20.50510	0.00000	1.00000

R^2 Adjusted R^2
0.9970 0.9960

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	48	2	0.96000	48	2	0.96000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.98000			0.98000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	50	0	1.00000	50	0	1.00000
Non-default firms	1	49	0.98000	1	49	0.98000
Overall accuracy			0.99000			0.99000

PANEL 7. q = 0.985 and p = 0.750

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q7	0.97790	12.26671	10.00000	2.99077	-1.53325	1.28197
p7	0.00000	250.00000	10.00000	36.63320	4.80986	25.01007

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	-46.01260	8.84242	-5.20362	0.00000	0.99929
q7	9.45061	0.81866	11.54405	0.00000	1.00000
p7	0.20065	0.06684	3.00218	0.00341	0.84432

R^2 Adjusted R^2
0.6610 0.6540

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	-67.71243	12.65768	-5.34951	0.00000	0.99957
q7	11.35387	1.13938	9.96498	0.00000	1.00000
p7	0.00205	0.10691	0.01918	0.98473	0.05004
q7 * p7	0.20599	0.08778	2.34678	0.02099	0.64181

R^2 Adjusted R^2
0.6790 0.6690

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	33	17	0.66000	32	18	0.64000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.83000			0.82000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	35	15	0.70000	35	15	0.70000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.85000			0.85000

PANEL 8. q = 0.985 and p = 0.925

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q8	0.97790	12.26671	10.00000	2.99077	-1.53325	1.28197
p8	0.03336	75.03086	10.00000	17.11314	2.17101	4.12414

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	-68.43780	32.19536	-2.12570	0.03607	0.55754
q8	11.25651	2.74470	4.10119	0.00009	0.98215
p8	0.63727	0.47968	1.32854	0.18712	0.26013

R^2	Adjusted R^2
0.6360	0.6290

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	400.16628	35.56574	11.25145	0.00000	1.00000
q8	-27.21192	2.94747	-9.23229	0.00000	1.00000
p8	-3.82421	0.39396	-9.70701	0.00000	1.00000
q8 * p8	-0.77783	0.05133	-15.15435	0.00000	1.00000

R^2	Adjusted R^2
0.8930	0.8890

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	35	15	0.70000	35	15	0.70000
Non-default firms	3	47	0.94000	3	47	0.94000
Overall accuracy			0.82000			0.82000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	36	14	0.72000	36	14	0.72000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.86000			0.86000

PANEL 9. q = 0.985 and p = 0.985

a) Descriptive statistics

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
q9	0.97790	12.26671	10.00000	2.99077	-1.53325	1.28197
p9	4.31045	19.24579	10.00000	4.30475	0.52349	-0.89360

b) Main effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	182.83330	0.88449	206.71080	0.00000	1.00000
q9	-4.08136	0.05341	-76.42102	0.00000	1.00000
p9	-9.15197	0.03710	-246.65308	0.00000	1.00000

R^2 Adjusted R^2
0.9990 0.9990

c) Main and two-way effects model

Financial variable	Parameter estimate	Standard error	t statistic	Significance	Statistical power
Intercept	207.06146	0.63015	328.58879	0.00000	1.00000
q9	-6.08109	0.05068	-119.99529	0.00000	1.00000
p9	-10.52430	0.03480	-302.38141	0.00000	1.00000
q9 * p9	0.10713	0.00263	40.72956	0.00000	1.00000

R^2 Adjusted R^2
1.0000 1.0000

d) Classification accuracy of the main effects model

	Estimation data:			Lachenbruch crossvalidation:		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	50	0	1.00000	50	0	1.00000
Non-default firms	2	48	0.96000	3	47	0.94000
Overall accuracy			0.98000			0.97000

e) Classification accuracy of the main & 2-way effects model

	Estimation data:			**Lachenbruch crossvalidation:**		
	Predicted:			Predicted:		
Observed:	**Default**	**Non-default**	**Correct, %**	**Default**	**Non-default**	**Correct, %**
Default firms	48	2	0.96000	47	3	0.94000
Non-default firms	0	50	1.00000	0	50	1.00000
Overall accuracy			0.98000			0.97000

APPENDIX 2. Effect of financial variables on the likelihood of non-default (main effects model).

PANEL 1. Fractiles of financial variables.

	Fractile of variable (%):						
Financial variable	**5**	**10**	**25**	**50**	**75**	**90**	**95**
Logarithmic net sales	9.70	10.50	11.47	12.58	13.60	14.78	15.65
Growth in net sales (%)	-55.81	-36.07	-13.20	2.60	25.30	73.74	165.17
Return on investment ratio (%)	-55.47	-28.27	-1.88	10.20	29.08	57.14	85.61
Quick ratio	0.10	0.20	0.40	0.90	1.80	4.00	8.13
Cash flow to net sales ratio (%)	-29.31	-12.74	0.10	5.00	12.90	24.50	35.14
Equity ratio (%)	-71.92	-20.17	6.40	27.70	57.30	81.30	90.47

PANEL 2. Effect of variables on the likelihood of non-default.

	Effect of variable:						
	Fractile of variable (%)						
Financial variable	**5**	**10**	**25**	**50**	**75**	**90**	**95**
Logarithmic net sales	0.2656	0.2877	0.3142	0.3446	0.3726	0.4049	0.4287
Growth in net sales (%)	0.0320	0.0207	0.0076	-0.0015	-0.0145	-0.0422	-0.0946
Return on investment ratio (%)	-0.0281	-0.0143	-0.0010	0.0052	0.0147	0.0290	0.0434
Quick ratio	0.0006	0.0013	0.0025	0.0056	0.0113	0.0251	0.0510
Cash flow to net sales ratio (%)	-0.0252	-0.0110	0.0001	0.0043	0.0111	0.0211	0.0302
Equity ratio (%)	-0.3195	-0.0896	0.0284	0.1230	0.2545	0.3611	0.4019

Likelihood of non-default	**-0.0353**	**0.2340**	**0.3912**	**0.5206**	**0.6891**	**0.8382**	**0.8999**

APPENDIX 3. Coefficients and median effects of financial variables in main & 2-way effects model.

PANEL 1. Quick ratio

Logarithmic net sales		Quick ratio	
Fractile	**Value**	**Coefficient**	**Median effect**
	0.00	0.02197	0.01977
5	9.70	0.00896	0.00807
10	10.50	0.00788	0.00709
25	11.47	0.00658	0.00592
50	12.58	0.00509	0.00458
75	13.60	0.00372	0.00335
90	14.78	0.00214	0.00192
95	15.65	0.00097	0.00087

PANEL 2. Equity ratio

Logarithmic net sales		Equity ratio	
Fractile	**Value**	**Coefficient**	**Median effect**
	0.00	-0.00547	-0.15140
5	9.70	0.00276	0.07640
10	10.50	0.00344	0.09537
25	11.47	0.00426	0.11813
50	12.58	0.00521	0.14421
75	13.60	0.00607	0.16821
90	14.78	0.00707	0.19594
95	15.65	0.00781	0.21634

PANEL 3. Cash flow

Growth in net sales		Cash flow	
Fractile	**Value**	**Coefficient**	**Median effect**
	0.00	0.00000	0.00000
5	-55.81	-0.00124	-0.00622
10	-36.07	-0.00080	-0.00402
25	-13.20	-0.00029	-0.00147
50	2.60	0.00006	0.00029
75	25.30	0.00056	0.00282
90	73.74	0.00164	0.00821
95	165.17	0.00368	0.01840

PANEL 4. Return on investment ratio

Coefficient

		Fractile and value of growth in net sales							
Logarithmic net sales			**5**	**10**	**25**	**50**	**75**	**90**	**95**
Fractile	**Value**	**0.00**	**-55.81**	**-36.07**	**-13.20**	**2.60**	**25.30**	**73.74**	**165.17**
	0.00	-0.00484	-0.00409	-0.00436	-0.00467	-0.00488	-0.00518	-0.00583	-0.00706
5	**9.70**	-0.00043	0.00032	0.00005	-0.00026	-0.00047	-0.00077	-0.00143	-0.00266
10	**10.50**	-0.00007	0.00068	0.00042	0.00011	-0.00010	-0.00041	-0.00106	-0.00229
25	**11.47**	0.00037	0.00112	0.00086	0.00055	0.00034	0.00003	-0.00062	-0.00185
50	**12.58**	0.00088	0.00163	0.00136	0.00106	0.00084	0.00054	-0.00011	-0.00134
75	**13.60**	0.00134	0.00209	0.00183	0.00152	0.00131	0.00100	0.00035	-0.00088
90	**14.78**	0.00188	0.00263	0.00236	0.00206	0.00184	0.00154	0.00089	-0.00034
95	**15.65**	0.00227	0.00302	0.00276	0.00245	0.00224	0.00193	0.00128	0.00005

Median effect

		Fractile and value of growth in net sales							
Logarithmic net sales			**5**	**10**	**25**	**50**	**75**	**90**	**95**
Fractile	**Value**	**0.00**	**-55.81**	**-36.07**	**-13.20**	**2.60**	**25.30**	**73.74**	**165.17**
	0.00	-0.04940	-0.04175	-0.04445	-0.04759	-0.04976	-0.05287	-0.05952	-0.07206
5	**9.70**	-0.00443	0.00323	0.00052	-0.00262	-0.00479	-0.00790	-0.01454	-0.02709
10	**10.50**	-0.00068	0.00697	0.00426	0.00113	-0.00104	-0.00416	-0.01080	-0.02334
25	**11.47**	0.00381	0.01146	0.00876	0.00562	0.00345	0.00034	-0.00631	-0.01885
50	**12.58**	0.00896	0.01661	0.01391	0.01077	0.00860	0.00549	-0.00116	-0.01370
75	**13.60**	0.01370	0.02135	0.01864	0.01551	0.01334	0.01023	0.00358	-0.00896
90	**14.78**	0.01917	0.02682	0.02412	0.02098	0.01881	0.01570	0.00905	-0.00349
95	**15.65**	0.02320	0.03085	0.02815	0.02501	0.02284	0.01973	0.01308	0.00054

The Venture Capital Investment Process In Greece: Some Evaluation Aspects

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M. Bakatsaki-Manoudaki, K. Kosmidou, Y. Papadopoulos, C. Zopounidis*

Abstract – The term "Venture Capital" is quite new in Greece and in the beginning was referred only to the ventures of new innovative firms. Recently it has been expanded to include a wide range of financing, which already covers the existing developed firms. The Venture Capital was firstly appeared in U.S.A. in the early of 40's and later in Europe in the early of 70's. The foundation of venture capital firms was introduced with the laws No 1775/88 & No 2166/93, but due to their insufficient results the law No 2367/95 was instituted to reject the two previous in period of two years and to change the name of the venture capital firms.

The purpose of this paper is to present the development of Venture Capital in Greece. The realization of this development was succeeded via a) a questionnaire, which was sent to all the venture capital firms of Greece and b) interviews, which were held to the managers of the venture capital firms. Consequently, the objective of this paper deals with the results of this research, which are:

- The development and the investment policy of the venture capital firms (geographical division of the invested amounts, sectorial division, type of venture capital (seed capital, start-up financing, etc)
- The decision procedure, which is adopted by the venture capital firms (time-sharing of the venture capital process, evaluation criteria).

Finally, the paper deals with the conclusions derived from this market research and the development perspectives of the venture capital firms in Greece.

JEL Classification: G39, C10.

Keywords: Venture Capital, Investment policy, Evaluation criteria, Statistical Analysis

1. Introduction

The Venture Capital (VC) was firstly appeared in the U.S.A. in the early of 40's and since then it has been expanded worldwide. The VC finances new companies or start-ups especially those that develop new technologies and conquer new markets and helps them to grow and become profitable. At the same time, VC contributes to the development of business spirit.

The profits from the use of VC as financing tool, according to the authors Ganetsou and Fronistas (1995), could be categorized in two levels: (1)in the economy of a country, and (2)in the firm. In the level of economy, the two authors report that VC facilitates the foundation of new enterprises and simultaneously supports the renewal and modernization of the already existing companies, contributing to the economic growth and the confrontation against the unemployment. For example in the U.S.A. the 4% from the developing companies which were financed from VC created the 70% of the new places of work. In France, the firms, that are financed by VC, contributed to an increase of 34% to the work-

* Technical University of Crete, Dept. of Production Engineering and Management, 73100 Chania, Greece, tel. +302821037236, fax. +302821037529, email: kostas@dpem.tuc.gr

ing places, 42% to the sales, 80% to the exportations as well as a duplicating of the investments in the period 1981-1991. Concerning the level of the firm, VC allows the firm to accomplish the necessary investments of growth and modernization without the imminent financial risk due to the loans. At the same time, VC with its participation to the stock capital of the firms adds value, which is expressed with its support on issues of strategic planning, marketing and sales, financial planning and control, technology transfer and introduction of modern methods of management [Zopounidis (1990)].

The VC finances and intervenes to all the stages of growth of a firm: creating, start-up, development and introduction to the stock market. Each stage of growth corresponds to special financing. Moreover, the needs of financing and management support of the companies and the involving risk for the investors of VC differ enough depending on the stage of growth.

The comparison of the VC with the traditional kinds of financing (e.g. loan) leads to the following three differences: 1)The VC is invested in relatively new firms, for which there are no sufficient historical data, 2) the investment is provided to small firms and with direct participation in the stock capital, in order that the investor participates in the life of the firm; this fact does not happen with the investors of large firms that entered into the stock market (their role is inactive), 3) the investment in venture capital does not ensure short-term liquidity to the investor because the capital is "trapped" in the company for a period of 5 to 10 years.

This paper presents, for the first time, the results of a survey based mainly on questionnaires, that were distributed to all the venture capital societies that exist in Greece and on interviews of the executive staff of the above firms. This research refers to the profile of the VC societies, their investment policy and their evaluation criteria.

The next section presents the basic characteristics of this survey. In the last section the conclusions are summarized and the basic results of the research are outlined as well as further research directions for the development of the VC in Greece are proposed.

2. The survey

The initial sample of the research, that began on July 2001, was constituted of 24 VC firms. During the first year it was reduced to 15, since many of them interrupted their activities after the financial crisis of the Greek Stock Market. The questionnaire was finally answered by 11 VC firms. The main objective of the survey was to outline the profile and the investment policy of the VC firms as well as to determine their investment decision-making process. Consequently, the responses have been separated to three units: a) Profile of the VC firms, b) Investment policy and c) Evaluation criteria.

2.1 Profile of the venture capital firms

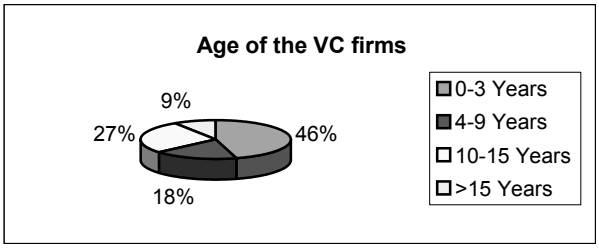
The legislation of VC was firstly introduced in Greece with the law of 1775/25-5-88, according to which the VC firms are Sociétés Anonymes (S.A.), whose main objective is the promotion and the financing of high technology and innovative ventures. Due to the inefficiency of this law the next modification of the law cancels the previous one and expands the financing to other activities like agricultural, industry, tourism, commerce etc (law N2367/95).

The growth of the VC afterwards 1999 was related direct with the dynamic growth of the Greek Stock Market. The returns of the VC firms' investments were impressive and there were founded a lot of venture capital firms (more than 10), the majority of which was subsidiary of stock exchange companies. This fact is also confirmed by the present survey where the majority of the VC firms are young and they are less than 3 years old (46%). 27% of the VC firms are among 10 and 15 years old, whereas 18% and 9% belong to the age among 4 and 9 years old and greater than 15 years old respectively (Figure 1).

Only one VC is administrated by another company and uses the staff of the financing company (in the figure it is referred as exterior management).

The others constitute members of the groups (27%) or they are subsidiaries of other companies (mainly banks) (37%), whereas the rest 27% refer to independent companies (Figure 2). It is also worth noting that even when few companies are independent they have no staff and charge their administration to other economic company. Due to this the

majority of VCs has few staff (64% from 0 to 9 persons). Only one VC firm could be characterized as intermediate firm, since it disposes 69 persons (9%). Generally, they are very small firms, since 91% in total does not employ more than 50 persons (Figure 3).



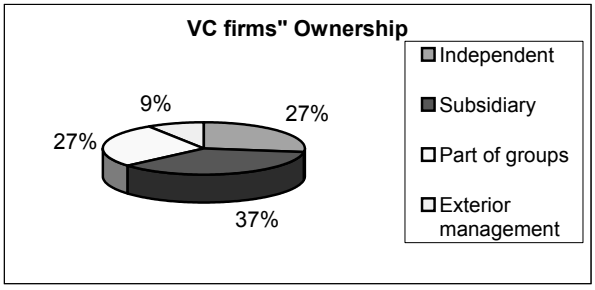


Figure 2

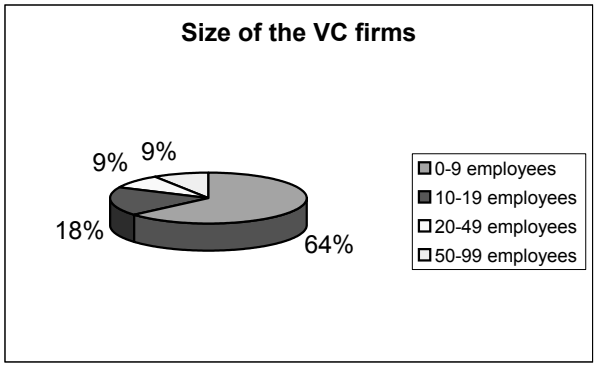


Figure 3

The education level of the staff is very high, since 8% possess a Phd, 46% has a master, 20% a Bachelor, 13% belongs to the under graduate level, while only 6% is of higher education and 7% of senior high school (Figure 4). From these, 48% includes stock market analysts, 23% works on secretarial support, 14% is top management staff, and only 3% includes legal consultants (Figure 5).

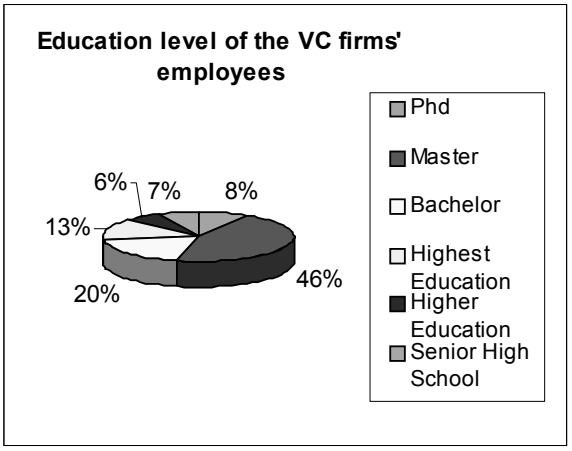


Figure 4

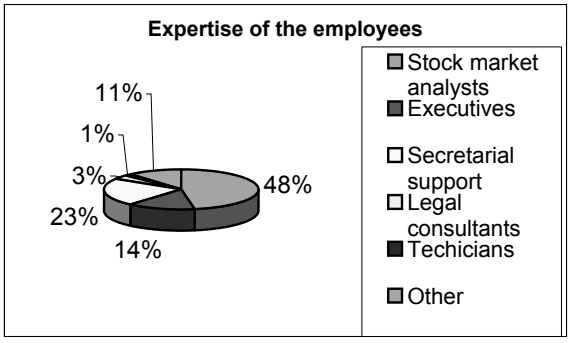


Figure 5

2.2 Investment Policy

The investment policy of the Greek VC firms is conditioned by the Greek law 2367/95, as it determines the way that a VC firm participates in the firm, the support that will provide to the management team and its liquidation from the investment, that should take place among 3 years.

The foundation of the New Economy Fund S.A. (TANEO), constituted by the article 28 of the law N. 2843/2000, contributes to the growth of VC in Greece. The main objective of TANEO is to co-finance the foundation of venture capital firms, which invest on innovative preferable start-ups firms in Greece and to support the capital market, as well as the development of entrepreneurship. On April of 2002 the declaration of the tax neutrality was founded posing a more flexible law frame. The recognition of TANEO by the European Union was a great success for Greece concerning the conditions

TABLE 1. Available and invested funds for the years 1998-2001. Number of submitted and approved deals foe the same period. iod

(in Keuro)	1998	1999	Change (%)	2000	Change (%)	2001	Change (%)
Available amount of VC	82.708	86.369	4,43	301.583	249,18	491.549	62,99
Invested amount on VC	23.127	44.289	91,50	133.013	200,33	52.996	-60,16
Percentage of Invested/Available VC (%)	6,44%	1,72%		11,28%		8,12%	
Number of submitted deals	167	238	42,51	907	281,09	905	-0,22
Number of approved deals	18	14	-22,22	47	235,71	37	-21,28
Percentage of approved /submitted deals (%)	10,78%	5,88%		5,18%		4,08%	

of governmental reinforcement and since nowadays the first Greek fund of funds is activated.

According to the data of Table 1, the available and invested VC funds presented extraordinary increase during the period 1998-2001 (494.32% for the available and 129.15% for the invested funds). This is due to the creation of 5 newly founded VC firms afterwards 1999, which substantially started their activities in 2000. In 2001, the invested amounts on VC presented a significant reduction of 60%, although the available capital had a remarkable increase (63%) because of the lack of interesting deals, as the venture capitalists had notified. However, due to the continuous fall of the Greek Stock Market the interest of the venture capitalists turned to the start-up firms, that include higher risk and consequently they seem to be less seductive investments.

The number of the approved deals was doubled during the period 1998-2001, but the percentage of the approved deals was decreased although the increase of the number of the submitted deals (the percentage falls from 10.78% in 1998 to 4.08% in 2001). This fact shows that the VC firms apply an extremely selective policy whatever is the evaluation of deals.

The VC firms derive their investment capitals mainly from private sources (32%), from corporate investors (13%) and from European reinforcements (13%), while alternative resources are the increase of the share holders' capital sources (7%), the national reinforcements (7%), the administration of Private Equity Fund (7%), the Reserve Funds (7%) and the banks (7% especially those that are subsidiaries or members of groups of banks) (Figure 6).

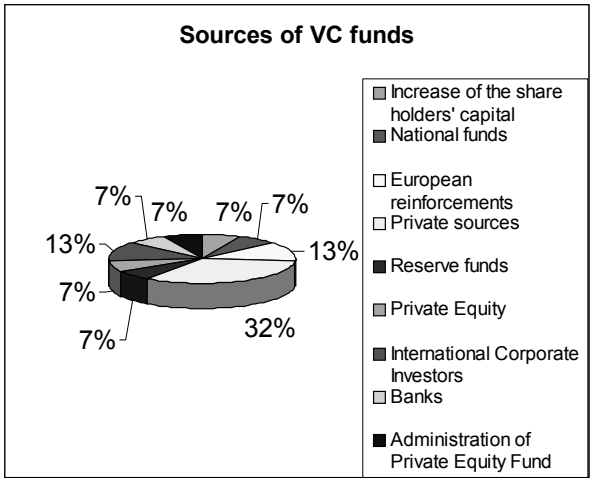


Figure 6

In the deal originating phase the candidate firms determine to approach the VC companies (100%). Since each VC firm has more than one choices of approaching the firm planning, the results are presented in Figure 7. For example the selection "Initiative of the candidate firm" has been proposed by the 11 VC firms and for this reason it takes 100%, while both the selections "Initiative of VC firm" and "Recommendation of another VC firm" present 82%. It should be mentioned that based on researches that took place abroad (USA), the origin of the firm derives mainly from the recommendations of other VC firms.

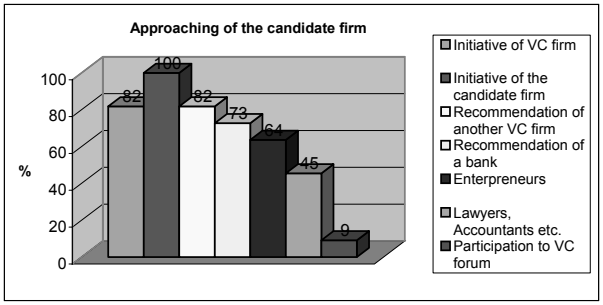


Figure 7

Concerning the investments on venture capital these are given mainly on industries. Especially the Food and Beverages Industry had absorbed the 72% of the total investment amount, having conducted the 50% of the total number of the approved deals. Figures 8 and 9 show how these investments are distributed according to the invested amount, as well as the number of the investments.

The geographical distribution of the VC firms is presented in Figure 10. Athens with percentage 78.95% accepts the majority of the investment capital of all the VC firms. Then, follows Thessaloniki with 8.17%. This result shows that it is preferable to invest in developed industrial areas.

Most of the VC firms invest abroad (55%). The most preferable regions are mainly Eastern Europe (27%) and Balkans (27%), while follow Cyprus, Western Europe and North Africa with percentages 23%, 18% and 5% respectively (cf. Figures 11 and 12).

The VC firms liquidate almost at 24.35% of the total investments (47 out of 193 investments) (cf. Figure 13), preferring mainly (43%) the sale of their shares afterwards the introduction of the firm in the Stock Exchange Market (Public Offer) and less (31%) the sale in a strategic investor (Trade Sale). More seldom (2%) they prefer the sale in the management team of the financed firm. Quite high is the percentage of the failures (Write Off) in these investments, which reach the 23% of the total investments (Figure 14).

It is worth mentioning that it is interesting to study in depth the venture capital performances but this survey needs a long period of operation in a country in order to have reliable results.

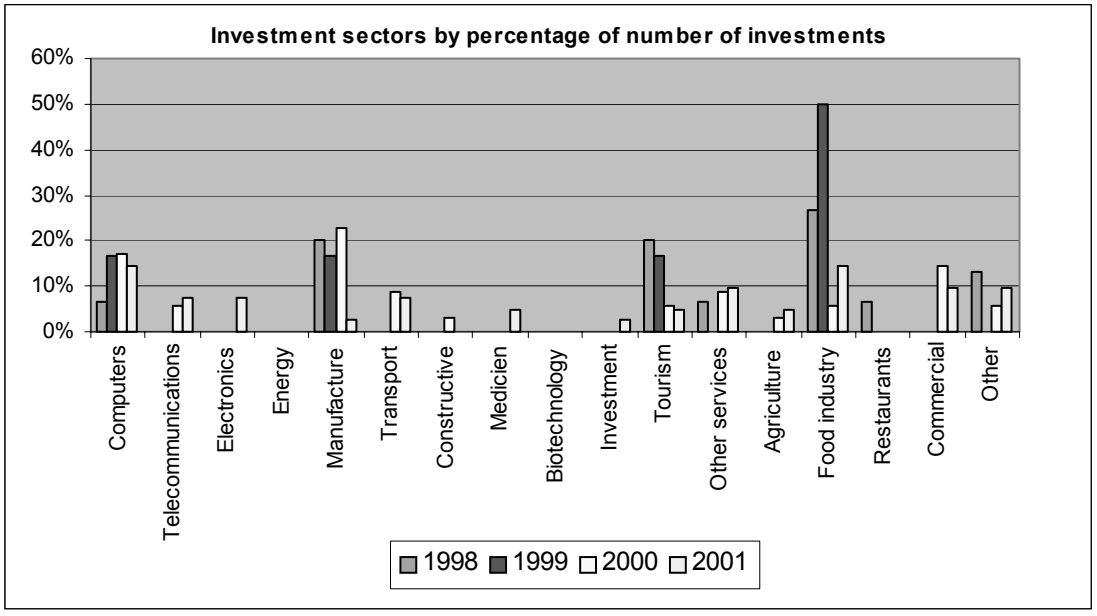


Figure 8

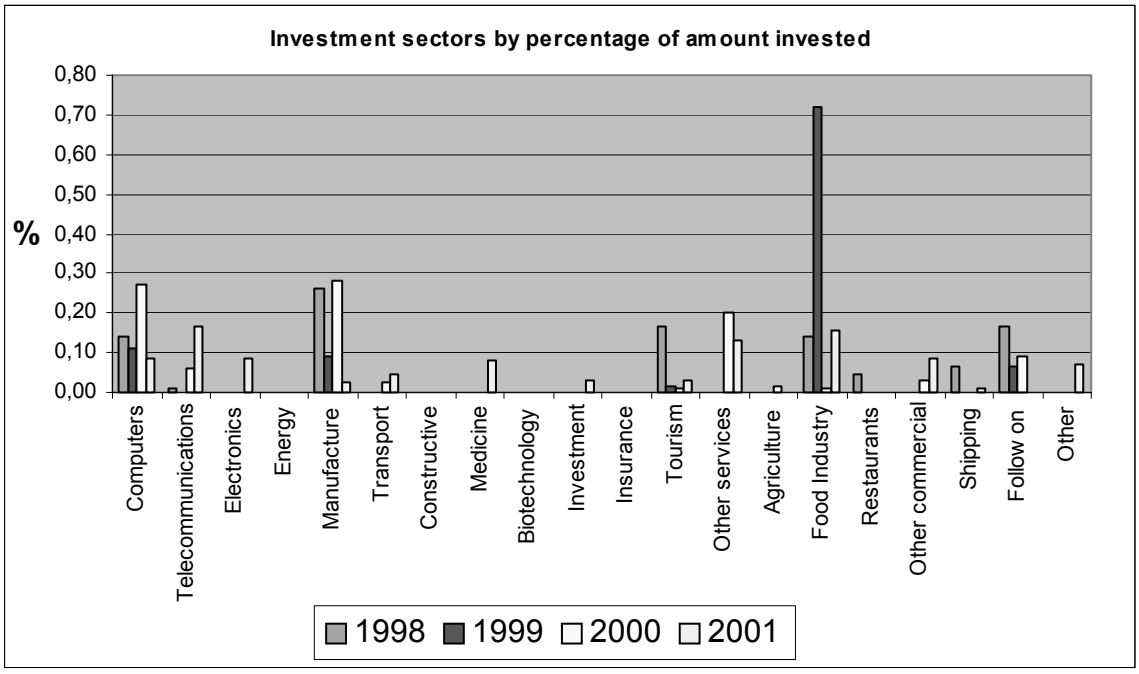


Figure 9

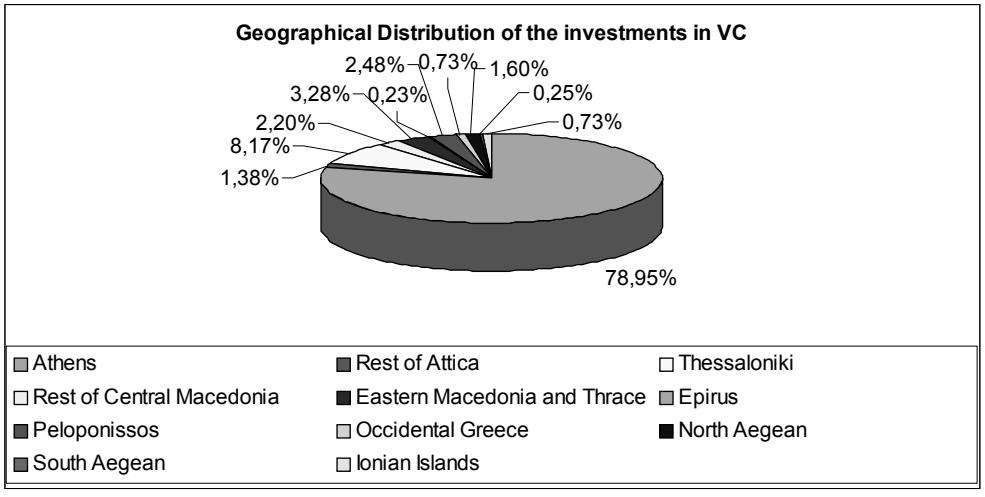


Figure 10

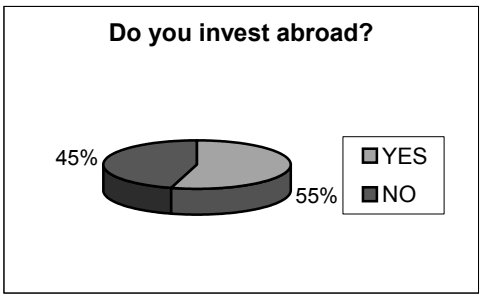


Figure 11

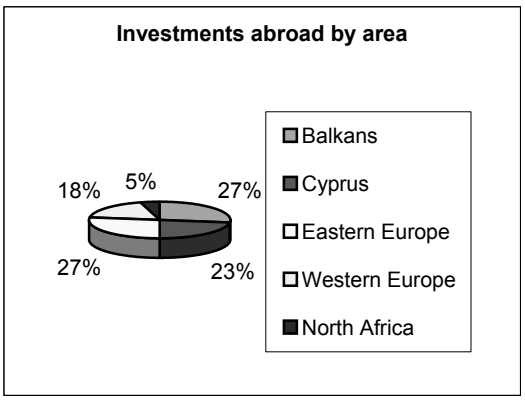


Figure 12

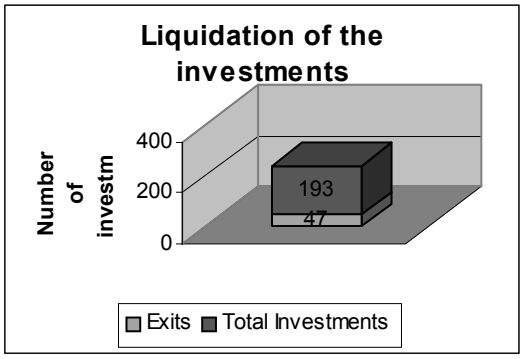


Figure 13

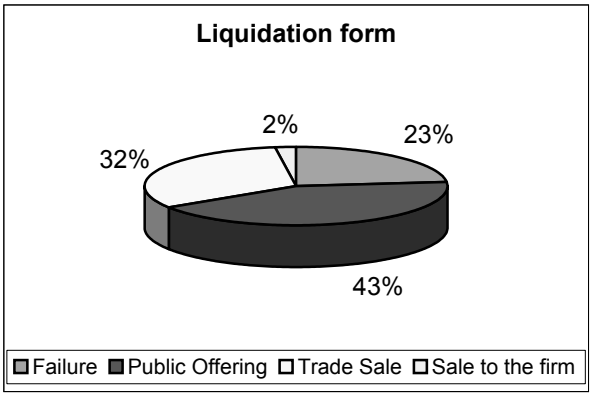


Figure 14

2.3 Finance stages

The VC finances a firm in various development stages. In general the fundamental role of venture capital is to finance and help young companies or start-ups to grow and become profitable. When starting a new firm, an entrepreneur will in many cases require money to buy assets or hire staff. In a later stage, money will be used to finance the development of a product, for the set-up of an organization and for initial marketing and manufacturing activities but it can also be used to bridge the time period until a venture goes IPO. Although it does not exist precise limits among the stages, the development stages of a company can be discrete to the following categories [EVCA (2000)], [Zopounidis, C. (1999)]:

1. *Seed Capital.* Funding for research, evaluation and development of a concept or business before the business actually starts trading. It is the most risky kind of investment, where the 70% of the investments is abandoned.
2. *Start-Up Financing*. Funding for the product development and the first market plan of a new company or even being to the process of establishment, which have not promoted their products commercially yet. The investment may last up to three years and is characterized by high risk.
3. *Other Early-Stage Financing.* It is given to companies that have not completed the stage of product development and there is need for further funds to start the commercial production and the sales. It should not be produced still profits.
4. *Development or Expansion Financing.* Funding for the growth and the expansion of a firm, which is trading profitably. The fund may be used to grow up the production possibility, the development of the market or the product and/or to supply additional labor. The cost is not extremely high because of the relatively low risk, while it can last much more time or to demand much higher funding than it has been programming
5. *Mezzanine (Bridge) Financing.* It prepares the sale of part or all of a company on a stock exchange and lasts at most one year.
6. *Management Buy-Out/Buy-In Financing.* Financing to enable the existing management team (Management Buy-Out) or a new management team (Management Buy-In) to acquire their business from the existing owners. These investments became profitable in relatively short time, present low risk, while their returns are not so important.
7. *Turn Around or Rescue Financing.* Buyout of a company with damages and financing them with purpose to become profitable.
8. *Replacement Financing.* Funding for the purchase of existing shares in a firm from other shareholders, be they individuals, other VC firms or the public stock market.

In Greece, VC firms invest mainly on already existing firms for their development and expansion (with percentage 16% for 1998, 80% for 1999, 82% for 2000 and 28% for 2001) which include limited risk. It is quite remarkable the fact that due to the continuous fall of the Greek Stock Exchange the VC firms turned to new born firms which in the long run create higher values. Consequently, while in 2000 the

percentages of the invested money on seed-capital, start-up finance and early-stage occupied the 0.5%, 3% and 2% of the total investments respectively, in 2001 the percentages of the invested amount raised to 3% , 39% and 19% respectively. It should be mentioned that the contribution of TANEO to the start-up firms should be taken into consideration, since TANEO funds the business plan of start-ups (Figure 15). About the same behavior was observed before the increase of the Stock Exchange in 1998 where the VC firms were invested to start-up and early-stage firms the 45% and 38% of the invested amounts (Figure 16).

The VC firms provide the firms except from financial support (100%) other services such as consulting for the strategic and business development (91%). Since their participation to the invested firm includes high risk they pursue to be represented to the boarding council according to the percentage of the possessed shares (82%). Consequently its main purpose is to help the firm to have a successful and profitable business development contributing to the expansion of the business relation network (73%), and supplying consulting for the Human Resource Management (64%), its financial planning (64%) and its expansion to new markets (64%). Only few (9%) change the management team of the supported firm. The results are presented in Figure 17 as the questioned venture capitalist had chosen more than one responses. Giving 100% to the financial support means that all the venture capitalists (11 out of 11) selected this answer.

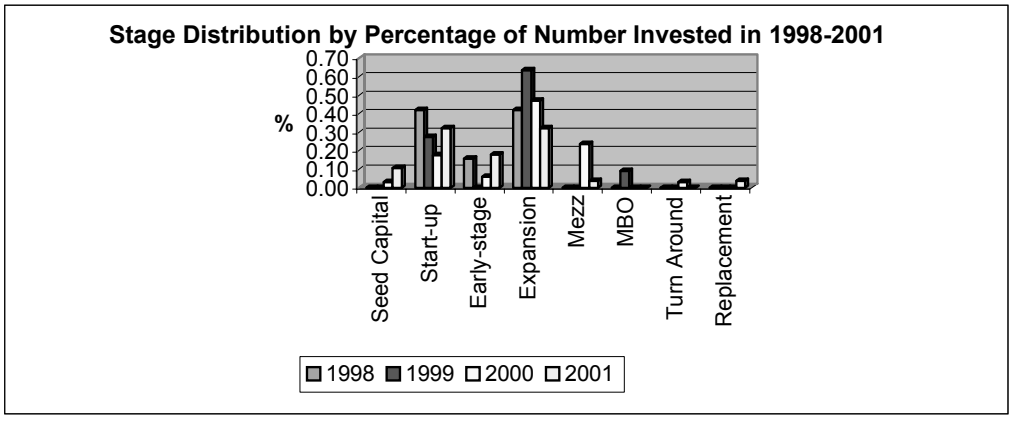


Figure 15

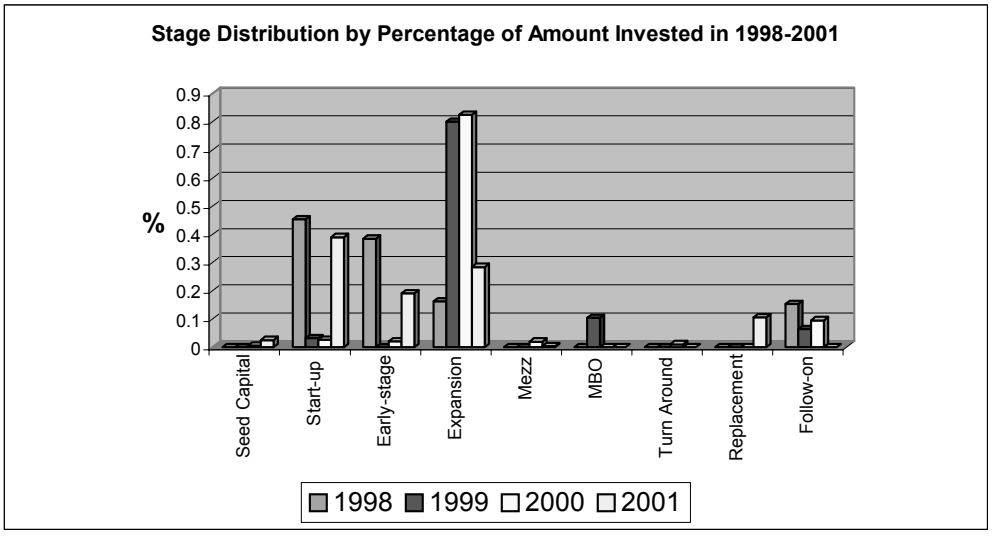


Figure 16

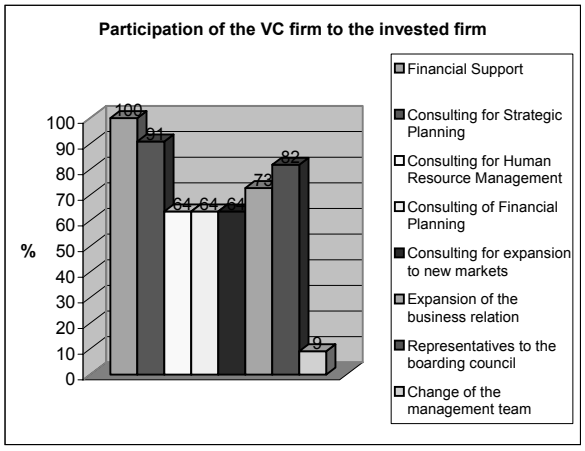


Figure 17

2.4 Evaluation Process in Venture Capital Investment

The process of VC investment between the deposit of a deal and the closing of the investment is generally sequential. According to the Tyebjee and Bruno (1984) four stages precede the investment and three stages follow:

A. Prior-investment activities

- Firm origination: VCs deal with the estimation of the elements concerning the firm origination.
- Screening Phase: it is the initial evaluation of the firm, the criteria are not so strictly and the most possible candidate business plans are selected.
- Evaluation Phase: the evaluation of the products/services with more strictly criteria takes place and the most interesting business plans are selected for further in- depth review of the company (due diligence).
- Structuring phase: at this phase it is structured the relation with the candidate firm, as well as the financial and logistic control and the final negotiation take place and if everybody agrees this phase ends with the signing of contracts and money transfer.

B. Post-investment activities

- Cooperation with the management team; after the signature of the contract the VC firms become an active partner.
- Consulting activities can refer to a) the strategic and the business development of the firm, b) the human resource management, c) the financial planning and d) the expansion to new markets.
- Liquidation from the investment, which if it does not end as failure, can be either Public Offer, or Trade Sale or sale to the existing management team of the firm.

Calculating the mean time that the venture capitalists devoted for these activities before and after the investment, we could observe the following:

a) Before the investment the venture capitalists consume most of their time in the evaluation phase

TABLE 2. Time Distribution by percentage of the Venture Capitelist for the prior and post-investment activities.

	PRIOR-INVESTMENT ACTIVITIES				POST-INVESTMENT ACTIVITIES		
	Firm Origination	Screening Phase	Evaluation Phase	Structuring	Cooperation with the management team	Consulting	Liquidation
VC firm 1	5%	30%	45%	20%	30%	50%	20%
VC firm 2	9%	25%	33%	33%	37%	26%	37%
VC firm 3	20%	10%	40%	30%	0%	100%	0%
VC firm 4	10%	40%	30%	20%	50%	20%	30%
VC firm 5	20%	40%	30%	10%	70%	20%	10%
VC firm 6	20%	25%	25%	30%	40%	30%	30%
VC firm 7	5%	10%	20%	65%	40%	20%	40%
VC firm 8	20%	20%	30%	30%	0%	0%	0%
VC firm 9	20%	20%	40%	20%	50%	30%	20%
VC firm 10	10%	40%	30%	20%	80%	20%	0%
VC firm 11	5%	15%	30%	50%	50%	30%	20%
Mean time	14%	28%	35%	33%	45%	35%	21%

(35%), but also in the preparatory processes until the signature of the contracts (structuring) (33%), while in the screening phase they dedicate less time (28%) but quite enough as there is usually a large number of proposed plans.

b) After the investment most of their time is dedicated to cooperation with the management team (45%) in order to have a successful growth of the firm, while important time is dedicated to the supply of consulting support to different areas concerning the survival and the development or the firm. The time of liquidation is less (21%), but half of the Greek VC firms are very new (they were founded after 1999-2000), so they have not started to work on them.

During the screening and the evaluation phase the venture capitalists' estimation is based mainly on the business plan (100%). They consider it so important that some VC firms present via their web page a form of a business plan and give instructions for its completion. Most of them are monitoring also the firm for quite a long time (73%) before they take any decision, while few venture capitalists follow their intuition. Sources of data are also the collaborators of the firm (consultants, lawyers, banks, accountants, etc.) (27%), the market research (27%) or more seldom (9%) the opinion of specialists or the fundamental analysis (Figure 18).

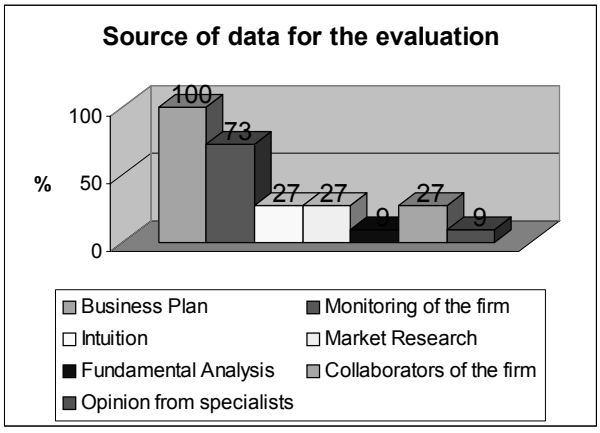


Figure 18

The final evaluation of the deals has been attempted via the questionnaire to find out the evaluation criteria and methodology. Only one venture capitalist answered that he does not use any method, while two of them did not give any answer for the methodology. The rest 72% of the sample responded differently among each other. Each one has its own methodological approach. Even the international literature and practice does not provide any specific method, as venture capital differs radically from the formal investments in the Stock Market.

More specifically, the modeling of venture capital investment in firms is a complex problem because:

- venture capital is invested in relatively new firms, for which there are no sufficient historical data
- value is added to the invested capital by an active participation
- long term orientation (5 to 10 years during which the investment will provide sizeable returns) an then the risks attached to the investment
- most of the VC's information comes from business plan and there is a potential threat that the information included in the plan could be inaccurate.
    - lack of remuneration
    - lack of real or personal guarantee
    - non-capital liquidity

In case of formulation of the evaluation methods of VC firms, the reader could study the paper of Zopounidis (1994).

In the present study, based on the international bibliography and the interviews of the VC firms managers, 19 evaluation criteria for the selection of candidate deals of the firms were taken into consideration. These criteria describe the management, the market, the product, the organizational and technical characteristics of the financing candidate firm. In order to examine which of the criteria are more important to the evaluation of the deals from the Greek VCs, the managers ranked the 19 criteria.

For this reason they were asked to rank from 6 to 1 (where 6 is the most significant) the most important criteria for them from a list of 19 criteria. They had also the possibility to propose any criteria that they were not referred to the questionnaires. The preferences of the venture capitalists for each criterion are described analytically to the following Figure 19:

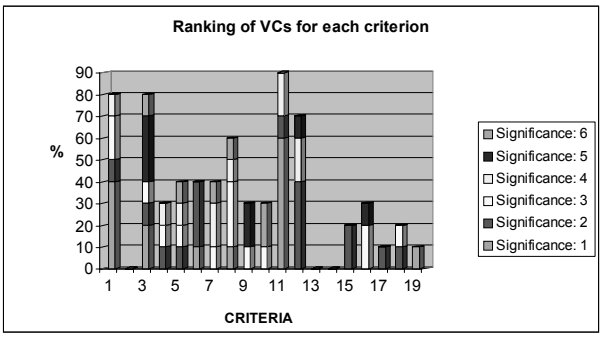


Figure 19

In order to obtain an overall evaluation of the significance of each criterion in the VC evaluation process, an aggregation of the criteria rankings defined by each participant in the survey is required. The most simple aggregation form that is suitable in this context is to use a weighted average of the rankings defined for each criterion, as follows:

$$S_i = \frac{\sum_{j=1}^{k} j \times p_{ij}}{n}$$

where:

- S_i is the overall significance of criterion i assigned on the basis of the individual criteria rankings defined by the participants (venture capitalists) in the survey.
- n is the number of participants in the survey (in this study $n = 11$).
- k is the number of levels in the rank-ordering of the criteria by the participants in the survey. In this study, the venture capitalists were asked to evaluate the significance of the criteria in a 6-point ordinal scale, ranging from 1 (least important criterion) up to 6 (most important criterion). Therefore, $k = 6$.
- p_{ij} is the number of participants that assigned criterion i a significance equal to j in the aforementioned 6-point ordinal scale.

The measure S_i of the overall significance of criterion i ranges between 0 and 6. The case $S_i = 0$ indicates that all venture capitalists that participated in the survey consider criterion i as totally irrelevant to the VC investment decision. On the other hand, the case $S_i = 1$ indicates that all venture capitalists that participated in the survey consider criterion i as the most important one to the VC investment decision.

The results for the overall significance of the criteria and their final aggregate ranking according to the above index are given to Table 3. According to the presented results the criterion that the venture capitalists consider most significant during their decision making investment process is «The expected rate of return of the investment» (total score=4.7). The second significant criterion is «Skills and experience of the management team» (Total score=4), while the criteria «Branch characteristics» and «Expected risk», «Market growth» and «Originality/Innovation» are ranked as fourth (total score=2.8), fifth (total score=2.2) and sixth (total score=2.1) respectively etc.

3. Conclusions and future research

Generally, during the last two years the development process of VC is spectacular, since the investments to VC have increased rapidly and concerning the legislation framework, important evolutions have taken place, such as a)the foundation of TANEO, a fund that invests VC especially to newly founded start-up firms, and b)the voting of a law for the foundation of Mutual Funds of Business Participation, for which is valid the principle of tax neutrality.

However, although there is a plethora of capital offer from the VC and the TANEO, there is not sufficient offer of remarkable business plans. Basically, due to the continuous fall of the Greek Stock Market, there was no longer the ability of retirement from the Stock Market and the venture capitalists were enforced to change their interest to start-ups that include higher risk.

It should be also encouraging the fact that the Greek VC firms are more risky than the European ones and invest high percentages (42%) of their total capital during the first stages of financing (seed-capital, start-up, early stage financing). This trend is due to the fact that the venture capitalists were obliged to turn to start-ups firms, whose investments create in the long run higher additive values and not to firms whose their liquidation from the Stock Market is unfeasible due to the continuous fall of the Greek Stock Market.

The VC could constitute an important tool for the development of the entrepreneurship in Greece,

TABLE 3. Ranking of the Evaluation Criteria in Venture Capitalists Decision Making Investment Process.

CRITERIA	No. of Companies that have selected it	%	Sum of the choices of ranking for each criteria						Score S_i	Ranking
			6	5	4	3	2	1		
1. Skill and experience of the management team	8	80	4	1	2	1	0	0	4	2
2. Personal Motivation	0	0	0	0	0	0	0	0	0	17
3. Branch characteristics	8	80	2	1	1	0	3	1	2,8	3
4. Product differentiation	3	30	0	1	1	1	0	0	1,2	8
5. Growth potential	4	40	0	1	1	1	0	1	1,3	7
6. Originality/Innovation	4	40	1	3	0	0	0	0	2,1	6
7. Market size	4	40	0	0	1	2	0	1	1,1	9
8. Market growth	6	60	1	0	3	1	0	1	2,2	5
9. Competitive threat	3	30	0	0	1	0	2	0	0,8	13
10. Cash-out method	3	30	0	0	1	0	0	2	0,6	14
11. Expected rate of return	9	90	6	1	0	2	0	0	4,7	1
12. Expected risk	7	70	0	4	0	2	1	0	2,8	3
13. Percentage of equity	0	0	0	0	0	0	0	0	0	17
14. Investors provisions	0	0	0	0	0	0	0	0	0	17
15. Size of investment	2	20	0	2	0	0	0	0	1	10
16.Liquidity	3	30	0	0	2	0	1	0	1	10
17. References	1	10	0	1	0	0	0	0	0,5	15
18. Venture development stage	2	20	0	1	1	0	0	0	0,9	12
19. Ensurements of the branch possibilities from the financed firm	1	10	0	0	0	0	0	1	0,1	16

since in combination with the existing institutional framework, it is ideal for the support of the Greek small or medium firms, that would like to be innovative and competitive towards the European market.

Further research on VC in Greece could be turned to the following two directions:

1. The study of the venture capital profitability to all the stages of financing.
2. The research on a complete and acceptable method of the venture capital investment evaluation, that will constitute an effective tool for the venture capital's decision making process in real time.

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Convergence with IFRSs and the Evolution of the Regulation of the Concept of Control used for Consolidated Accounts: a UK Perspective*

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Dr. Renata Stenka, Peter Taylor[1]

Abstract – For any jurisdiction with pre-existing domestic regulations on consolidation the requirement to converge on IFRSs involves a change in an important part of its GAAP which would instigate major economic consequences. UK GAAP relating to group accounts is very complex and had evolved over a long time. The convergence with IFRSs is the latest phase in this evolution and the paper seeks to analyse this process and certain of the issues arising from it. The analysis is focused on the concept of control used to determine the scope of consolidation.

JEL Classification: G39, C10.

Keywords: Accounting (M 41), Accounting Regulation, Consolidated Accounts, International Accounting Standards, Harmonization

1. Introduction

There is a clear trend towards a globalisation of accounting standards under the lead of the International Accounting Standard Board (IASB)[2] whose International Financial Reporting Standards (IFRSs)[3] are increasingly becoming a common set of regulations followed by companies in a many of the world's economies. Almost 100 countries worldwide use IASB's accounting rules and still more are expected to follow (McGregor, 1999; Cairns, 2000; Davies, 2000; Nobes, 2000b, 2000c; Herz, 2003; and Gannon and Ashwal, 2004). IASB regulations have been accepted or recommended on many stock markets, including Amsterdam, London, Frankfurt, Zurich, Hong Kong, and Tokyo and there is a long-standing and continuing discussion on whether they should be endorsed by the International Organisation of Securities Commissions (IOSCO) and individual securities commissions such as the US Securities and Exchange Commission. The importance of this process in the context of the EU is amplified by the

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1. Dr R. Stenka is Lecturer in Accounting, School of Economic and Management Studies Keele University. Corresponding author: Dr. Renata Stenka; Keele University, Staffordshire, ST5 5BG, UK; tel: +44 (0)178258 3431; fax: +44 (0)178258 4277; email: r.i.stenka@mngt.keele.ac.uk.
   Peter Taylor is Professor of Accounting, School of Management The University of Liverpool.
2. The abbreviation IASB will be used throughout this paper to refer both to the International Accounting Standards Board and its predecessor organisation the International Accounting Standards Committee (IASC). IASC will be used in referencing the publications of that body.
3. Hereafter for ease of expression 'IFRSs' will be taken to include both International Accounting Standards (IAS) and International Financial Reporting Standards when general reference is made to both. Otherwise IAS and IFRS will be used as appropriate to the context of the argument.

fact that from 1st January 2005 all companies with debt or equity securities admitted to trading on any regulated market of any Member State[4] have been required to apply IFRSs that have been approved by the EU to their consolidated financial statements (Co-ordinating Group on Audit and Accounting Issues, 2003, Chapter 4).

For any jurisdiction with pre-existing domestic regulations on consolidation the requirement to converge on IFRSs involves a change in an important part of generally accepted accounting principles (GAAP) which is likely to have significant impacts on regulation and financial reporting practices and therefore may have major economic consequences (Nobes, 2000b; Holgate, 2003; House, 2003; Larson and Street, 2004 and Ormrod and Taylor, 2004). In the UK group accounts have been prepared for many years and regulations have been in place for over 50 years. Within this evolving framework of GAAP, consolidation was practised and then emerged as the dominant basis of accounting practice and regulation. Thus, by January 2005 UK GAAP relating to group accounts and consolidation was both complex and mature and had evolved over a long period but this evolution had by no means been smooth and without controversy (Kelly *et al.*, 1990 and Nobes, 1993). The convergence with IFRSs is the latest phase in this evolution and this paper seeks to analyse this process and certain of the issues arising from it. We focus our analysis on one part of GAAP for consolidation namely the concept of control used for consolidation. We do so because the regulatory concept of control is the starting point, and a critical issue, for consolidation procedures since it determines which entities should be covered by the consolidation requirement. A universal factor determining the scope of consolidation has been the ability to control another entity and that factor has come to provide a basis for the controlling entity's accountability. This issue has been at the centre of much of the controversy in the evolution of UK GAAP for consolidation (Pimm, 1990) and convergence on IFRSs represents a new phase in the development of the regulatory concept of control. At the time of writing the IASB is working on the project *Consolidation (Including Special Purpose Entities)* whose ultimate objective is to issue a new standard which would address consolidation of all controlled entities, both subsidiaries and special purpose entities (SPEs)[5]. The main focus of IASB deliberations is the development of the concept of control that would effectively determine the scope of consolidated accounts in a way to minimize opportunities for off-balance sheet financing.

The remainder of the paper is organised as follows. The next section presents an overview of the literature on harmonisation of accounting procedures. The following section discusses the data and methodology applied in the study. In section three we briefly consider the evolution of consolidated financial reporting in the UK which sets a context for the following sections. In section four we focus on the development of regulations relevant to the concept of control and consider the relationships between domestic regulations, the EU Directive, and IFRSs. We then review current developments within the IASB in this area and consider future prospects. The final section contains our conclusions.

2. Prior Research

A substantial body of research, both professional and academic, has been devoted to issues concerning convergence with international accounting standards worldwide and the implications of the global harmonisation of accounting regulation. Some studies examine regulatory activities of the IASB (and previously the IASC) as a "global standard setting body" looking at the institutional and political implications of its standards increasingly becoming a mandatory set of accounting regulations (Zeff, 2002 and Kwok and Sharp, 2005). Other research studies analyse the main differences between IFRSs and domestic standards of relevant countries and consider

4. Within the meaning of Article 1 (13) of Council Directive 93/22/EEC of 10 May 1993 on investment services in the securities field.

5. A special purpose entity (SPE) is taken to be created to accomplish a narrow and well-defined objective (e.g. to effect a lease, research and development activities or a securitisation of financial assets). Such an SPE may take the form of a corporation, trust, partnership or unincorporated entity. Frequently SPEs are created with legal arrangements that impose limits on the decision-making powers of their governing bodies. Usually, the right to change the continuing activities of an SPE is reserved to its creator or sponsor (SIC-12, 1999, para 1.2). The concept of a SPE is similar to the concept of a quasi-subsidiary in UK accounting regulations as noted below.

the potential consequences of the harmonisation of accounting regulation in those countries and globally. Several studies have been conducted on the main differences between US GAAP and IASB standards (Bloomer, 1999; Street and Gray, 1999; Street *et al.,* 2000; Pacter, 2002, Leuz, 2003; Tarca, 2004; and Ampofo and Sellani, 2005). Similar research has also been undertaken in the Australian context by, for example, Collet *et al.* (2001) and Jones and Wolinzer (2003). There are also studies devoted to compare the analysis of IASB regulations with regard to China (Chen, 1999; Tang, 2000) and Egypt (Abd-Elsalam and Weetman, 2003). A considerable body of research has addressed the convergence process within the EU and other European countries (Thorell and Whittington, 1994; Hoarau, 1995; Canibano and Mora, 2000, Aisbitt and Nobes, 2001; Alexander and Archer, 2001; Haller, 2002; Robers *et al.*, 2002; Alexander and Schwencke, 2003; Evans, 2003; Homollee, 2003; Walton, 2003; Larson and Street, 2004; and Street and Larson, 2004). Additionally, other studies have focused on convergence issues in the context of transition economies, mainly from Eastern Europe (Bailey *et al.*, 1995; Dutia, 1995; De Bruin, 2000; Daniel *et al.*, 2001; King *et al.,* 2001; and Kosmala-MacLullich, 2003).

Street (2002) has conducted a multinational study of the harmonisation process based on two surveys of financial reporting practices in 59 and 62 countries sponsored by the six largest (at that time) accounting firms in the context of international accounting standards [6]. These two surveys aimed to identify main differences between local reporting standards and standards issued by the IASB. Street (2002) analysed these surveys in order to assess the progress and perceived impediments to convergence in the relevant countries[7]. Zeff (1998) and Choi *et al.,* (2002) have summarised and examined differences in US, UK and IASB GAAPs.

The vast majority of the studies noted above focus on convergence issues by conducting general comparisons of national accounting practice with accounting procedures prescribed by IFRSs. The present paper focuses on only one issue, namely the regulatory concept of control used for consolidated accounts. This narrow focus allows us to perform a very detailed comparable analysis of the international concept of control in the context of UK practice. Additionally, the concept of control that determines the scope of consolidation is a very central and important issue in modern financial accounting where the majority of financial reporting for large economic entities is conducted through the medium of consolidated accounts.

3. Data and Methodology

The present study conducts detailed examination of the relevant legal and regulatory documents within UK, EU and IASB jurisdictions and of summaries and minutes of the meetings of technical committees of IASB. In case of the UK, the pronouncements relevant to the concept of control are included in Companies Act 1989 which are then applied by Financial Reporting Standard 2 *Accounting for Subsidiary Undertakings* (ASB, 1992) and Financial Reporting Standard 5 *Reporting the Substance of Transactions* (ASB, 1994). In case of the EU legislation, the relevant pronouncements are mainly included in the Seventh Directive on *Consolidated Accounts* (EEC, 1984). Finally, the concept of control is addressed by IASB regulations in IAS 27 *Consolidated and Separate Financial Statements* (IASB, 2003), IFRS 3 *Business Combinations* (IASB 2004), and SIC 12 *Consolidation – Special Purpose Entities* (IASB, 1999). The analysis are also applied to the content of the IASB Project *Consolidation (Special Purpose Entities)* (IASB, 2002) and to the minutes of the meetings relevant to the development of the project.

The study reviews these documents using content analysis, a method applied widely in the social sciences to examine different kinds of documentary accounts. Generally, content analysis is a research technique to make inferences from documents; these are about the sender(s) of the message contained in the document, the message itself, or the audience for the message (Berelson, 1952; Weber, 1990; Zikmund, 1994; and Bryman, 2001). In context of accounting research, content analysis has

6. GAAP 2000 and GAAP 2001 are available at www.pwcglobal.com

7. The similar research but in European context was conducted by Larson and Street (2004). Authors used six largest accounting firms' 2002 survey of financial reporting practices in 17 European countries (GAAP Convergence 2002, available at www.pwcglobal.com).

been primary used to investigate financial information communicated through written narratives included in corporate annual reports; accounting, finance, and tax textbooks; official pronouncements by accounting bodies; and written records of tax and legal cases (e.g. Bowman and Hire, 1975; Bowman, 1982, 1984; Beattie and Jones, 1992, 1996, 1997; Aerts, 1994; Mather *et al.,* 1996; Bryan 1997; Smith and Taffer, 1992a, 1992b, 2000; and Faux, 2004).

4. The Evolution of the Concept of Control in Consolidated Financial Reporting in the UK

Consolidated financial reporting in the UK grew out of the limitations of individual company accounting and sought to provide a representation of an economic reality where business activities were no longer conducted through the individual enterprise but through groups of inter-related businesses and globalisation has enhanced this tendency (Moonitz, 1978; Mumford, 1982; Nobes, 1987, 1993, 2000a; Bircher, 1988; Nobes and Parker, 1988; Kelly *et al.,* 1990; and Alexander, 1999). In the UK, group accounts have been prepared since the 1920s but they were not required by law until the Companies Act 1948. That Act, however, did not specify any detailed rules and a parent company could choose between several options in presenting its group accounts. These options were narrowed to the form of consolidated accounts by SSAP 14 *Group Accounts* issued by the Accounting Standard Committee (ASC) in 1978. Consolidation became the only permissible form of group accounts by statute rather later through the Companies Act 1989 (s 227) which implemented the EU Seventh Directive into UK company law. From 1948 to 1989, the recognition of a parent-subsidiary relationship was mainly based on the ownership of equity and required a parent either to (a) hold more than half in nominal value of the subsidiary's equity, or (b) be a member of it and control the composition of its board of directors. These tests for control recognition were criticised for not being effective nor based on any clear conceptual view of the nature of control as criterion (a) did not necessarily imply control if all equity did not carry equal voting rights, whereas criterion (b) was only one of various means of exercising control. Shaw (1976, p. 71) commented that majority ownership should have been merely an example or refutable presumption of circumstances of possible dominance. It was possible for one company to be the subsidiary of two parent companies where one held the majority of equity and the other a minority of equity but a majority of votes. Additionally, these tests did not consider additional arrangements that could have resulted in establishing control (Bircher, 1988; Pimm, 1990; and Taylor, 1996). As a result, the tests gave scope for off-balance sheet financing schemes enabling companies to establish effectively controlled entities outside the legal specifications (Peasnell and Yaansah, 1988; Nobes, 1987; and Pimm, 1990). The situation changed with the implementation of the EU Seventh Directive by Part I of the Companies Act 1989. The criteria for recognition of a parent-subsidiary relationship were amended significantly (Arthur Andersen, 1983; Brown, 1990; Nobes, 1990, 1993a; Wooldridge, 1991; Prentice, 1991, and 1993). The new criteria moved away from a concept of control based mainly on one assured by a legal rights proprietary criterion (*de jure* control) to one based on actual domination (*de facto* control). This broader definition brought within the scope of consolidation many entities which were effectively controlled but had previously not fulfilled any of the legal tests (Pimm, 1990, p. 88). As a result of these changes, SSAP14 *Group Accounts* was no longer consistent with company law and needed to be thoroughly reviewed. The review was undertaken initially by the ASC and then by ASB and in 1992 FRS 2 *Accounting for Subsidiary Undertakings* was issued. The issue of the scope of consolidation through controlled non-subsidiaries was tackled by overlapping regulatory activity. Technical Release 603, *Off Balance Sheet Financing and Window Dressing*, was issued by the Institute of Chartered Accountants in England and Wales (ICAEW) in 1985. The Technical Committee of the ICAEW passed its work to the ASC (later superseded by the ASB) and after the release of three exposure drafts[8] and a lengthy period of deliberation and controversy, FRS 5 *Recording the Substance of Transactions* was issued in April 1994.

8. These were: ED 42, *Accounting for Special Purpose Transactions*, issued by the ASC in 1988, ED 49, *Reflecting the Substance of Transactions*, issued by the ASC in 1990, and finally FRED 4, *Reporting the Substance of Transactions*, issued by the ASB in 1993.

5. The Evolution of the Concept of Control in Consolidated Financial Reporting in International Accounting Standards

During the period of regulatory development in the UK which we have just reviewed the IASB had issued IAS 3 *Consolidated Financial Statements* in 1976 and this was the first accounting standard on the subject of consolidated accounts outside the US. The concept of control used by IAS 3 to determine the scope of consolidation was similar to that used in SSAP 14 in being based on the ownership of another entity's equity or control of the composition of its board of directors. IAS 3 was subsequently superseded by IAS 27 *Consolidated Financial Statements and Accounting for Investments in Subsidiaries* (IASC, 1988). More recently the IASB added the project *Consolidation (Including Special Purpose Entities)* to its work agenda in 2002 with the aims of re-examining the basis on which an entity should consolidate its investments and providing more rigorous guidance on the concept of control. The project has worked towards the amendment of IAS 27 and also the reconsideration of SIC 12 *Consolidation–Special Purpose Entities*.[9] A new version of IAS 27 (*Consolidated and Separate Financial Statements)* was introduced in 2003 (IASB, 2005).

With the superseding of IAS 3 the concept of control moved from one based on a legal rights proprietary criterion to *de facto* control assured by voting power or other arrangements. The recognition of the parent-subsidiary relationship was also dealt with in IAS 22 *Business Combinations* issued by the IASC in 1983 and revised in 1998, which in March 2004 was superseded by IFRS 3 *Business Combinations*. IFRS 3 (and previously IAS 22) mentions business combinations resulting in a parent-subsidiary relationship and lists conditions applicable when an acquirer obtains control. The criteria cited by that standard are in line with control tests listed in IAS 27, *Consolidated and Separate Financial Statements*. Additionally, the IASB Standing Interpretation Committee (SIC) issued in 2002 Interpretation 33 *Consolidation and Equity Method – Potential Voting Rights and Allocation of Ownership Interests* which was relevant to the concept of control as it dealt with the treatment of potential voting rights for determining a controlling interest in another entity. However, SIC 33 was withdrawn at the end of 2003. The problem of controlled non-subsidiaries is addressed in IASB regulations by SIC 12 *Consolidation – Special Purpose Entities*. This Interpretation supplements IAS 27 *Consolidated and Separate Statements* (IASB, 2005) and covers entities that have not fulfilled any of the control tests listed in paragraph 12 of IAS 27 but nevertheless are effectively controlled according to the definition of control itself.

6. Tests for Parent-Subsidiary Relationship Recognition: A Comparative Analysis of Current UK Domestic Regulations, EU Regulations and IASB Regulations

In the UK the current criteria for control recognition for the purpose of consolidated accounts are included in section 258 of the Companies Act 1989 and adapted by FRS 2, *Accounting for Subsidiary Undertakings* (ASB, 1992, paragraph 14). These criteria determine which entities fulfil the legal definition of a subsidiary. IASB regulations, as already noted, provide tests for control recognition in IAS 27, *Consolidated and Separate Financial Statements* (IASB, 2005) and IFRS 3 *Business Combinations* (IASB, 2004). Table 1 provides a comparison of control criteria included in UK domestic and non-domestic regulations. It should be noted that since the tests for control recognition in the UK are determined under legislation introduced to implement the EU Seventh Directive, the control recognition criteria are consistent with mandatory conditions included in the EU provisions.

As summarised in Table 1 compulsory criteria $A_{UK,}$ A_{EU}, A_{IASB}, B_{UK}, B_{EU} and B_{IASB} all refer to situations where one entity alone controls the majority of the voting rights in another by means of simply possessing it or having an explicit, legally binding agreement with other shareholders or members. In the case of controlling the majority of the voting power through such an agreement, the parent company must be, at the same time, a member of the potential subsidiary. Compulsory criteria $C_{UK,}$ C_{EU},

9. This project is discussed in more detail in a later section of the paper.

TABLE 1. Legal and regulatory tests for parent-subsidiary relationship recognition

UK regulations (Companies Act 1989, FRS 2)	**EU regulations (7th Directive)**	**IASB standards (IAS 27, IFRS 3)**
	Compulsory criteria:	
A_{UK} : Majority of the voting rights	$A_{EU:}$ Majority of the voting rights	$A_{IASB:}$ Majority of the voting rights
B_{UK}: Controlling alone, pursuant to an agreement with other shareholders or members, a majority of the voting rights.	$B_{EU:}$ Controlling alone, pursuant to an agreement with other shareholders or members, a majority of the voting rights	$B_{IASB:}$ Controlling alone, pursuant to an agreement with other shareholders or members, a majority of the voting rights
C_{UK}: Having the right to appoint or remove members of the board of directors entitled to majority of the voting rights at board meetings	$C_{EU:}$ Having the right to appoint or remove members of the board of directors entitled to majority of the voting rights at board meetings.	$C_{IASB:}$ Having the right to appoint or remove majority of the members of the board of directors or having right to cast the majority of votes at board meetings.
D_{UK}: Having the right to exercise a dominant influence by ▪ virtue of provisions in a subsidiary's memorandum or articles or, ▪ virtue of a control contract	$D_{EU:}$ Having the right to exercise a dominant influence by ▪ virtue of provisions in a subsidiary's memorandum or articles or, ▪ virtue of a control contract[10]	$D_{IASB:}$ Having the right to govern the financial and operating polices by ▪ a statute or, ▪ an agreement
	E: Being an ultimate parent for all subsidiaries	
	Optional criteria	
F_{uk}: Having a 'participating interest' in a subsidiary and ▪ actually exercising a dominant influence or, ▪ managing itself and a subsidiary on unified basis	$F_{EU:}$ Having a 'participating interest' in a subsidiary and ▪ actually exercising a dominant influence or, ▪ managing itself and a subsidiary on unified basis	
	$G_{EU:}$ Having appointed the majority of the members of the governing bodies who have held office during the preceding financial year, solely as the result of a parent's voting rights (dispersed ownership)[11]	
	$H_{EU:}$ Management on a unified basis pursuant to a contract or provision in the articles or memorandum (horizontal group)	
	$I_{EU:}$ The same personnel are a majority of the boards of both companies (horizontal group)	

10. A Member State may additionally require the parent company to be a member of the subsidiary undertaking. If the control contracts or clauses mentioned in this test are in conflict with a Member State's laws this criterion does not have to be applied.

11. A Member State may require a participating interest.

and C_{IASB} refer to membership with a right to appoint directors with a majority of the voting rights at board meetings. The three versions of criteria A, B and C are consistent across the three regulatory structures of the UK, EU and IASB. The fourth compulsory control recognition criterion (D in table 1) is based on the right to exercise a dominant influence by constitution or contract. Although this criterion is present in each of the three regulatory structures a definition of "a right to exercise the dominant influence" is provided neither by EU nor IASB regulations.

The interpretation of this criterion is accordingly left to each country implementing this test for control recognition. UK statutory and regulatory provisions define the "right to exercise the dominant influence" as "a right to give directions with respect to the operating and financial policies of another undertaking with which its directors are obliged to comply whether or not they are for [its] benefit…" (Companies Act 1989, Schedule 10A 4(1); FRS 2, ASB, 1992, para 7(a)). IASB regulations additionally accompany this test by a membership requirement which is included in EU provisions as an option. It should be mentioned that a control test based on contractual dominance may have little impact in those countries where it is in conflict with the fiduciary duties of directors of a potential subsidiary. Statutory provisions in the UK subject directors to fiduciary duties and therefore this test has been assumed to have a limited impact on the UK accounting practice[12] (Pennington, 1990; Nobes, 1993a; Davis *et al*., 1994; and Taylor, 1996).

Compulsory criterion E, being an ultimate parent for all subsidiaries, is common under the three regulatory structures and recognises control through a vertical chain of subsidiaries so that sub-subsidiaries would be treated as subsidiaries of an ultimate parent (Companies Act 1989, s 258 (5); and ASB, 1992, paragraph 14 (f)).

12. Davis *et al*. (1992) and Edwards (1999) suggested that this provision would probably only be relevant where the parent has a German subsidiary undertaking or is in a country where German style legal provisions are in force. Germany has been the only EU Member State where this type of "control contract" *(Beherrschungsvertrag)* has existed, under which one undertaking gives all responsibility for management to another undertaking which may direct the former's affairs in its own interest.

Criterion F relates to the situation of having a participating interest and actual exercise of dominant influence or unified management. This is an optional criterion under EU provisions and was implemented voluntarily by UK legislation. This test is not addressed in the IASB regulations. A "participating interest" here means an interest held on a long term basis for the purpose of securing a contribution to a potential subsidiary's activities by the exercise of control or influence arising from or related to that interest. A holding of 20% of equity is presumed to be a participating interest unless rebutted (EU Fourth Directive, 1978, paragraph 17). It is important to note that smaller holdings could also constitute a participating interest. Nobes (1993a, p. 234) points out that the reason for requiring such an interest to be present is to prevent a strong commercial relationship (such as that of a supplier, customer or lender) alone leading to consolidation. In the case of the participating interest the *right* to exercise a dominant influence is not sufficient and the actual exercise of dominant influence is required. Again, the concepts of "dominant influence" and "managed on a unified basis" are not defined in EU provisions and have been left for Member States to determine. In the UK the expression "managed on a unified basis" is interpreted by FRS 2 to mean that:

" … the whole of the operations of the undertakings are integrated and they are managed as a single unit. Unified management does not arise solely because one undertaking manages another. The operations…[must be] integrated.", ASB, 1992, paragraph 74)

The EU Seventh Directive contains additional optional provisions which have not been incorporated into the UK regulations and which also are not mentioned in the IASB standards. One of these provisions, G_{EU} in table 1, identifies a parent-subsidiary relationship where the parent undertaking has appointed board members with a majority of votes, solely as a result of its own voting rights (Council of the EC, 1983, Article 1aa). This option caters for cases where shareholdings may be widely dispersed and where a minority holding could exercise *de facto* control. Such control would be achieved without an explicit, legally binding agreement and would rely on cooperation with other shareholders, either by their passive allegiance (transferring proxies) or

their disinterest in decision-making (for example in the case of small investors). In practice these arrangements are fluid and lack long-term certainty and this has been a reason suggested for this criterion not having been implemented into either UK regulations or IASB provisions (Nobes, 1993; Davies *et al*., 1994; and Taylor, 1996). The Directive mentions two further ways in which groups can be established (Council of the EC, 1983, Article 12). It is recognised that undertakings can be managed on a unified basis under a contract or clauses in their corporate statutes (criterion H_{EU} in table 1) or have interlocking directorships (criterion I_{EU} in table 1). These two criteria provide for consolidation in the case of so-called horizontal groups with no link of share ownership (Arthur Andersen, 1983; McKinnon, 1984; and Pennington, 1990). These conditions are based heavily on the German practice of consolidating subsidiaries subject to central and unified management and have been criticised as being too subjective (Nobes, 1990, 1993a).

The issue of the inclusion of controlled non-subsidiaries in consolidated financial statements through direct reference to definition of control is addressed within UK domestically originating regulations in FRS 5 *Reporting the Substance of Transactions* (ASB, 1994), and in SIC 12 *Consolidation – Special Purpose Entities* (IASB, 1999) within IASB regulations. Both regulations agree that an entity should be consolidated when the substance of the relationship between another enterprise and the entity indicates that it is controlled by that enterprise" (ASB 1994, FRS 5, paragraph 100 and IASB 1999, SIC-12, paragraph 8). FRS 5 and SIC 12 provide indicators of when *de facto* control exists which are based mainly on the ability to obtain the majority of benefits and the exposure to risks inherent in these benefits (ASB 1994, paragraph 32, and IASB 1999, paragraph 10). The ability to direct the financial and operating policies of another entity is the most common way to guarantee the benefits' flow from its activities. However, in many cases, arrangements may be made for allocating the benefits such that the active exercise of control is not necessary (ASB 1994, paragraph 98, and IASB 1999, paragraph 9). For example, the party who will gain the benefits might be irreversibly specified in advance as being different to the one systematically directing the policies of the quasi-subsidiary (ie, in so-called auto-pilot vehicles). The phenomenon that directing the policies of another entity is not necessary to establish effective control is a common reason why the existence of control has not been captured by legal criteria. FRS 5 includes application notes which give guidance on the accounting treatment of complex transactions where the location of control is difficult to determine. They seek to assist in judgements on whether a party to a transaction is controlled by another enterprise and thus should be consolidated. The standard mentions five types of complex transactions in this regard: (a) consignment stock transactions; (b) sale and repurchase agreements; (c) factoring of debts; (d) securitisation of assets; and (e) loan transfers.

The forgoing discussion highlights differences in the coverage and detail of the UK and IASB regulations governing the concept of control used for consolidated accounts. Generally IASB regulations (how they are at the moment) embrace the least number of circumstances under which recognition of control can occur and do not cover any of the optional criteria provided by EU regulations. All of its control tests require existence of the shareholding in order to justify the recognition of control. Similar differences can be expected in other EU Member States. The presence of such differences in this regulatory space[13] presents obvious problems for GAAP and regulatory enforcement in jurisdictions where IFRSs apply and where domestic and other regulations co-exist. The significance of such differences will depend in part on how the IASB regulations develop and it is to this that we now turn.

7. The Further Development of IASB Regulations

In an earlier section of the paper we referred to the IASB's project *Consolidation (Including Special Purpose Entities)* and we shall now consider this project in more detail. This section of the paper provides an overview of the IASB's deliberations to date on the Consolidation project with regard to changes in the regulatory interpretation of the concept of control. A main focus of the project has been

13. Using the term "regulatory space" in the sense of **Young (1994).**

TABLE 2. Summaries of topics discussed to date by the IASB on the Consolidation Project.

Board meeting	Topic
July 2002	Initial discussion of control as basis for consolidation of all entities including consideration of principles for consolidation of SPEs; principal objectives of consolidation
October 2002	Discussion of basis for consolidation of SPEs
June 2003	Project plan discussed
September 2003	Detailed discussion of the concept of control as basis for consolidation for entities generally, without considering SPEs in particular; consideration of three criteria of control: Power, Benefit and Link Criterion
December 2003	Initial discussion of whether the concept of control discussed at the September 2003 meeting can be applied to a particular subset of SPEs[14]
February 2004	Discussion of the relevance of potential voting rights to the current assessment of Power Criterion; discussion of how the holdings of an entity's de facto agents should be treated in assessing whether an entity meets the Power Criterion
March 2004	Further discussion of the circumstances when an entity satisfies the control criteria
May 2004	Initial discussion of distinction between fiduciaries and controllers, and discussion of the assessment of control criteria in the funds management industry
November 2004	Project plan revised

Source: IASB, Projects in Progress (www.iasb.org/current)

to develop a comprehensive definition of control that could be used as the basis for consolidation by all entities. The Board initially intended that the output from the project would be a single IFRS on consolidation of all controlled entities, both subsidiaries and controlled non-subsidiaries (labelled within IASB regulations as Special Purpose Entities).

At the time of writing there have been nine meetings of the Board since July 2002 when the project was initiated. Table 2 gives the dates of these meetings and briefly summarises topics discussed at them.

At the first meeting in July 2002 the Board made a tentative decision that control should be the decisive factor for consolidation of all entities including SPEs. Additionally, the Board agreed that an entity's control of another entity should be used as a "shortcut" or "surrogate" to identify the underlying assets controlled by the first entity. It was suggested that only an entity able to determine how assets are employed and how related future benefits are deployed, so as to benefit that entity, controls those assets.

At the subsequent meeting, in October 2002, the Board tentatively agreed that criteria for consolidating SPEs should be consistent with the criteria for consolidating subsidiaries. Additionally, the Board made the following initial decisions:

- in the absence of an ability to determine the policy of an SPE, control would need to be assessed by other means;
- the holder of those interests in an SPE exposed to the majority of variability of expected outcomes is most like that of a majority ordinary shareholder in a non-SPE; it was tentatively agreed that such holders should consolidate an SPE.

At the September 2003 meeting, the concept of control to be used to determine the scope of consolidation was discussed in more detail. The follow up to these discussions was conducted at the meeting in March 2004 (refer to Table 2). Deliberations

14. This subset of SPEs refers to a narrow range of entities, being those whose policies are so extensively predetermined that the remaining policies cannot be described as those entities' strategic operating and financing policies.

at these two meetings addressed control of entities generally, without considering SPEs in particular. The Board tentatively agreed that the control of an entity is "the ability to direct the strategic financing and operating policies of an entity so as to access benefits flowing from the entity and increase, maintain or protect the amount of those benefits" (IASB, Consolidation Project Summary, paragraph 8) Therefore, the concept of control should require satisfaction of three criteria: Power, Benefit and Link Criteria.

With regard to the Power Criterion, it was agreed that a controller must have a non-shared (or unilateral) ability to direct strategic operating and financing policy of another entity. It was also tentatively agreed that a controller may gain this ability directly or indirectly through agents that will vote or act at the controller's direction. Additionally, it was also established that a controller would satisfy the Power Criterion when it has the *ability* to control, even if it elects not to exercise that power or has delegated (but not transferred) its power to another party, or even if it has a history of not utilising, or has no intension of utilising, its ability. The Board has also tentatively agreed that economic dependence (such as that of a supplier, customer or lender) would not normally, of itself, satisfy the Power Criterion. However, assessing control in such circumstances can be difficult. The Board therefore intends to consider this issue further. The use of the word "normally" and the stated intension of further consideration of the issue leave the possibility, under certain circumstances, of embracing economic dependence by the concept of control promoted by IASB regulations. This is in contrast to UK domestic regulations and EU regulations which explicitly state that economic dependence cannot, under any circumstances, lead to control.

The Benefit Criterion, is based on the ability to access benefits and it was agreed that such an ability is sufficient to satisfy this criterion even if benefits have been not received. The Board emphasised that the types of benefits not be restricted to those flowing from a residual ownership interest or those in the nature of a residual or ownership benefit. For example, benefits may include:

- establishing policies that result in the controller realising revenue enhancements or cost savings;
- sourcing scarce products;
- gaining access to proprietary knowledge;
- combining functions to achieve economies of scale

It was also decided that benefits need not flow from the controlled entity directly, but may arise in combination with other assets. For example, a controller may benefit from a wholly owned subsidiary with an unutilised next-generation patent by excluding competitors' access to the patent and protecting the controller's market share.

The Link Criterion is based on the ability to use power so as to increase, protect and maintain benefits flowing from another entity. This criterion is a connecting element between the two criteria already discussed and is intended primarily to assist in distinguishing fiduciaries from controllers. A fiduciary with broad delegated power may have apparent power to determine policy and an ability to benefit through the receipt of fees. However, a fiduciary can be distinguished from a controller as it has a duty to use its power to benefit its principal rather than itself.

It was emphasised by the Board that the existence of control through fulfilling these three criteria is a judgmental assessment based on the circumstances of each case. The Board agreed that irrespective of the form of control, if the control criteria are satisfied consolidation should be required. In other words, effective control (being the ability in practice to control in the absence of legal control) is a sufficient basis for consolidation. This includes control by an entity holding less than a majority voting interest in another entity when the balance of voting interest is widely dispersed. Non-consolidation should not be permitted merely because dispersed investors could coalesce in future. An important difference between *legal* and *effective* control in this case is that a minority holder can lose the ability to exert dominance as a result of circumstances beyond his control. For example, the typical number of shareholders who actually vote at a meeting may increase due to poor performance of the investee or as a result of a change in the identity of shareholders; a new shareholder may acquire a controlling stake in the company and outvote the minority; or a proxy fight could be initiated, effectively organising the votes of dispersed shareholders against the mi-

nority shareholder such that the policies proposed by him are no longer implemented. This contrasts with legal control, which is permanent as long as ownership of shares is retained or a legally binding agreement with other shareholders or members exists (see criteria A and B in Table 1). These deliberations cater for an option included in the EU control criteria (but not covered either by UK domestic regulations or existing IASB tests) which refers to the situation of a dispersed ownership (see criterion G in Table 1). It was also agreed that current control, even if of uncertain duration, is sufficient to justify consolidation. The Board has tentatively concluded that the fact that control of an entity might be temporary does not of itself change the assets controlled by an entity. During the time that control is held and until such time as control ceases, the controlled assets are part of the economic entity and should be recognised as such. Furthermore, it was emphasised that a controller need not have a minimum level of ownership. We may also note the Board's view that a minority shareholder that has been able to dominate strategic policy determination can satisfy control criteria if the balance of holdings is dispersed or disorganised, but not if the balance of holdings is held by a passive majority shareholder. Finally, the Board also confirmed that control might arise through contract.

At the meeting in December 2003 the Board considered whether the concept of control agreed in September 2003 could be applied to a particular narrow subset of SPEs with policies so extensively predetermined that the remaining policies cannot be described as that entity's "strategic and operating policies". In effect these are entities whose policies are determined to a degree that precludes any action that would alter that entity's performance. The Board believed this subset might require separate consideration in the Consolidation Project. However, the control concept agreed at the September 2003 meeting should be applicable to all other entities including those SPEs outside the subset discussed. The Board agreed that for the subset of SPEs discussed, the party responsible for predetermining the SPEs strategic operating and financing policies satisfies the Power Criterion and is likely to be that SPE's controller. The Board noted that identifying the party ultimately responsible for policy determination would be a question of substance. The indicators, such as the risk exposure and whether the SPE's activities further the party's business purposes, might assist in identifying the party ultimately responsible for an SPE's predetermined policies. Participants in an entity in the subset of SPEs discussed who obtain their interests after the SPE's policies have been determined, although able to control their particular interests in the SPEs, are unable to determine how that SPE's assets are employed or how the future benefits on those assets are deployed. Therefore, such participants may be unable to control that SPE's assets. Additionally, while parties exposed to an entity's residual risks usually require control of that entity to protect their risk position causing risk and risks to be correlated, investors exposed to fluctuations in an SPE's performance do not have the same motivation to control an SPE if they choose to rely on its predetermined strategic operating and financial policy. The above suggested that participants in such SPEs that have not predetermined the SPE's strategic operating and financing policy, and that have no capacity to change such policies, should only recognise their interests in the SPE rather than consolidating the SPE.

The Board meeting held in February 2004 considered the role of potential voting rights and rights held by an entity's agents (termed "strawmen") when assessing the satisfaction of the Power Criterion. The Board tentatively agreed that a holder of potential voting rights (such as unexercised but currently exercisable[15] holdings of options or convertible securities) should be relevant to the assessment of current control[16]. For example, if Entity A has a 100% ownership interest in Entity B, but Entity C holds currently exercisable options over all of the equity instruments in B, then C rather than A would, in the absence of other factors, satisfy the Power Criterion in relation to B. However, if the holder of potential voting rights would not have the ability to dominate policy determination following exercise of these rights than he does not satisfy Power Criterion even if that exercise would result in currently

15. That is, the right to exercise or convert is not contingent on the passage of time or the occurrence of a future event.
16. This decision is consistent with the IASB Standing Interpretation Committee Interpretation 33 *Consolidation and Equity Method – Potential Voting Rights and Allocation of Ownership Interests* (IASB, 2002). However, the Interpretation has been recently withdrawn.

controlling entity having no assurance of sustaining the controlling influence. In other words, the Board agreed that although that currently controlling entity may not be assured of a continued ability to dominate policy determination, it has a present ability to dominate policy determination and the third party with potential voting rights would be unable to dominate, so that entity should satisfy the Power Criterion. However, the situation would not be so if the third party with potential voting rights could, following the exercise of these rights, dominate policy determination. The Board has also tentatively concluded that whether or not exercise of potential voting rights is economically favourable to the holder of those rights is not relevant to the assessment of whether the Power Criterion is satisfied. The wide inclusion of potential voting rights in determination of controlling interest promotes broader concept of control in comparison to UK regulations . It should be noted that in case of the UK statutory provisions and accounting standards potential voting rights are taken into consideration only with reference to the participating interest.

Additionally, during the February meeting it was tentatively concluded that the holdings or interests of parties effectively acting as agent for another entity should be considered in assessing whether that other entity is a controller. For example:

- A minority equity holder has a 40 % voting interest in an entity, but an investment bank with which the minority has a close business relationship holds a 12 % voting interest. In addition, the minority may have assurance that the voting of the investment bank will always be aligned with its own, ensuring that the minority holder cannot be outvoted.
- An entity has a 45 % voting interest in another entity, but officers of the shareholding entity hold a 10 % voting interest in that other entity such that the shareholding entity is assured that, collectively, it will be able to dominate decision-making.

The Board had tentatively decided that a future Exposure Draft should include the rebuttable presumption that the holdings of the following parties should be regarded as available to a potential controller:

- the potential controller's related parties as defined in IAS 24, *Related Party Transactions*;
- an entity that received its interest in the investee as a contribution or loan from the potential controller;
- an entity that has an agreement that it cannot sell, transfer, or encumber its interest in the investee without the prior approval of the potential controller;
- an entity that cannot finance its operations without financial support from the potential controller;
- senior managers of the potential controller, but only to the extent that they are highly likely to be dominated by the potential controller;
- an entity that has a close business relationship with the potential controller (like that between a professional service provider and one of its significant clients), but only to the extent that the party is highly likely to be dominated by the potential controller. This is not intended to include "standard" business relationships such as those between a customer and its suppliers;
- an entity with the same board of directors as the potential controller.

At the May 2004 meeting the Board discussed in more detail issues of distinguishing fiduciaries from controllers. A fiduciary relationship exists when one party (the fiduciary) is required to work for the benefit of one or more other parties to who it owns fiduciary responsibilities under common law, equitable principles, contract, statute or regulation. This task of differentiating between fiduciaries and controllers might be quite complex when a fiduciary is entitled to a performance-linked fee (e.g. fund managers). The Board agreed that such a fee structure does not result in the satisfaction of the Power Criterion as a party receiving such a fee is able to benefit only as a consequence of using its power to benefit its principal. In particular, a potential controller should be regarded as failing the control test when the effect of its obligation to another party is that:

- it fulfils the Power Criterion (ie its role enables it to determine another entity's strategic financing and operating policies) but is explicitly required by agreement or at law to use that Power for the benefit of third parties; and
- its ability to benefit from the assets over which it has Power (in the sense of the Power Criterion)

is restricted in that it is not able to deal with the assets as if they were its own, and its entitlement to benefits must be agreed between itself and the third parties in whose interest it must act, with those benefits in effect limited to a fee for services provided.

According to the Board, in the above circumstances the entity would be unable to meet the second and third tests of control (Benefit and Link Criteria).

During its meeting in November 2004 the Board considered the state of its deliberations thus far and their implications for the planned timetable for the publication of a single IFRS on consolidation to replace IAS 27 *Consolidated and Separate Financial Statements* and SIC-12 *Consolidation – Special Purpose Entities*, which was at that time scheduled for issue in the second quarter of 2006. The Board considered whether it should publish in the near term (meaning at that time mid-2005) an Exposure Draft of proposed amendments to IAS 27 before embarking on its deliberations on how the principles developed in the project should apply to SPEs. The purpose of such an Exposure Draft would be to incorporate into IAS 27, sooner rather than later, the considerable material and guidance which the Board had so far developed on the concept of control as it would apply generally. The incorporation of this material into standard would have, according to the Board, significantly strengthened the regulation through broadening the concept of control. However, the recent Exposure Draft *Proposed Amendments to IAS 27 Consolidated and Separate Financial Statements*, issued by IASB in June 2005, does not include any changes to the interpretation of the concept of control. The changes covered by the Exposure Draft reflect proposals arising from the Board's *Business Combinations* Project and are mainly relevant to accounting for minority interests (to be renamed non-controlling interests). Thus, after a considerable passage of time, the Board has decided to continue deliberations on the project and produce the complete exposure draft which would apply to both subsidiaries and SPEs.

8. Conclusions

The process of shaping the concept of control to be used for consolidated accounts by IFRSs is not yet complete and special attention should be given to issues emerging on this concept as it will supersede statutory and regulatory provisions used in the UK.

Generally, the concept of control as emerging through IASB recent deliberations is more comprehensive (in comparison to the UK as well as already existing IASB provisions) covering a wider range of circumstances that would appropriate the regulatory recognition of control. Firstly, the fixed set of control tests got replaced by three general criteria based directly on the discussion of control, namely Power, Benefit and Link criterion. This change might be associated with a fact that the aim of the new regulatory developments is to cover consolidation of both subsidiaries as well as SPEs.

The new concept of control covers additionally control of uncertain duration under the assumption that the fact that control of an entity might be temporary does not of itself change the assets controlled by an entity. These deliberations justify recognition of control when it occurs due to dispersed ownership or when currently controlling entity may not be assured of a continued ability to dominate policy determination due to the third party with potential voting rights (provided the third party would not be able to have controlling stake after exercising its holdings). At the same time, the inclusion of potential voting rights while determining controlling influence widens the concept of control promoted by the UK regulations that consider such rights only when estimating participating interest. Finally, the possibility of consideration of economic dominance as one of the circumstance appropriating recognition of control is also an evidence of broadening of the regulatory concept of control.

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Hedging and Taking Risk: On the Role of Derivatives and Stock Options*

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Mikiharu Noma**

Abstract – This paper empirically examines the relation between the use of derivatives and the risk level of firms in a sample of 431 large Japanese nonfinancial firms. Previous studies investigating whether firms systematically reduce or increase their risk with derivatives show that firms reduce their risk. By contrast, this paper shows that the use of derivatives increases total risk and firm-specific risk. However, the magnitude of the increase is not economically significant. Further analysis provides some evidence on the association between derivatives and stock options. The results show that there is a positive relation between the use of derivatives and stock options. In addition, firms introducing stock options invest in R&D activities to a greater extent than firms that do not introduce stock options. These findings suggest that Japanese firms use derivatives to hedge homogeneous risk and adopt stock option compensation to take core-business risk.

JEL Classification: G1, G3, G32, M41.

Keywords: Derivatives; Hedging; Risk Management; Stock Options; R&D

1. Introduction

In the corporate finance literature, the empirical research on risk management by using derivatives has focused on three questions[1]. First, a large body of empirical derivatives research explores why firms use derivatives to hedge. In other words, the studies on this topic examine the incentive to hedge using financial derivatives (Tufano(1996), Geczy, Minton and Schrand(1997), Schrand and Unal(1998) and Goldberg, Godwin, Kim and Tritschler(1998)). For example, Turano(1996) finds that firms in the gold mining industry use derivatives to hedge because of managerial and owner risk aversion. As well, Geczy, Minton and Schrand(1997) examine currency hedging activities for a sample of Fortune 500 firms and show that firm's use of currency derivatives is positively related to growth opportunity.

Second, some studies investigate how firms use financial derivatives. Petersen and Thiagarajan(2000) show that the risk hedging method depends on the ability to adjust operating costs. Barton(2001) and Noma(2001,a) find that firms use derivatives and discretionary accruals as partial substitutes to smooth earnings. Also, Adam(2006) analyzes the use of options strategies in the North American gold

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** Graduate School of International Corporate Strategy, Hitotsubashi University, Japan

1. According to the classical Modigliani and Miller paradigm, risk management does not affect firm value. Further, it is not irrelevant to the firm, because equity holders are capable to hedge on their own. Some studies suggest that hedging activity increases firm value. For example, Smith and Stulz(1985) argue that risk management increases firm value for three reasons: (1) taxes, (2) cost of financial distress, and (3) managerial risk aversion. Also, Froot, Schafsteina and Stein(1993) argue that if capital market imperfections make externally obtained funds more expensive than those generated internally, they can generate a rationale for risk management.

mining industry. He finds that firm with large investment programs and firms which focus on gold mining activities use options extensively.

Third, several recent studies examine the net consequence of the use of derivatives on firm risk. Guay(1999) finds that firm risk declines following the use of derivatives. Hentschel and Kothari(2001) investigate whether the use of derivatives is related to the overall stock return risk. They find that there is no association between the volatility of a firm's stock prices and the size of its derivatives position. Guay and Kothari(2003) report the magnitude of risk exposure hedged by financial derivatives for 234 large nonfinancial corporations. They conclude that the use of corporate derivatives appears to be a small component of the overall risk profile of nonfinancial firms. For Japanese firms, Noma(2001,b) and Konishi, Shimizu and Yasuda(2003) investigate whether firms systematically reduce or increase their risk with derivatives. Although numerous attempts have been made to study whether the use of derivatives decrease firm risk, it is still controversial.

The primary objectives of this paper are as follows: (1) to empirically explore how the use of derivatives affects firm risk and (2) to investigate the relation between the use of derivatives and risk-taking activities, for a sample of 431 Japanese nonfinancial firms.

Our main results show that the use of derivatives increases total risk and firm-specific risk. The results are noteworthy because most of the sample firms use derivatives to hedge. One plausible explanation is coordinated risk management proposed by Schrand and Unal(1998). They define "the approach of simultaneously increasing core-business risk and decreasing homogeneous risk to achieve or maintain a target total risk level as coordinated risk management". In order to explore whether Japanese firms hedge homogeneous risk and take core-business risk, this paper examines the relation between derivatives and risk-taking activities. The results show that firms that introduce stock options use derivatives and invest in R&D to a greater extent than firms that do not introduce stock options. These results suggest that Japanese firms hedge homogeneous risk and take core-business risk. For this reason, the use of derivatives increases total risk and firm-specific risk.

The remainder of the paper is organized as follows. Section 2 presents the sample. Section 3.1 describes the research methodology used to examine the association between derivatives and risk. Section 3.2 presents the summary statistics. Section 3.3 shows that the use of derivatives increases firm risk. Section 3.4 shows that there is a positive relation between derivatives and risk-taking activities, and Section 4 concludes this study.

2. Sample Selection

The empirical tests are conducted using Japanese firms listed on the first section of the Tokyo Stock Exchange. In this paper, we use the consolidated financial statements[2] for the fiscal year ending March 2000 for two reasons.

First, before the fiscal year ending March 2000, Japanese GAAP required firms to disclose information about derivatives on the parent-only financial statements. Since firms use derivatives on a consolidated basis, it is inappropriate to use the financial data of the periods before the fiscal year ending March 2000 to examine whether the use of derivatives increases or reduces firm risk.

Second, after the fiscal year ending March 2001, Japanese GAAP does not require firms to disclose information about derivatives when firms adopt hedge accounting[3]. This accounting treatment allows firms to not disclose information about derivatives by adopting hedge accounting. Consequently, the information that is relevant for our analysis is available for only one year.

As a basis for the Nikkei sector classification, this paper covers nine business sectors: fabric, chemical engineering, petroleum, iron and steel, nonferrous metal and metal manufacture, machinery, electric equipment, automobile and auto parts, and precision apparatus. These sectors include firms that are representative of all Japanese firms. All financial information is obtained from the Active Management

2. Japanese firms report not only parent-only but also consolidated financial statements.
3. In contrast, International Accounting Standards Board and Financial Accounting Standards Board require disclosure of derivative information whether firms adopt hedge accounting. See, for example, Statement of Financial Accounting Standards No.133, *Accounting for Derivative Instruments and Hedging Activities*.

Support System (AMSUS) supplied by Quick Corp. In addition, this paper excludes firms whose shares are not traded for more than 75 days in a year. This selection process yields 431 firms.

3. Empirical Analysis

3.1 Methodology

To examine the relation between the use of derivatives and firm risk, this paper runs the following OLS regression using pooled cross-section data:

$$\sum^{k} i \times n \qquad (1)$$

In equation (1), Risk is the measure for the level of firm risk. Following Konishi, Shimizu and Yasuda(2003), this paper uses six alternative risk measures: total risk, firm-specific risk, systematic risk, market risk, interest rate risk, and foreign exchange rate risk. Total risk is defined as the standard deviation of a firm's daily stock returns for each fiscal year measured in percentage points. To estimate the other risk measures, this paper uses the following three-index model as a return-generating process:

$$R_{i,t} = \beta_0 + \beta_1 R_{M,t} + \beta_2 R_{I,t} + \beta_3 R_{E,t} + e_{i,t} \qquad (2)$$

In equation (2), $R_{i,t}$ and $R_{M,t}$ are the daily stock returns of the firm's stock and the market at date t, respectively. We use TOPIX (Tokyo Stock Exchange value-weighted stock price index) as market portfolio. Also, $R_{I,t}$ is the daily change in the ten-year Japanese government bond yield at date t; and $R_{E,t}$ is the daily change in the U.S. dollar/yen exchange rate at date t. We define firm-specific risk as the standard deviation of the residual of equation (2) for firm year. Systematic risk is measured as the difference between total risk and firm-specific risk. The estimated β_1 is market risk, the estimated β_2 is interest rate risk, and the estimated β_3 is foreign exchange rate risk.

This paper defines the independent variables of equation (1) as follows.

Derivative is the aggregate notional value of all reported derivatives contracts deflated by the sum of the book value of liabilities and the market value of equity[4]. Size is the natural logarithm of the market value of equity at the beginning of the year for which derivative holdings information is collected. Leverage is the ratio of the book value of liabilities to the market value of equity plus the book value of debt, where all variables are measured at the beginning of the year. B/M is the book value of assets divided by the market value of equity plus the book value of debt, where all variables are measured at the beginning of the year.

3.2 Use of Derivatives by the Sample Firms

Of the 431 firms, 273 use derivatives. In other words, 158 firms do not use derivatives. Among these 273 firms, only one firm uses derivatives not only to hedge risk but also to speculate. The remaining 272 firms use derivatives to hedge risk.

Table 1 shows the descriptive statistics of the outstanding contract amounts for firms that use derivatives. The outstanding contract amounts are measured in million yen. The sample comprises 273 firms that use derivatives. Table 1 shows that Japanese firms use mostly currency or interest rate derivatives. Japanese firms' average notional amount of currency (interest rate) derivatives is 34,706 (48,682) in million yen. In contrast, Japanese firms seldom use equity, bond, commodity, or other derivatives.

Panel A (Panel B) of Table 2 provides the basic financial statistics of all firms (derivative users). Panel B shows that the aggregate notional amount of derivatives held by derivative users averages 10% of assets. However, the median notional amount of derivatives is only 2%. Hentschel and Kothari(2001) report that the average (mean) notional amount of derivatives held by U.S. nonfinancial firms is 12% (5%) of assets. Consequently, Japanese nonfinancial firms use derivatives to a slightly smaller extent than U.S. nonfirnancial firms.

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4. Triki(2005) discusses four measures proposed in the literature for corporate hedging: (1) the dummy variable indicating derivative usage, (2) the gross notional value of derivatives contracts, (3) the net notional value of derivatives, and (4) the delta percentage. This paper uses the gross notional value for three reasons. First, a dummy variable captures information only about the decision to hedge. Second, the net notional value of derivatives does not discriminate between different derivatives contracts. Third, to calculate the delta requires detailed data relating to derivatives activities and financing operation.

TABLE 1. Descriptive Statistics on Derivative Positions for Derivative Users.

(in million yen)

	mean	median	Q1	Q3	standard deviation
Currency	34,706	321	0	5,819	167,785
Interest Rate	48,682	3,343	180	18,995	291,429
Equity	4	0	0	0	61
Bond	376	0	0	0	6,208
Commodity	490	0	0	0	3,297
Other	51	0	0	0	604

Table 1 shows the descriptive statistics of the outstanding contract amounts in each derivative category. The outstanding contract amounts are measured in million yen. The sample comprises 273 firms that use derivatives.

3.3 Relation between Derivatives and Risk

Table 3 provides the empirical results when Derivative is defined as the aggregate notional amount of all derivatives. Panel A and Panel B indicate the results for all firms and derivative users respectively. The empirical results for the specification wherein the dependent variable is total risk or firm-specific risk show that the coefficient of Derivative is statistically significantly positive. The results reveal that the use of derivatives increases firm risk although firms use derivatives to hedge. Specifically, these regression results suggest that Japanese nonfinancial firm that increase its derivative holdings by 1% of total firm asset would –*ceteris paribus*– raise the total risk and firm-specific risk by approximately 0.16-0.17%. That is to say, if a firm were increase its derivatives holdings from zero to the sample average of 10% of assets, one would expect to raise its total risk and firm-specific risk by about 1.6-1.7%.

For the specification wherein the dependent variable is total risk or firm-specific risk, the coefficient of Size is negative and significant, and the coefficients of Leverage and B/M are positive and statistically significant.

Further, the empirical results for the specification wherein the dependent variable is systematic risk or market risk show that the coefficient of Derivative is not statistically significant. With regard to the control variables, the coefficients are not statistically significant.

Table 4 presents the regression results for the specification wherein the dependent variable is the sensitivity of stock returns to the daily change in interest rates for firms that use interest rate derivatives. Column 2 of Table 4 shows the regression results when Derivative is defined as the aggregate notional amount of all derivatives. On the other hand, column 3 presents the regression results when Derivative is defined as the aggregate notional amount of interest rate derivatives. This table shows that there is no evidence that derivatives increase or reduce interest rate risk. Also the coefficients of Size, Leverage and B/M are not statistically significant.

Table 5 presents the regression results for the specification wherein the dependent variable is the sensitivity of stock returns to the foreign exchange rate index for firms that use foreign exchange rate derivatives. Column 2 of Table 5 shows the regression results when Derivative is defined as the aggregate notional amount of all derivatives. In contrast, column 3 indicates the regression results when Derivative is defined as the aggregate notional amount of foreign exchange derivatives. This table shows that there is no evidence that derivatives increase or reduce foreign exchange rate risk. In addition, the coefficients of Size, Leverage and B/M are not statistically significant.

Given that firm use derivative to hedge, the regression results suggesting that derivatives may increase firm risk are noteworthy. Additionally, risk management theory depends on incentives to reduce firm risk (Smith and Stulz(1985) and Froot, Scharfstein and Stein(1993)). Furthermore, according to previous researches examining whether derivatives

TABLE 2. Descriptive Statistics.

Panel A: All Firms (n = 431)

	mean	median	Q1	Q3	standard deviation
Total risk	3.44	3.40	2.90	3.81	0.75
Firm-specific risk	3.33	3.25	2.79	3.73	0.74
Systematic risk	0.12	0.07	0.04	0.15	0.13
Market risk	0.55	0.48	0.33	0.72	0.33
Interest rate risk	–0.46	–0.64	–1.56	0.48	1.87
Foreign exchange risk	0.14	0.13	–0.07	0.32	0.31
Derivative	0.06	0.01	0.00	0.03	0.43
Derivative (Interest rate)	0.04	0.00	0.00	0.00	0.43
Derivative (Currency)	0.02	0.00	0.00	0.02	0.08
Size	5.14	5.05	4.71	5.47	0.58
Leverage	0.57	0.59	0.44	0.72	0.21
B/M	0.38	0.23	0.15	0.41	0.47

Panel B: Derivative Users (n = 273)

	mean	median	Q1	Q3	standard deviation
Total risk	3.41	3.42	2.92	3.77	0.68
Firm-specific risk	3.30	3.27	2.79	3.69	0.68
Systematic risk	0.11	0.08	0.04	0.14	0.11
Market risk	0.55	0.51	0.35	0.70	0.31
Interest rate risk	–0.52	–0.69	–1.54	0.36	1.80
Foreign exchange risk	0.12	0.13	–0.05	0.31	0.29
Derivative	0.10	0.02	0.01	0.05	0.54
Derivative (Interest rate)	0.07	0.00	0.00	0.01	0.53
Derivative (Currency)	0.03	0.01	0.00	0.04	0.09
Size	5.33	5.25	4.88	5.72	0.60
Leverage	0.63	0.63	0.51	0.75	0.18
B/M	0.33	0.21	0.14	0.36	0.40

Total risk is measured as the standard deviation of a firm's stock returns for each fiscal year measured in percentage point. To estimate, firm-specific risk, systematic risk and market risk, we use the following three-index model as return-generating process, i.e.,

$$R_{i,t} = \beta_0 + \beta_1 R_{M,t} + \beta_2 R_{I,t} + \beta_3 R_{E,t} + e_{i,t} \ .$$

Firm specific risk is measured as the standard deviation of the residual of this equation for firm year. Systematic risk is measured as the difference between total risk and firm-specific risk. Market risk is the estimated β_1. Interest rate risk is the estimated β_2. Foreign exchange risk is the estimated β_3. Derivative is the aggregate notional value of all reported derivatives contracts deflated by the sum of the book value of liabilities and the market value of equity. Derivative (Interest rate) is the aggregate notional value of derivatives contracts whose underlying asset is related to interest rate deflated by the sum of the book value of liabilities and the market value of equity. Derivative (Currency) is the aggregate notional value of derivatives contracts whose underlying asset is related to currency deflated by the sum of the book value of liabilities and the market value of equity. Size is the natural logarithm of the market value of equity at the beginning of the year for which derivative holdings information is collected. Leverage is the ratio of the book value of liabilities to the market value of equity plus the book value of debt, where all variables are measured at the beginning of the year. B/M is the book value of assets divided by the market value of equity plus the book value of debt, where all variables are measured at the beginning of the year.

TABLE 3. Derivatives use and firm risk: cross-section results.

Panel A: All Firms (n = 431)

	Total Risk	Firm-Specific Risk	Systematic Risk	Market Risk
Variables	Coefficient	Coefficient	Coefficient	Coefficient
Intercept	5.109	5.324	–0.214	–0.131
	(17.46)***	(18.66)***	(–4.60)***	(–1.04)
Derivative	0.160	0.161	–0.001	0.010
	(2.14)**	(2.21)**	(–0.12)	(0.31)
Size	–0.510	–0.565	0.055	0.103
	(–8.97)***	(–10.18)***	(6.03)***	(4.19)***
Leverage	1.359	1.357	0.001	0.050
	(7.29)***	(7.47)***	(0.04)	(0.62)
B/M	0.440	0.305	0.135	0.337
	(5.36)***	(3.82)***	(10.33)***	(9.55)***
Adjusted R^2	0.21	0.24	0.30	0.24
No. of Obs.	431	431	431	431

Panel B: Derivative Users (n = 273)

	Total Risk	Firm-Specific Risk	Systematic Risk	Market Risk
Variables	Coefficient	Coefficient	Coefficient	Coefficient
Intercept	4.701	4.963	–0.263	–0.296
	(13.10)***	(14.09)***	(–4.47)***	(–1.84)
Derivative	0.170	0.166	0.004	0.019
	(2.42)**	(2.41)**	(0.32)	(0.61)
Size	–0.409	–0.472	0.064	0.128
	(–6.34)***	(–7.47)***	(6.04)***	(4.43)***
Leverage	1.193	1.186	0.007	0.099
	(4.60)***	(4.66)***	(0.15)	(0.85)
B/M	0.382	0.285	0.097	0.295
	(3.20)***	(2.43)**	(4.97)***	(5.51)***
Adjusted R^2	0.18	0.21	0.21	0.18
No. of Obs.	273	273	273	273

This table presents the results for pooled regressions of the use ode derivatives on firm risk. Panel A and Panel B show the regression results for all firms and derivative user, respectively. Variable definitions can be found in Table 2. Figures in parentheses denote t-statistics. ***:and ** denote Significance at the 1% and 5% levels, respectively.

TABLE 4. Derivative use and interest rate risk: cross-section results.

Variables	Interest Rate Risk Coefficient	Interest Rate Risk Coefficient
Intercept	–0.939	–0.970
	(–0.71)	(–0.74)
Derivative	–0.072	–0.580
	(0.91)	(–0.37)
Size	–0.019	–0.028
	(0.93)	(–0.12)
Leverage	0.673	0.769
	(0.49)	(0.76)
B/M	0.093	0.210
	(0.85)	(0.35)
Adjusted R^2	–0.02	–0.02
No. of Obs.	209	209

This table presents the results for pooled regressions of the use of derivatives on interest rate risk. Column 2 shows the regression results when Derivative is defined as the aggregate notional amount of all derivatives. Column 3 shows the regression results when Derivative is defined as the aggregate notional amount of interest rate derivatives. Figures in parentheses denote t-statistics.

TABLE 5. Derivative use and foreign exchange rate risk: cross-section results.

Variables	Foreign Exchange Rate Risk Coefficient	Foreign Exchange Rate Risk Coefficient
Intercept	0.020	0.012
	(0.10)	(0.06)
Derivative	0.017	0.023
	(0.52)	(0.70)
Size	0.018	0.020
	(0.51)	(0.55)
Leverage	–0.054	–0.053
	(–0.38)	(–0.38)
B/M	0.106	0.106
	(1.56)	(1.56)
Adjusted R^2	0.01	0.01
No. of Obs.	189	189

This table presents the results for pooled regressions of the use of derivatives on foreign exchange rate risk. Column 2 shows the regression results when Derivative is defined as the aggregate notional amount of all derivatives. Column 3 indicates the regression results when Derivative is defined as the aggregate notional amount of foreign exchange derivatives. Figures in parentheses denote t-statistics.

increase or reduce firm risk, derivatives reduce firm risk. For example, Guay(1999) finds that firm risk declines following the use of derivatives.

Coordinated risk management proposed by Schrand and Unal(1998) offers one plausible explanation for the results that derivatives increase firm risk. Schrand and Unal(1998) provide an explanation for hedging as a means of allocating rather than reducing risk. They classify risk into two types based on a firm's information advantage with respect to the source of risk. "Firms earn rents or economic profit for bearing risk related to activities in which the firm has a comparative information advantage (core-business risk). By contrast, firms earn zero economic rents in efficient markets for bearing financial risks such as unexpected changes in interest rates, foreign currency exchange rates, or commodity prices (homogeneous risk)." (Schrand and Unal(1998),p.980) They define "the approach of simultaneously increasing core-business risk and decreasing homogeneous risk to achieve or maintain a target total risk level as coordinated risk management." (Schrand and Unal(1998),p.980) Further, they provide evidence that thrifts increase credit risk and decrease interest rate risk.

3.4 Derivatives and Risk-Taking Activities

The form of risk management followed by Japanese non financial firms, which involves hedging homogeneous risk and taking core-business risk, may have resulted in the above-mentioned empirical results. In other words, the use of derivatives by Japanese nonfinancial firms increases firm risk because Japanese firms take core-business risk. In fact, the empirical results show that derivatives increase total risk and firm-specific risk. However, systematic risk, market risk, interest rate risk, and foreign exchange rate risk are not increased by the use of derivatives.

To explore whether Japanese firms hedge homogeneous risk and take core-business risk, this paper examines the relation between derivatives and risk-taking activities. In particular, we investigate the relation among stock options, derivatives, and R&D investment.

Rajgopal and Shevlin(2002) and Rogers(2002) investigate whether stock options affect managerial motives on hedging policy. The former observe a significant negative association between the extent of hedging and risk taking by stock options. In addition, the latter shows that there is a strong negative link between CEO risk-taking incentives and the amount of derivative holdings. However, if Japanese firms hedge homogeneous risk and take core-business risk, the association between derivatives and stock options may be positive and that between stock options and R&D investment may also be positive.

In order to test for coordinated risk management, we classify firms into two subsamples based on the introduction of stock options. Specifically, we define firms that introduce stock options, if the firm introduced stock options at the end of the fiscal year ending March 2000. We then hypothesize that there is a positive relation between derivatives and stock options and between stock options and R&D investment.

In Table 6, we present evidence for coordinated risk management. As previously defined, Derivative is the aggregate notional value of all reported derivatives contracts deflated by the sum of the book value of liabilities and the market value of equity. RD is defined as R&D expenditures divided by the market value of equity. Table 6 shows that there is a signifi-

TABLE 6. Derivative use and foreign exchange rate risk: cross-section results.

	Firms that introduce stock options		Firms that do not introduce stock options		Wilcoxon Z-statistics
	Mean	Median	Mean	Median	
Derivative	0.078	0.025	0.060	0.005	2.35**
RD	0.020	0.014	0.015	0.011	1.87*
No. of Obs.	72		359		

This table shows the mean, median and results of Wilcoxon's sign rank sum test. We classify firms into subsamples based on the introduction of stock options. We define firms that introduce stock options, if the firm introduced stock options at the end of the fiscal year ending March 2000. Derivative is the aggregate notional value of all reported derivatives contracts deflated by the sum of the book value of liabilities and the market value of equity. RD is measured as R&D expenditures divided by the market value of equity.
** and * indicate denote at the 5% and 10% levels, respectively.

cant difference between the medians of the two subsamples (based on the two-sided Wilcoxon's sign rank sum test for the median). Further, it shows that firms that introduce stock options use derivatives to a greater extent than firms that do not introduce stock options. The results are not consistent with previous researches that show a significant negative association between derivatives and stock options (Rajgopal and Shevlin(2002) and Rogers(2002)).

In addition, this table provides evidence that firms adopting stock options invest in R&D to a greater extent than firms that do not adopt stock options. This result is consistent with the previous literature that shows that stock options are used more often by R&D-intensive industries in Japan (Nagaoka(2005)).

These empirical results suggest that if a firm were introduce stock options, *–ceteris paribus–* one would expect to raise derivatives holdings from 0.5% to the sample median of 2.5%. Correspondingly, if a firm were introduce stock options, *–ceteris paribus–* one would expect to raise R&D expenditures from 1.1% to the sample median of 2.5% of market value of equity.

These results suggest that Japanese firms hedge homogeneous risk and take core-business risk. For this reason, the use of derivatives increases total risk and firm-specific risk.

4. Conclusions

This paper examines whether firms systematically reduce or increase their risk with derivatives. The empirical results show that the use of derivatives increases total risk and firm-specific risk. In contrast, derivatives do not affect systematic risk, market risk, interest rate risk, and foreign exchange rate risk. The empirical results suggesting that derivatives may increase firm risk are noteworthy because firms use derivatives to hedge.

Coordinated risk management proposed by Schrand and Unal(1998) provides one explanation for the results showing that derivatives increase firm risk. Schrand and Unal(1998) define the approach of simultaneously increasing core-business risk and decreasing homogeneous risk to achieve or maintain a target total risk level as coordinated risk management.

To explore whether Japanese firms hedge homogeneous risk and take core-business risk, this paper examines the relation between derivatives and risk-taking activities. In particular, it investigates the relation among stock options, derivatives, and R&D investment. The results show that firms that introduce stock options use derivatives and invest in R&D to a greater extent than firms that do not introduce stock options. These results suggest that Japanese firms hedge homogeneous risk and take core-business risk. For this reason, the use of derivatives increases total risk and firm-specific risk.

A further direction of this study will be to examine whether coordinate risk management increases firm value. However Allayannis and Weston(2001) and Adam and Fernando(2006) investigate the net effect of the use of derivatives on firm value, it is debatable whether coordinate risk management increases firm value. Firms taking core-business risk might increase cash flows. However taking core-

business risk might increase cost of capital at the same time, even if firms use derivatives to hedge homogeneous risk. In consequence it is not clear whether coordinate risk management results in an increase of firm value. Thus, this study provides focus for a new and potentially fruitful area of risk management research.

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